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BOX No.
FOLDER Proposed Biology Unit Program

PROPOSED BIOLOGY UNIT PROGRAM

HSHP:CAH

I. Statement of Purpose

During recent months, it has become more and more apparent that there is a real and pressing need for a clearly defined, active, organized and practical biology program in the Division. I mean by this not so much that there are obvious areas of work which need to be done, but that we have people and facilities which are not being fully utilized. You and I have discussed this matter between ourselves and with the Division Director and the Assistant Director for Operational Safety.

The first step toward the establishment of an active biology program is to determine and agree upon a statement of program aims or program purposes. This determination and agreement should not be limited to yours and mine but must include those of Mr. Batie and Mr. Horan. It is the purpose of this memo to convey my opinion of what the aims and purposes of our biology program should be and the work which should be done to accomplish those purposes. The following paragraphs contain the rationale and considerations which form the basis for my opinion.

II. General Considerations

In reviewing the various projects being done and those which have been proposed over the last year, it becomes obvious that those which are good (that is, have shown promise of being worthwhile from the standpoint of ID operations and the AEC in general) are those directly connected with the environmental safety aspects of reactor operation. I refer specifically to the low-level liquid waste algae study, the farm-census-survey, and the CERT program. It is interesting to note that each of these three will have their major impact outside the area of biology. Considering the prime responsibility of ID, this is as it should be. It is obvious that one approach toward the full utilization of the biology unit would be to work specifically on environmental safety problems.

Basic radiobiology is being researched heavily around the world by people

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eminently more qualified and equipped for basic research than any we currently have on the staff. By basic radiobiology I mean biophysics, cytology, biochemistry, genetics, etc. If such work is to be done in the division, a sweeping change of personnel and probably a reorganization would be necessary.

Another realm of biologically-oriented research is in Ecology. Although the biology unit was originally designed to pursue such studies, to do so under the current charters of ID and the Health and Safety Division is difficult to justify and finance. A better approach, which is currently being implemented, is to get such studies done under DBM grants to Universities.

The above does not consider all possible alternatives, of course, but should serve to illustrate where we currently stand in relation to the overall field of radiobiology. It is my firm conviction that of the choices open to us, research associated with environmental reactor safety would prove to be the most fruitful, and would be most compatible with the Division's responsibilities.

III. Specific Considerations

If it is agreed that the environmental reactor safety approach is the best one, the next step is to review our current capabilities and potentials in producing worthwhile work.

A. Personnel - The following listing shows Biology Unit personnel and their general backgrounds:

D. Adams - B. S. (Agronomy) U. of Idaho, 1953. One year agronomist and office manager for fertilizer company. Site Survey Inspector 1956 - 1959. 1959 to present as Ecologist. Experienced in plant growth techniques, autoradiography, soil analysis, plant nutritional studies, soil microbiology.

J. Detmer - B. S. (Business Pre-Law) Idaho State University, 1957. Ecologist, Ecology Branch 1957 to present. Experience in Ecology, animal husbandry, accounting, budgeting.

J. Echo - B. S., M. S. (Wildlife Management) Montana State College, 1952 & 1954. Biologist, State of Montana, 1954-1955. Electronics Technician, PPCO, 1955-1959. Experienced in botany, microscopy, electronic and mechanical instrument design, taxonomy, ecology.

R. McBride - B. S. (Wildlife Management) Utah State College, 1939. Predatory animal control, range management & examination, B. L. M. Joined Ecology Branch as Ecologist in 1954. Branch actually formed in 1955. Experienced in range management, botany, taxonomy, ecology, predatory animal control.

M. Tiernan - B. A. (Zoology) Adelphi College, 1961. M. S. (Zoology) U. of Wyoming (Research Fellowship), 1962. 1962-1963 Technical Intern, U.S.A.E.C. Ecology Branch 1963, to present. Experienced in microscopy, histology, statistical analysis.

B. Facilities

Facilities for our use in CF-690 include:

Room 150 - Plant Growth & soil labs
Room 143 - Microscopy Laboratory
Room 149 - General laboratory
Room 148 - General laboratory
Room 147 - Animal room
Room 146 - Animal room

C. Manpower

The work of the biology unit can be generally categorized into two classes; research and routine. The routine work, which consists of such things as predatory animal and noxious weed control administration, evaluation of routine monitoring data, and the collection of biological monitoring samples, uses roughly one-fifth of the available manpower. This, of course, varies with the seasons. Thus, of the five man years per year available from the current staff, four man years per year can be devoted to research activities. (The five man years per year figure assumes that the Section Chief will use his time in administration, literature review, technical writing and editing, etc., and will do no "bench type" research).

