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PLANS AND HAZARDS ANALYSIS FOR THE FIRST HANFORD I^{131} FIELD RELEASE TEST

C. C. Gamertsfelder

Physics and Instruments Laboratory
HANFORD LABORATORIES

July 19, 1963

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PLANS AND HAZARDS ANALYSIS FOR THE FIRST HANFORD I^{131} FIELD RELEASE TEST

INTRODUCTION

The determination of the dispersion and subsequent behavior of I^{131} released to the atmosphere is important in the determination of the possible hazards which can exist as the result of releases of significant quantities of iodine from atmospheric bomb testing or from accidental releases from nuclear establishments.

Hanford Laboratories has long been involved in investigation of I^{131} as part of the Environmental Monitoring, Biological and Chemical Laboratory investigations. This planned experiment is a cooperative endeavor utilizing personnel from Radioecology, Atmospheric Physics, Radiological Chemistry, Chemical Effluents Technology, Environmental Studies and Evaluation, and Radiation Monitoring. Experiment will be conducted on the atmospheric diffusion grid operated by Atmospheric Physics personnel. The data obtained from this experiment with carefully selected meteorological conditions should provide increased understanding of the details of the interactions involved that cannot be separated in observations made during the varying conditions encountered when fallout or nuclear plant produced iodine is present in the atmosphere.

The following sections give plans for the experiment and estimates of the expected results. The appendix contains the makeup of the Test Organization and Operational Procedure.

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EXPERIMENT DESCRIPTION

Experimental Grid

The Hanford Stable Grid is located near the Meteorology Tower near the 200-West Area. Samplers are located along arcs 200, 800, 1600, 3200, and 12800 meters distant from the source release point. The four innermost arcs are each equipped with five towers to enable the vertical distribution to be measured also.

The experiment will be conducted during moderately stable night-time conditions with surface wind speeds in the range from 0.5 to 3 meters/sec. The vertical temperature difference between 200 and 3 feet (T_{200}-T_3) being in the range from +1.5°F to +10.0°F.

Source

Two 150 mc sources have been ordered from Oak Ridge for delivery at Hanford on July 22. Each source will consist of 10-15 mg of elemental iodine sealed in a two-inch long glass ampoule 8 mm outside diameter.

A direct calibration will be performed with a low-geometry gamma counter which has been calibrated for I^{131}. Accuracy expected is conservatively ±5 percent. After calibration each source ampoule will be loaded into the release fixture and shield.

The release fixture consists of two 1/4-inch stainless steel ball valves joined by a short length of 9/16-inch thin-wall stainless steel tubing. A nipple for an air supply and an outlet nipple are provided. The release fixture is mounted in a lead shield consisting of two 2" x 4" x 8" lead bricks milled out to receive the ball-valve assembly.

The shield will be placed in a plastic bag and mounted at a suitable elevation with the outlet nipple pointing downwind. An air hose will be

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connected to the inlet nipple. (Air or helium will be used to sublime the iodine.) The gas to be used will be passed through a rotameter and membrane filter before entering the ball-valve assembly. On signal to start the release, the ball valves will be opened and the release gas adjusted to the proper flow. The 9/16" thin wall tube will be compressed with the 1/2" bolt and pressure foot to crush the ampoule. The release will proceed until the iodine is exhausted from the tube. During release the source will be monitored by a recording count rate meter which is fed by a GM tube located in the source shield.

Any residual iodine will be washed from the assembly and an aliquot of the washings assayed for I^{131}.

The second source will be standby in case additional iodine-131 is needed due to delay or other causes. If not used in the test, it will be used as a cross check of the calibration.

Air Sampling

Special air samplers each consisting of a membrane filter backed up by a four-inch thick bed of silver plated copper turnings, a charcoal impregnated filter paper and a 1.5-inch bed of activated charcoal will be operated at 608 locations in the sampling grid. This sampler design provides the capability to identify the fractions of I^{131} associated with particulate, elemental iodine and other possible chemical forms which might be formed after release from the source. A few other air samplers will be operated in the field after the experiment to detect any release of iodine from contaminated soil and vegetation.

Vegetation and Soil Sampling

Seven vegetation plots measuring 5 by 20 feet have been placed end to end along the 200-meter arc of the field grid. Each plot is planted with rye and a pasture mixture of various grasses. This arrangement of vegetative cover is designed to simulate an irrigated farming area. Because the plume width will be narrow at this distance and because of limited sample counting facilities only three plots of the seven will be used for sampling and analysis.

