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FZM-1707
6 June 1958

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# FISSION PRODUCT FIELD RELEASE TESTS

## -EXPERIMENT DESIGN-

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Henry K. Peterson 5-1-90

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A DIVISION OF GENERAL DYNAMICS CORPORATION
FORT WORTH

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# FISSION PRODUCT DISPERSAL EXPERIMENT

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# INTRODUCTION

An overall safety program for nuclear aircraft has been organized under the direction of the joint USAF-AEC Aircraft Nuclear Propulsion Office (ANPO). As part of this program, fission product field release tests are sponsored by the Air Research and Development Command. Management of these experiments on behalf of ARDC is exercised by the Air Force Special Weapons Center (AFSWC). Convair has been assigned the responsibility for conducting these experiments and will serve as Test Director.

The first experimental series will be conducted at the National Reactor Testing Station (NRTS) during July through September of this year. Participating agencies are the AEC Idaho Operations Office, General Electric ANP Department, University of Rochester, and Air Force Special Weapons Center.

Earlier coordination for the series was achieved at a meeting on April 11, 1958, at the NRTS (Convair report FZM-1109). The purpose of the present report is to reflect the current status of the planning and to serve as a basis for discussions at the final coordination meeting in Albuquerque at AFSWC on June 11, 1958.

The purpose of these tests is to determine the behavior of select fission products released to the atmosphere under conditions simulating the most probable nuclear aircraft accident, i.e., loss of aftercooling (meltdown). The series is expected to provide valuable information regarding fission product release fractions; the effect of diffusion conditions on downwind air concentrations and ground contamination levels; and animal inhalation exposures. The tests have been designed to reduce some of the uncertainties which exist regarding cloud depletion rates, particle size distributions, contamination levels at distances of several miles, and biological retention.

Fluorescent tracers are of interest, since it is planned to ascertain the diffusion characteristics of potential operating sites by this method.

It is felt that the data generated in these tests will enable a more realistic appraisal of nuclear aircraft hazards.

# TEST OBJECTIVES

- TO DETERMINE THE RELEASE, AIRBORNE ACTIVITY AND GROUND DEPOSITION OF FISSION PRODUCTS FROM MELTDOWN OF ANP-TYPE FUEL ELEMENT SAMPLES UNDER GOOD AND POOR DIFFUSION CONDITIONS

- TO COMPARE THE DISPERSION OF FLUORESCENT TRACER MATERIAL WITH FISSION PRODUCTS

NPC 7278

The test program will consist of two series of experiments, each consisting of six ground level releases. In the first series, segments of HTRE-type fuel elements containing only long-lived isotopes will be used. Total gamma activity of these specimens is about 3 curies, and the dominant isotope released will be cesium-137. In the second series, freshly irradiated segments of HTRE-type elements will be employed which will contain appreciable quantities of iodine and xenon. This will enable determinations of external dose in addition to more extensive airborne dispersal and ground contamination measurements. Gross gamma activity for the first of these segments will be approximately 400 curies. Three of the releases of each series will be conducted during lapse condition, and three will be conducted during inversions. Each radioactive release will be accompanied by the release of a fluorescent tracer. Smoke releases will be made before and after the radioactive release for visual indication of the cloud's course.