IV. Proposed Research Program

This section is incomplete inasmuch as it is based on the assumption that a significant effort by the biology unit will be necessary in the forthcoming inhalation studies which are to be directed by Dr. Voelz. At this date, the inhalation studies are being discussed and formulated, so an accurate estimate of manpower requirement is not possible. It is

assumed that one man year per year will be required for the inhalation study, and that the study will continue for a minimum of three years. Considering this and the information in parapraph III, C., above, the program proposal herein contained is predicated on the basis that three man years per year should be utilized. The three man years, I believe, will split about even between CERT and this proposed program.

Our most significant contribution to environmental reactor safety has been the CERT program. In discussions with DBM personnel, I have been led to believe that proposals for continuation and expansion of this type of work would be welcomed. As you know, the CERT program is basically an "engineering" type of research which is designed to yield working numbers. A review of the literature shows that various relationships measured during CERT tests show wide variations. A discussion of some of these variations and uncertainties, prepared by R. P. Bird, is attached. It is toward the examination of the whys and wherefors of these variations that this program proposal is directed.

One point should be made very clear. The following descriptions of experiments are written around the examination of radioiodine, but the proposed program is not limited to the study of radioiodine alone. The experiments using radioiodine will illustrate the direction of the proposed research. The isotope being investigated will dictate experiment design, and it is beyond the scope of this proposal to convey all the detailed experimental considerations for the entire length of the program. Indeed, each will require a thorough literature search before such experiments can be designed.

In general, the purpose of the proposed program is to utilize our manpower and facilities in laboratory experiments which will explain and elucidate isotopic behavior patterns in the environment as they are defined by actual field releases. We have noted some of these behaviorial characteristics in the first two CERT releases, and the literature, and have written experiments to examine them.

You will note that the proposal assumes that CERT-type investigations will continue. As we have discussed, the best approach toward planning future releases would be to assign isotope hazard priorities and use these priorities to direct the CERT course of action. I tentatively propose the following list of hazard priorities.

1. I-131
2. Cs-137
3. Sr-90
4. Mixed Fission Products
5. Pu-239
6. Ce-144
7. Ru-106

One of the expected results of the development of our laboratory abilities

is that, if all goes well, we can then meaningfully examine some of the ornery ones such as Pu-239 in the laboratory without actually releasing relatively large quantities in the field.

For lack of a better name, I have dubbed the subject research proposal as Controlled Environmental Radionuclide Tests - Laboratory Experiments (CERTLE).

V. Programmatic Details

As a starting point, examinations of radioiodine deposition and translocation phenomena have been chosen. Future experiments should generally follow these same lines. Modifications based on experience and the nature of the contaminant will be necessary.

A. Deposition Phenomena

Objective - The objective of this experiment will be to determine, under conditions of turbulent flow, why deposition varies with the state of the iodine-131 in the depositing cloud.

Purpose - The purpose of the experiment will be to investigate the mechanisms associated with particle deposition on pasture grass in order to more fully understand differences measured after release of iodine-131 in the CERT field tests.

Problem - Clouds of gases escaping from reactor accidents usually contain radioiodine. This radionuclide occurs mainly in three forms; molecular, nucleated (ionic), and complexed (organic). (1.2.3.) Field measurements of the deposition velocities of these three states of radioiodine indicate variations of a complicated nature, largly unexplained. Controlled laboratory investigation of these phenomena leading to the elucidation of their mechanisms would permit considerably more confidence in predicting the behavior of effluent reactor gases.

Description of Preliminary Experiments - These experiments will be done in a closed environmental chamber, see Sketch I. (4) This chamber will be two by three by approximately five feet and probably be made of plexiglass. One end will be the inlet port and the other the outlet. Provision will be made for access to grass samples in flats or growth boxes which can be changed at will. The geometry of the chamber samples, air flow, temperature, and humidity will be held as close as possible to the same values for all tests in this series. Gasses entering the chamber from the inlet side will first strike a tumble board which will initiate turbulence. This will be maintained by baffle boards hanging over the sample from the top. Exhaust from the chamber will be by High Volume Air Samplers, as

many as needed to support turbulence. Through-put will be directly readable from the flow-rate meter on the back of the exhaust sampler. Further control of reproductability will be by hot wire anemoter within the chamber. Standard filters will be used on the exhaust sampler to remove contaminants from the air stream. Any type of scrubber, impactor, or classifier can be added at this point to embellish the data from subsequent tests if needed. Other modifications will be suggested under specific test descriptions.

1. Molecular State - Principle modifications of this test will be in the headend hardware. Generation of molecular iodine-131 will be attempted by the Analysis Branch personnel. Induction of the gas will be from the generator through a short columator directly into the chamber. Initiation of the test will be electronic. See control sketch II. As soon as sufficient gas has passed through the cell, as determined by preliminary counting, the test will be terminated and the chamber isolated electronically. All further test termination will be by time clock therby eliminating as much as possible slight differences in operation. Several replicates of this test are planned such that the data deviation will be reduced as much as feasible.