The sampling program is designed to provide data on (a) the biological decay rate of atmospheric I^{131} deposited on standing plant material, (b) the degree of stratification of deposited I^{131} throughout the vegetative layer, (c) the effect of plant stature (low vs. tall) on deposition, and (d) the deposition on wet and dry soil. Plant morphology, different plant species and artificial plants will be used to determine if various materials have similar or different affinities for atmospheric I^{131}.

Three uniformly contaminated plots will be selected for sampling immediately following release. Five samples will be taken from each plot on the dates shown in the table. Green plant materials will be placed in 500 ml plastic containers and stored in a refrigerator until they can be counted.

Sampling Dates (post shot)	Type of Sample	Number of Samples
1, 2, 3, 4, 5, 8 12, 16, 20, 24	Total rye plant to study biological decay.	150
1, 4	Rye plants cut at 5 different heights to determine stratification of deposited I^{131}.	150
1, 2, 4, 8	Harvest low growing plants (plant stature)	60
1, 4, 8	Soil samples (wet and dry)	50

Sampling Dates (post shot)	Type of Sample	Number of Samples
1, 4, 8	Deposition on sage brush vs. plant canopy area.	45
1, 2, 4, 8, 16	Cheat grass upwind, downwind.	75
1	Geranium (morphology)	30
1, 8	Samples to determine total deposition on vegetable and soil.	10
1	Effectiveness of various washing solution to remove I^{131} from leaves.	50
	Total	620

In addition to these special plots at the 200 meter arc other vegetation such as cheat grass and sage brush and soil samples will be obtained at various locations near air samplers for determining deposition velocity at various other distances.

There will also be an attempt to measure vegetation contamination at the plant boundaries and while calculations indicate this might be possible the presence of other I^{131} from normal plant emissions could easily obscure the experimental plume deposits at such distances.

Animal Exposures

The experimental vegetation plots are too small to allow for measurements of uptake in grazing animals but there will be a measure of thyroid uptake due to inhalation in three experimental dogs which will be placed on the 200 meter arc.

EXPECTED RESULTS

Air Concentrations

Detailed predictions of the finer structure of the expected distribution cannot, of course, be made at this time. Observations of atmospheric behavior

such as the extent of the inversion, wind fluctuations in speed and direction will be made continuously both before and during the actual release. When the release is completed these data will be used to predict in detail the shape and magnitude of the expected distribution and will be used in programming the order of pickup of the various samples to minimize chances of cross contamination of samples.

Using experience obtained from previous test runs made with releases of fluorescent pigments during similar weather conditions the isopleths of expected exposures within the experimental grid have been estimated and are given in Figure I. The estimates of exposure are given in units of millicurie seconds per m^3. The major portion of the iodine, about 80%, should be collected on the silver plated copper. The remainder is expected to be largely on the charcoal with only minimal amounts associated with particulates in the membrane filter.

Vegetation and Soil

Separate isopleths for the expected ground and vegetation contamination have not been constructed but can be obtained by multiplying the exposure values by 0.007 (a deposition velocity of 0.7 cm/sec). The determination of the fractionation of this total deposit between the ground and the vegetationwill vary considerably, being largely on vegetation where the vegetation cover is fairly thick and correspondingly less where the cover is thin.

Animal Thyroids

The beagle dogs are expected to breathe at a rate of about 8×10^{-5} m^3/sec and the deposition in the thyroid to amount to 15% of the amount inhaled. Since the center line exposure at the 200 meter arc is expected to be 10^{-4} c sec/m^3, the maximum thyroid burden in the dogs is expected to

be

$$10^{-4} \times 8 \times 10^{-5} \times .15 = 1.2 \times 10^{-9} \text{ curies}$$

or 1.2 nc, a quantity which should be measurable.

HAZARDS ANALYSIS

The expected airborne exposures to iodine (Fig. I) are based on an assumed release of 0.1 curies with a wind speed of 1.3 m/sec. For purposes of estimating hazards it is desirable to assume somewhat more pessimistic conditions. Since the source may contain more than the quantity ordered, the source strength will be assumed to be 0.15 curies. The wind speed during the release might be a factor of three less than previously assumed so that the possible exposures could be approximately five times higher than was estimated. Using these higher exposure values and assuming the breathing rate for a standard man as 3.47×10^{-4} m^3/sec and an uptake in the thyroid of 0.23, the possible thyroid burdens of men exposed along the center line of the plume have been calculated and are given in the following table.

Distance (meter)	Thyroid Burden (nc)
200	35
800	4
1600	1

The point of nearest approach to the experiment site for persons not connected with the experiment is the road which runs north and south between the Meteorology site and 200 West and this is about 800 meters from the release point and in what is expected to be the upwind direction. The possible thyroid burden at this distance is only 4 nc and could occur only if there were a complete reversal in wind direction. The continuous per-

missible thyroid burden for occupational exposures is given by the ICRP as 140 nc. So this highly unlikely exposure could not be considered hazardous even if it did occur.

APPENDIX

TEST ORGANIZATION

Test Control Group

The following persons will comprise the Test Control Group at the Control Point at 622-A Building:

*J. J. Fuquay - Technical Director

C. C. Gamertsfelder - Scientific Director

F. P. Hungate - Biology Program Director

G. A. Little - Radiation Safety Representative

L. C. Schwendiman - Technical Consultant

C. L. Simpson - Test Conductor

* Chairman of the Control Group during test.

The Radiation Monitoring checkpoint will be located in the 622-D Bldg. (Quonset Hut) approximately 1000 feet west of the Meteorology Tower. All personnel will sign the log at this point and change to field clothing as prescribed by RMO. Vehicular traffic beyond this point will be controlled. No private cars will be permitted beyond this RMO check station. Contact can be made from 622-D with the Test Conductor at 622-A for admission beyond this point.

Except for the source, all equipment will be in place by T-10 hours. Entry to grid area after this time will be for equipment startup or placing perishable samplers in the field except as approved by the Technical Director.

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OPERATIONAL PROCEDURE - HANFORD IODINE RELEASE - 1963

Tentatively, the plans are to begin a release of iodine at 0200 PDT. The following count-down may be adjusted by "holding" or "jumping" the count. All times refer to Pacific Daylight Time.

T-15 Hr. (11 AM)	Simpson will obtain tentative forecast. In the event the forecast is favorable, Hungate and Ludwick will be informed via telephone.
T-12.5 Hr. (1:30 PM)	Background values from above will be phoned to C. L. Simpson (2-7778, 2-7716). Updated forecast obtained. Conference call between APO and C. C. Gamertsfelder to reach decision on "Go", "No-Go".
T-11.5 Hr. (2:30 PM)	In the event of a decision to go, APO notifies all group representatives as follows: (Hungate, Ludwick, Schwendiman, Rising, Little, Watson, Bair, Security Patrol Lt.-200-W.)
T-3.0 Hrs.	Forecast obtained by Simpson. Cline takes background sample and proceeds to Laboratory.
T-2 Hr. (Midnight)	All personnel arrive at 622-D Bldg. (Quonset hut) and sign log. APO field personnel be prepared to begin work at this time; stand-by at Hut for signal to dispatch to field. People are responsible for checking out through RMO and Test Conductor on activities that carry them from their assembly point.
T-1.5 Hrs.	Cline notifies Simpson via phone the results of background reading - conference with C. C. Gamertsfelder.
T-80 Min.	Start mast and B&W equipment.
T-1.0 Hr. (1 AM)	APO directed to field, begin starting engines. Source (Schwendiman) delivered from 200-W. Report of arrival of source reported to Simpson.

NOTE: At T-1.0 Hr., all people except those directly concerned with the release will not be permitted in the area around the source and between the source and the 200 meter arc. All traffic from the field will follow existing arc roads.

T-45 Min.	Cline waters dirt samples, dogs in field, Rising adjusts chamber at 200 meters.
T-20 Min.	Start arc 3 mast, wind component meter.
T-15 Min.	All personnel in field return to hutment and log in.
T-10 Min.	Control group assembles at 622-A.
T-5 Min.	RMO notifies Simpson that all personnel are accounted for excepting those at the control point (622-A Bldg.), source operators.
T-0	Iodine release, tower equipment on speed run.
T+30 (2:30 AM)	Iodine off.
T+40	Source returned to 200-W - Call (2-7778) (2-7716) on completion.
T+45	Monitors to 200-meter arc.
T+60 (3:30 AM)	APO personnel to 200 meter arc to pick up all samples (ground and tower) on RMO approval. Monitors to 800 meter arc.
T+75	APO personnel to 800 meter arc to pick up all samples on RMO approval.
T+90	RMO personnel to 1600 meter arc, all meteorological support instruments at source returned to slow speeds. Cline to sample vegetation, Ludwick to sample vegetation on advice of RPO, Rising also to 200 meters.
T+105	APO personnel to 1600 meter arc to collect samples on RMO approval.
T+120 (4:00 AM)	Cline begin plant stature studies.