   Grass samples for the test will be in three age groups; growing, mature, and dead. These will be clipped to a uniform standard height for each group. The top of the clipped grass will be the same distance from the baffle boards in all cases. In this way, differences due to age and the concommittant surface texture can be ascertained at the same time.

2. Nucleated State - In this test considerable head-end modification will be necessary to produce nucleated particles for deposition on the grass. Molecular iodine-131 will be generated in much the same fashion as before. Dust will be produced in a fluidyer type generator. These will be led through a concentric induction manifold into a centrifugal mixer and baffle box where nucleation will take place. Induction will then proceed through the columator and the chamber exactly as before. See nucleator sketch III. Deposition tests will duplicate the tests for molecular state iodine. Dry runs with the dust generator, which feeds dust particles into the nucleator, will be made before actual testing. It is anticipated that filter loading will occur fairly rapidly. This may require an additional filter and sampler modification of the final exhaust system. However, through-put will be maintained as near as possible to the other tests.

microscopic examination of the nucleated particles will be made with the use of autoradiography to determine if proper nucleation is being done prior to deposition tests. Particle size control will be maintained by the type of dust loading in the dust generators. For this test, particle sizes, although mixed, will be held as constant as possible to eliminate the variable. Subsequent tests will explore variations due to particle size, and the related impaction, sublimation, and absorption phenomena.

3. Complexed State - Head-end modification for this test will be mainly in the generators. Such complexed and chelated forms as methyl iodide produced in nuclear reactors, and generatable by the Analysis Branch, will be fed into the chamber and deposition tests made. No difficulties are anticipated with the series of tests. Operation will be very similar to the molecular state testing. Heavy contamination of the filter will probably occur, with a consequent low deposition on the grass. Constant experimental conditions will be maintained for comparison of the data. If any enlightening or complimentary tests are indicated throughout the series, modifications will be made to include these to augment the preliminary data before these are analyzed. Subsequent experimentation will necessarily be determined by the critique and evaluation of these preliminary tests.

Discussion - These experiments involving the deposition of iodine-131 onto pasture grass in a closed environmental chamber in the laboratory, should point up some of the mechanisms of deposition phenomena indicated by the field measurements made during the CERT test series. If there is, in fact, a real difference due to the age of the grass and the state of the contaminating iodine-131 particle, these should be indicated, at least in magnitude, by the test outlined. If these differences are of a magnitude or nature that would warrant further inquiry, then a more exotic experiment can be planned. In any case, real numbers will be generated which can be used with further field releases and accidental depositions of all kinds. Subsequent testing will be concerned with the microscopic site of actual deposition.

In the molecular state case, the particle will be chemically very active, perhaps modifying its condition while in transit. Sublimation following initial deposition is indicated. The relationships between the particle size and the texture of the grass, minute hairs, ridges, waxy covering, and the like, may play a decisive role in the secondary deposition. Absorption may only occur when conditions permit close proximity of the

particle to the plant cell wall. Impact velocity would conceivably vary this rate. Temperature, humidity, and the electro-chemical state of the cell wall are other variables likely to contribute differences. In the nucleated state case, secondary transition is less likely to occur, particularly when the iodine is chemically associated with the nucleating particle. Conditions of adsorption onto impermeable nuclei may cause sublimation, should electrostatic repulsion occur during deposition. Washoff by re-entrainment with the air stream is possible from lightly held particles. It is clear that the material of the nuclei as well as the particle size will contribute to the variation, and these being extremely diverse in nature, will pose a very difficult parameter to assess.

The complexed state of radioiodine may very well be the most likely case from a reactor incident. Its chemical and electrostatic condition is more generally stable than the other states, which will probably cause less deposition on the grass. Re-entrainment is more likely in situations of low impact velocity and/or lightly held sites on plant hairs. Modification, absorption, adsorption, and evaporation are likely to occur only in conditions of dissolution. Sublimation, depending of course on the chelation, is less likely to occur.

Methods - All of the CERTLE experimentation will be done in the laboratory. Deposition experiments will attempt to measure the resultant effects from the variables, iodine state and grass age, upon the rate and stability of radioiodine deposition on pasture grass. Data from these tests is intended to amplify and augment actual measurements taken under field conditions in the CERT tests, In this way it is hoped a better understading will be gained into the casual mechanisms underlying the differences observed in the field.

Basic measurements to be made in the preliminary tests will be in closed environmental exposure chambers, about two by three by five feet. These chambers during the test will contain an atmosphere contaminated with iodine-131. At all times the chamber will operate at a slight negative pressure so that any leakage will be inward rather than out. Sample gases will be inducted into the chamber by suction from high volume air samplers. These machines have a provision for adequate filtration on the inlet side which should remove all the contaminants at the outlet site on the chamber. It is possible however to load the

filter or to develop channels that would allow small amounts to pass through. For this reason tests will be performed in an adequately ventilated room such as the plant growth room or in laboratory hoods. In any case, bypass exhaust gases will be contained and vented through exhaust plenums to the stacks on the roof where mixing and dilution will prevent any hazard, even if leakage should occur.

The grass samples will be exposed to the contaminating gases or particles for a fixed and reproducable length of time, once this value has been determined by experimentation. Electronic circuitry will control the exposure in the following manner. Switch closure will energize the entire circuit. With the respect to the nucleated particles, which is the most difficult to control, this will start the two exhaust fans (see control sketch II), place the bypass vent in the vent position, start the centrifugal mixer and baffle box, and open the compressed air solenoid valve on the dust generator starting dust flow. A five second delay relay will start the iodine generator. Dust and iodine generation will then flow for 15 seconds through the vent system at a scavanging volume very similar to that of the sampling system. By this time equilibrium generation rates should be set up. A twenty second delay relay, energized at the start, will then flip the bypass vent from vent to sample and contaminated mixture will flow through the exposure chamber. After a preset length of time has elapsed, the time clock will terminate the exposure and isolate the chamber. Scavanging of the chamber will be accomplished by a lock-in relay on the exhaust fan if it is found that this is necessary or desirable. The studies of molecular and complexed forms will use generally the same system.

Grass will be grown in greenhouse flats and will be clipped to a standard height twenty-four hours before this test. This will vary, of course, with the age of the grass and general growth form. Clipping will insure a uniform shear surface at the bottom of the zone of flowage. Initial turbulence of the cloud will be started by a tumble board at the inlet end and maintained by baffle boards hanging from overhead. The rate of flow necessary to form a turbulent system will be determined by preliminary testing before the experiment. This rate will then be held as uniform as possible throughout the test series. Following exposure the grass will be given a set-up period of about one-half hour vefore sampling. Grass sampling will be machine clip with a set-height jig about two inches above the soil. All grass will be taken. These will then be bagged,

weighed and counted in a well type gamma counter previously calibrated for iodine-131.

Uniformity of samples will be maximized by assuring that all samples in the same age class have the same growth form volume, approximately the same growth density, and are grown in equilibrated humidity conditions. Duplicate numbers of necessary samples flats will be grown in the plant growth room. Four replicates will be run on each test and it is thought that this will be sufficient to provide significant results at the ninety-five percent confidence level. Should this prove insufficient, additional samples will be available for testing to this level of confidence.

Dust generation for the nucleated state series will have particle size control by providing known size particles in the generators. It is anticipated that these particles will be in the five to fifty micron size. Adequate nucleation will be determined by impaction of samples on microscope slides, autoradiographing, and examination by microscope. It may be necessary to modify this technique to surmount unforseen difficulties, but essentially that will be the method of assessment. The molecular state and complexed state particle generation will not present these problems.

The possibility exists of investigating the site of deposition on the grass integument. This surface may be quite different with different age and type grass. Minute hairs and waxy coatings will prevent particles coming into intimate contact with the living cells of the grass. Stable nucleated and complexed particles will probably not be affected by deposition site variations but the very active molecular state particles may be sensitive to electro-static boundary conditions and have intrinsic instabilities which might cause dramatic differences in behavior with varying site conditions. Microscopic and autoradiographic techniques as well as any other available scheme will be used to assess these causal factors.

Data from this experimental design should allow direct correlations to be drawn between the nine variables of the test. Following data analysis a report will be submitted for evaluation and critique. These evaluations will then be available for consideration of further testing along these lines and to refine judgements of feasibility of research into causal mechanisms.

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Equipment - It is anticipated that all the equipment needed for the preliminary tests can be made at the laboratory. The environmental exposure chamber is a fairly simple device. Equipment of a more sophisticated nature is not warranted for these simple counting type measurements even though the accuracy of the measurement is quite high. Dist generators will have to be made and tested until dust production is adequate for the job. It will probably be one of the fluidizer types. No difficulty is foreseen at this time. Mixing and scavanging as well as the electronic circuitry is straightforward and should present no problem. Major difficulties will probably be in the particle size control, nucleation assessment, and deposition site behavioristics. Since these are experimental parameters by definition, the design of the experiment is such that they will be minimized where ever possible. No additions to the existing laboratory equipment for microscopic and radiographic work are anticipated. Equipment design and laboratory allotment for major equipment will be found under equipment writeups.