T+150	RMO to 3200 meter arc.
T+175	APO personnel to 3200 meter arc on approval of RMO. Cline begins stratification studies.

ALL SAMPLES RETURNED TO HUTMENT FOR MONITORING

T+235	APO personnel, on completion of air sampling, return to Hutment, be monitored and go to breakfast. BEFORE anyone leaves the grid area they must check out with RMO with their vehicle and samples.
T+240 (6 AM)	Control Group meeting for post-analysis.

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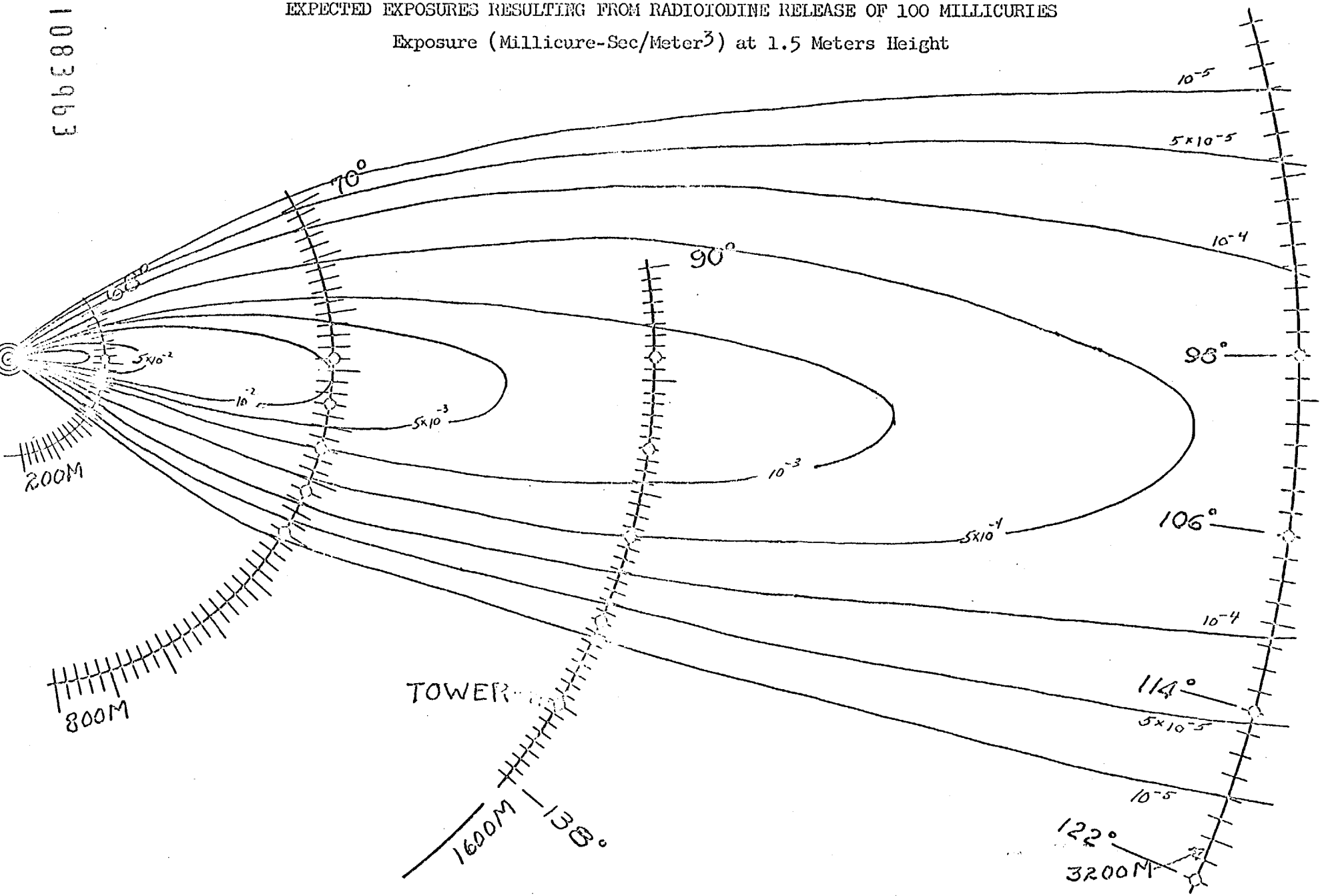
Figure I

EXPECTED EXPOSURES RESULTING FROM RADIOIODINE RELEASE OF 100 MILLICURIES

Exposure (Millicure-Sec/Meter^3) at 1.5 Meters Height



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