References:

1. J. Z. Holland; Physical Origin and Dispersion of Radioiodine, Table 6; Health Physics, Vol.9, pp 1095-1103, Dec. 1963.

2. A. E. J. Eggleton, etal; Chemical and Physical Nature of Fallout I-131 and Carrier-free I-131 Released in Air; Health Physics, Vol. 9, pp 1111, Dec. 1963.

3. R. W. Perkins; Physical and Chemical Forms of I-131 in Fallout; Health Physics Vol. 9, pp 1113-1122.

4. P. J. Barry and A. C. Chamberlain; Deposition of Iodine Onto Plant Leaves from Air; Health Physics Vol. 9, pp 1149-1157.

5. P. J. Barry; Health Physics 4, pp 305 (1961)

I^{131} generators

6. R. F. Taylor; Chem. Engng. Sci. 10, pp 68 (1958)

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B. Translocation Phenomena

Some work on iodine sorption by plants has already been done, especially at Hanford. Generally, except for barley, all of this work has been with broad-leafed plants and none has been with grasses per se. Since grasses are a special and rather structually complex group of plants it would not be surprising if iodine behavior in grass does not follow the pattern established for the broad-leafed species. The work revealed the following general pattern of iodine behavior. It is readily absorbed by the roots. 25 to 50% of the absorbed iodine is transported to the leaves. Once it reaches the leaves however there is little subsequent movement to other areas. There was quite a variation in uptake among the species tested. Iodine concentration is related to the age of the tissue, with the oldest tissues having the highest concentrations. Translocation of iodine after foliar application, whether in gaseous or liquid form, is minimal, usually less than 5%. From gaseous application about half the activity associated with the leaf was in the mesophgll, the remainder was presumably on the outside. This then would be the expected results of iodine behavior in grasses as judged from work on other species.

The experiments as presented may have to be modified as results are collected. The details of some of the experiments may appear sketchy but this is because only trial and error will produce the best and final methods.

The experiments on translocation and transpiration are intended to explain the variations between measured half-lifes of iodine-131 on grass. An accurate determination of this parameter is of particular importance in accurately assessing iodine-131 hazard in an area. Half-life may depend on a physiological function of the plant or on physical factors or on a combination of both so it will probably vary with time of year. By manipulating experimental conditions a half-life figure for various times of the year may be obtained. The ultimate objective of these studies is to generate a reasonably dependable set of numbers which can be used to predict the half-life of iodine-131 on grass.

Experiment I

Project Title: A study of the Translocation of Iodine-131 in grass through foliar application.

Objective: To determine if iodine-131 is translocated through grass leaves after foliar application.

Materials & Methods: For this experiment, grass will be grown in pots in the plant growth room and conditions of temperature, humidity, soil moisture,

and light will be strictly controlled. The iodine-131 will be applied to various points along the leaves as droplets, sprays, etc. Determinations will then be made, using radioautographs, to ascertain if the iodine has been translocated, and if so, how fast and in what direction. Following these preliminary experiments on iodine translocation, quantitative investigations of iodine movement will be made. Such quantitative measurements can be made using either a microscintillation or a microdissection technique.

Discussion: Selders and Hungate (1) report that generally there is less than 5% translocation of iodine in broad leafed plants. There is however, little information in the literature on iodine-131 movement in other types of plants, especially grasses. Grasses have a complex leaf structure, (2) in comparison to other plant types thus iodine movement in grasses may be considerably different than that reported for the broad-leafed species. Resolution of the question of iodine translocation is one of the fundamental objective of the CERTLE experiments.

Experiment II A study of the removal of radioiodine from grass by washing.

Objective: To determine if, and how much, radioiodine can be removed by washing vegetation after foliar contamination.

Methods & Materials Grass will be grown in pots in the plant growth room under controlled light, temperature, humidity and soil moisture. Radioiodines will be applied to the grass at different stages of development in an environmental chamber. (See paragraph V, A, above). Washing experiments will be made to determine if age of the plant has any effect on its ability to hold the radioiodine, if time the plant has been exposed to the radioiodine has an effect, and if different pasture grasses vary in their ability to hold radioiodine. Water will be the principle washing material. Some experimentation will be done with weak acids and organics.

Discussion: Analysis Branch reported approximately 40% removal of CERT II grass of I-131 in four washings with water. Fifty percent removal was obtained with chloroform. It was noted that during

1. Selders, A. A. and F. P. Hungate, the Foliar Sorption of Iodine by plants, Hanford report HW-44890, 1956.

2. Eames, A. J. and L. H. Mac Donald, An Introduction to Plant Anatomy, McGraw & Hill, New York, 1947, p. 335

his washing considerable green material was removed from the plant. One would think that the green material would represent some sort of plant damage, (cells, chlorphyll, parts of plants), If this is true the 40-50% removal by washing may not have been iodine from the outer surface of the plant but some absorbed iodine. To resolve this question a more gentle system of washing will have to be developed so as not to damage the plant.

Experiment III.

Project title: A study of Transpiration of iodine from grasses.

Objective: To determine if iodine-131 is absorbed from the substrate and if so, if it is translocated and subsequently transpired by the leaves.

Materials & Methods: In this experiment iodine-131 will be introduced with the irrigation water to the roots of potted grasses. Periodic checks will be made to determine if the iodine has been absorbed by the roots and if it has been translocated to the leaves. These determinations can be made with either autoradiographs or microscillintation counting techniques. Quantitative measutements may also be made by measuring the concentration of iodine-131 in dried plant tissue. If iodine-131 is indeed absorbed and translocated, a second experiment will be carried out to determine if the iodine is being tranpired. This determination will require an environmental chamber. If iodine is being transpired quantitative measurements will be made to measure rates, changes, etc. Measurement of iodine transpiration will be made with the soil covered and uncovered. In this manner, it can be determined if, and to what extent, soil evaporation is contributing iodine to the amount attributed to transpiration. In this experiment conditions of light, temperature, humidity, soil moisture and ph will be strictly controlled.

Discussions: Selders and Redixke (1) indicate that iodine is readily absorbed by bean, barley, Russian thistle, and tomato plants. There was however, quite a variation in results, indicating that plant type greatly influences uptake. Grasses should be investigated to determine their ability to absorb iodine from the substrate.

In the event of a great deal of rain, after an iodine release, the results may be quite different from dry post-release conditions because of additional iodine made available to the plant through seepage of contaminated rain water.

1. Selders, A. A., and J. H. Rediske, The Uptake of Iodine by Higher Plants, Hanford Report HW-33681, 1954

Although in Selder's work I-131 was readily absorbed by the roots, it was not readily translocated. The leaves of the plants studied contained less iodine-131 than the roots. It remains to be determined if iodine is readily transpired. A one shot experiment in our laboratory indicated that it is. An explanation of a half-life on the grass shorter than one explained by physical decay may not depend on a physiological function of the plant but rather on other conditions. This question, to our knowledge, has not been answered.

Experiment IV

Project Title: A study of the Transpiration of iodine-131 from grass contaminated with gaseous iodine.

Objective: To determine the rate of iodine transpiration under condition of contamination similar to those of the CERT tests.

Materials & Supplies: In this experiment, the grass will be placed inside an environmental chamber for contamination with gaseous I-131. Immediately after the contamination with iodine, the soil between the rows of grass will be covered to prevent evaporation and/or movement of iodine from the soil. Measurements of iodine-131 transpiration will then be made.

Discussion: A comparison with the results obtained from Experiment III should give an indication as to whether or not transpiration is the cause, in whole or in part, of the 5.5 day half-life found in the last CERT test.

Other factors such as sullimation, evaporation, etc., from the grass leaf blade, will also have to be investigated.

This phenomena may be contributing activity to that attributed to transpiration. It is possible to assess the influence of these factors by conducting the experiment in conditions approximating night and day. Grass grown under day conditions should transpire freely, that grown under night conditions should not transpire at all. If iodine is collected from the grass grown in the dark it would be evident that other factors besides transpiration are causing the plants to lose iodine. These factors may be sublimation, evaporation, etc. from leaf surfaces. The difference in the amount of iodine collected from grass grown under two conditions would be due solely to transpiration.

C. TIME REQUIREMENTS

The total time estimated for the various CERTLE investigations is five years, or fifteen man years. This of course includes many more projects than deposition phenomena and translocation of I-131 and will have to be adjusted as time goes on.

It is estimated that the nine by four replicated deposition tests will take one experimenter one year following construction of the equipment. This includes preliminary tests for equipment calibration and nucleation control but does not include deposition size investigation. The actual investigation will take another man-year. Due to the obscure nature of the unknown in this phase of the investigation time estimates would carry little confidence. However, by the time these investigations become feasible a much better understanding of particle size phenomena, chemical reaction to plant cell proximity, and intrinsic behavior of radioiodines particles will be available for planning purposes.

The investigation of translocation phenomena should require about 2 man years following check out of necessary equipment.

D. Cost Requirements (First two years)

The estimated cost figures listed below pertain exclusively to CERTLE, with the exception of the dust (particle) generating equipment which can also be used in the inhalation studies. For the purposes of this proposal, I have listed the entire estimated cost of the generating equipment.

1.

Microscintillator	$1500
Transpiration traps	2500
Washing apparatus	500
Microtechnique equipment	1500
Expendables (iodine, etc.)	1000
Particle generator equipment	2500
Design & construction of environ chambers	3000
	$12,500

2. Manpower Costs:

As is stated above, three man-years per year will be used on CERT and on CERTLE. This means that one and a half-man-years per year will be exclsuively CERTLE. The average annual salary of unit personnel is $8,800, this amounts to 13,200 dollars per year. The first two years' salaries, is applied to this project, equals $26,400.

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3. Publication Costs - $1,000

4. Total costs, equipment plus salaries, equals about $40,000. It should be remembered that this means an increase over current costs of only the equipment cost of $12,500.

It is not anticipated that our demands on Analysis Branch will increase to such an extent that cost estimates from them would be necessary. The $3,000 quoted above for environmental chamber design and construction includes about two-man months of the time (salary) for the Instrument Branch personnel.

4. Extra logistics -

a. It is estimated that twelve flats can be grown at one time in each of the plant growth rooms, CF-649 and CF-690, twenty-four in all.
b. Average growth rate indicates that grass will be in the usable new growth condition after a minimum of six weeks, starting with warm soil. A mature state will be reached in ten weeks, and at least sixteen weeks will be needed to push the grass to old dry conditions.
c. The minimum size grass flat will need to be 24 inches by 36 inches, one per test. Minimum number of flats looks like about 80; 40 for Echo and 40 for Adams and Tiernan.
d. Flats for the grass will have to be built. Also a considerable amount of greenhouse soil will have to be made up. A small cement mixer would be ideal. Seeds planted in warm soil will germinate about a week sooner than in cold soil.
e. Environmental chambers would better be set up in one of the animal rooms than in the plant growth room because that will be needed for growing grass. Off-grass could easily be vented to the vent system in these rooms. A preparation room adjacent to the experimental room would be handy. Two chambers could be operated simultaneously in one of the animal rooms. These rooms are 12 feet wide and 18 feet long and have exclusive air exhausts for contamination control. The room of preference is 147.

VI. Conclusions

I have concluded that the research program, as described in this memo, represents our best course of action. I believe that the personnel currently aboard can handle it adequately and at the

professional level.

VII. Recommended Action

The following actions are now indicated:

a. This memo be read by you, Mr. Batie and Mr. Horan;
b. The content be discussed in a meeting between the four of us;
c. The biology program aims be agreed upon before any further action is taken.

HSHP
CAHawley:dc
11-24-64

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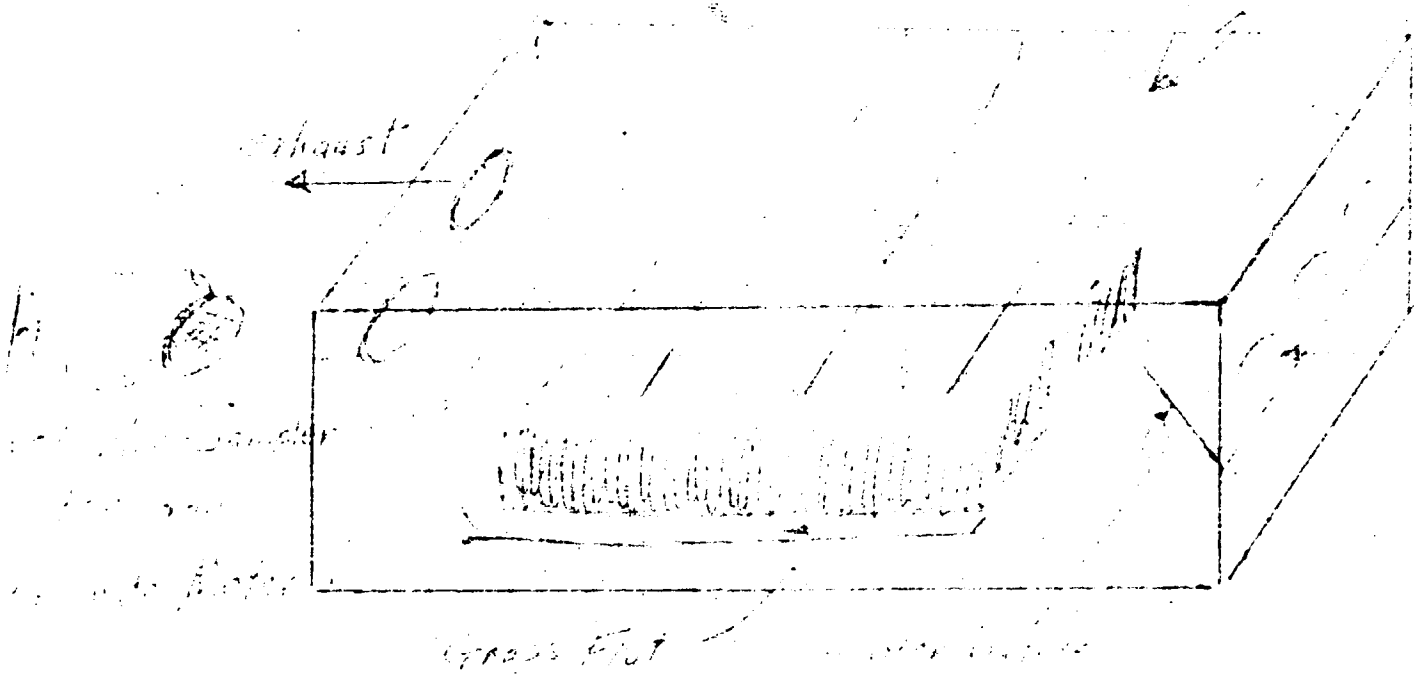

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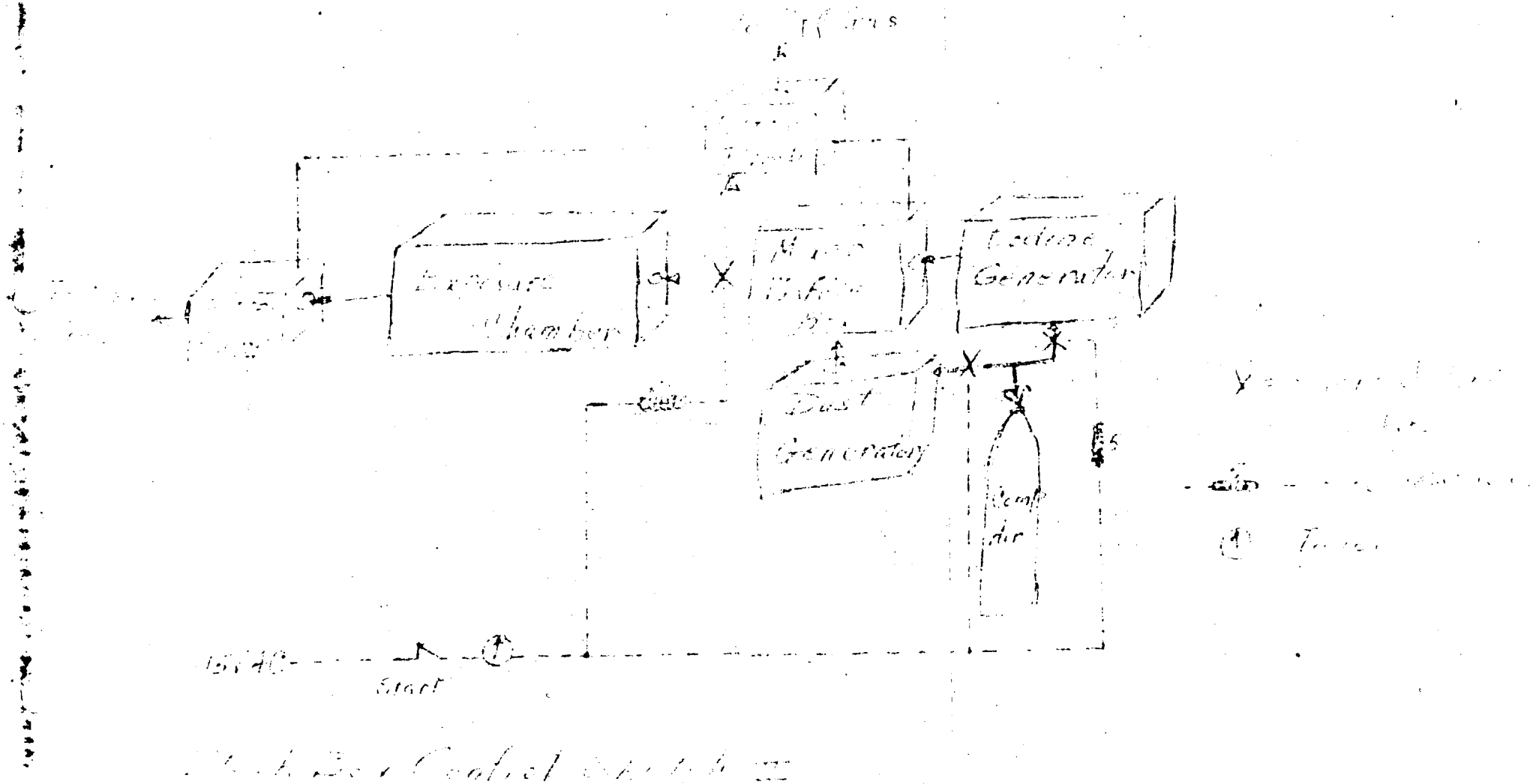

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