# EXPERIMENTAL PLAN

- RELEASE FISSION PRODUCTS AT GROUND LEVEL BY INDUCTION MELTING

  AGED ELEMENT SERIES
  3 LAPSE – 3 INVERSION

  FRESH ELEMENT SERIES
  3 INVERSION – 3 LAPSE

- RELEASE FLUORESCENT TRACER AND SMOKE

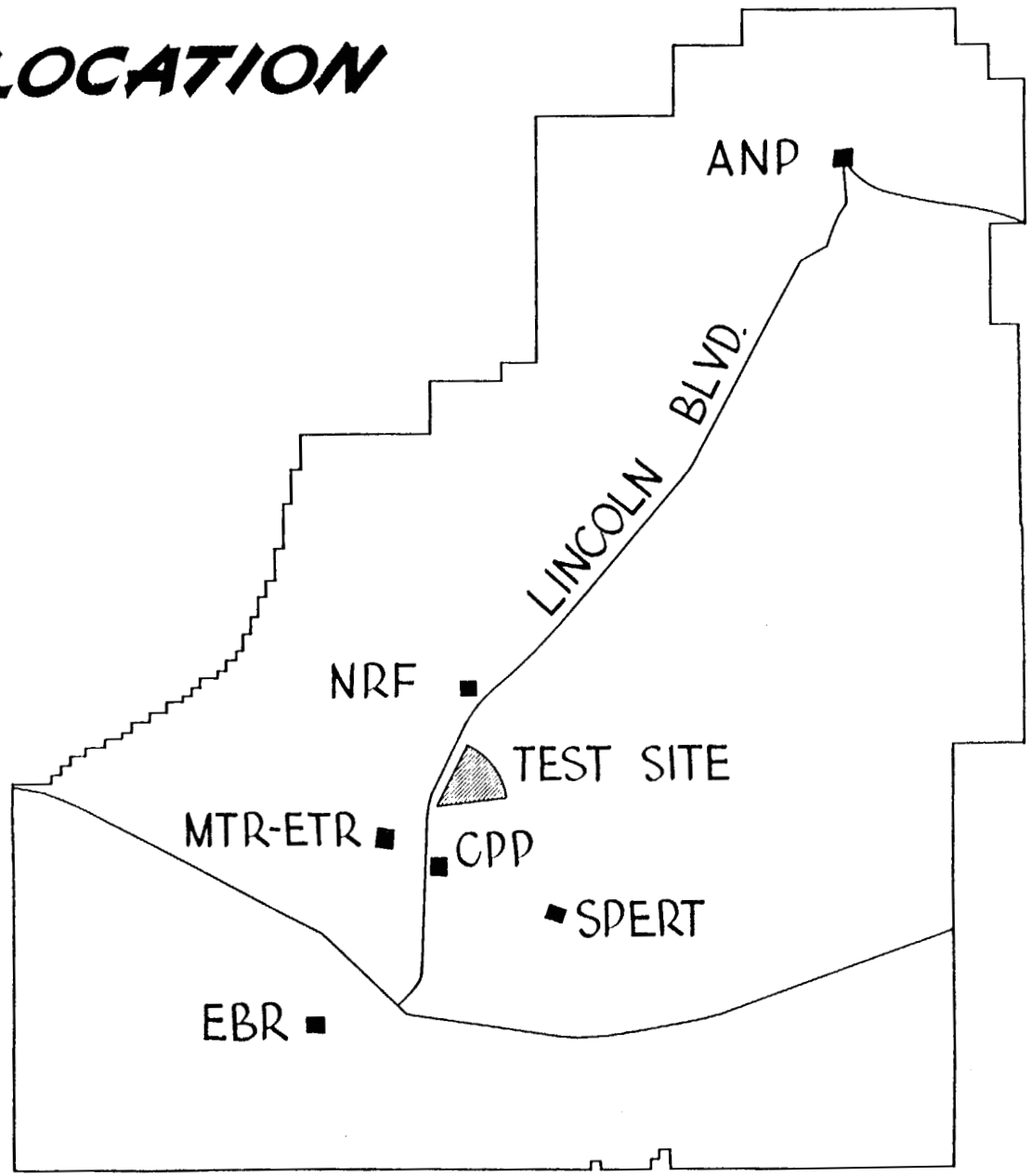
- MEASURE AIR AND GROUND ACTIVITIES

- PHOTOGRAPH SMOKE PLUME

NPC-7277A

The site will consist of a fan-shaped grid with the release point at the apex and extending 30 degrees on each side of N 55° E. The release point will be approximately 8,000 feet north of the Chemical Processing Plant, 7,000 feet northeast of the Materials Testing Reactor, and 18,000 feet south-southwest of the Naval Reactor Facility. This location is convenient to electrical power and the highway and has no persons downwind. The closest boundary of NRTS is 17 miles distant.

# SITE LOCATION

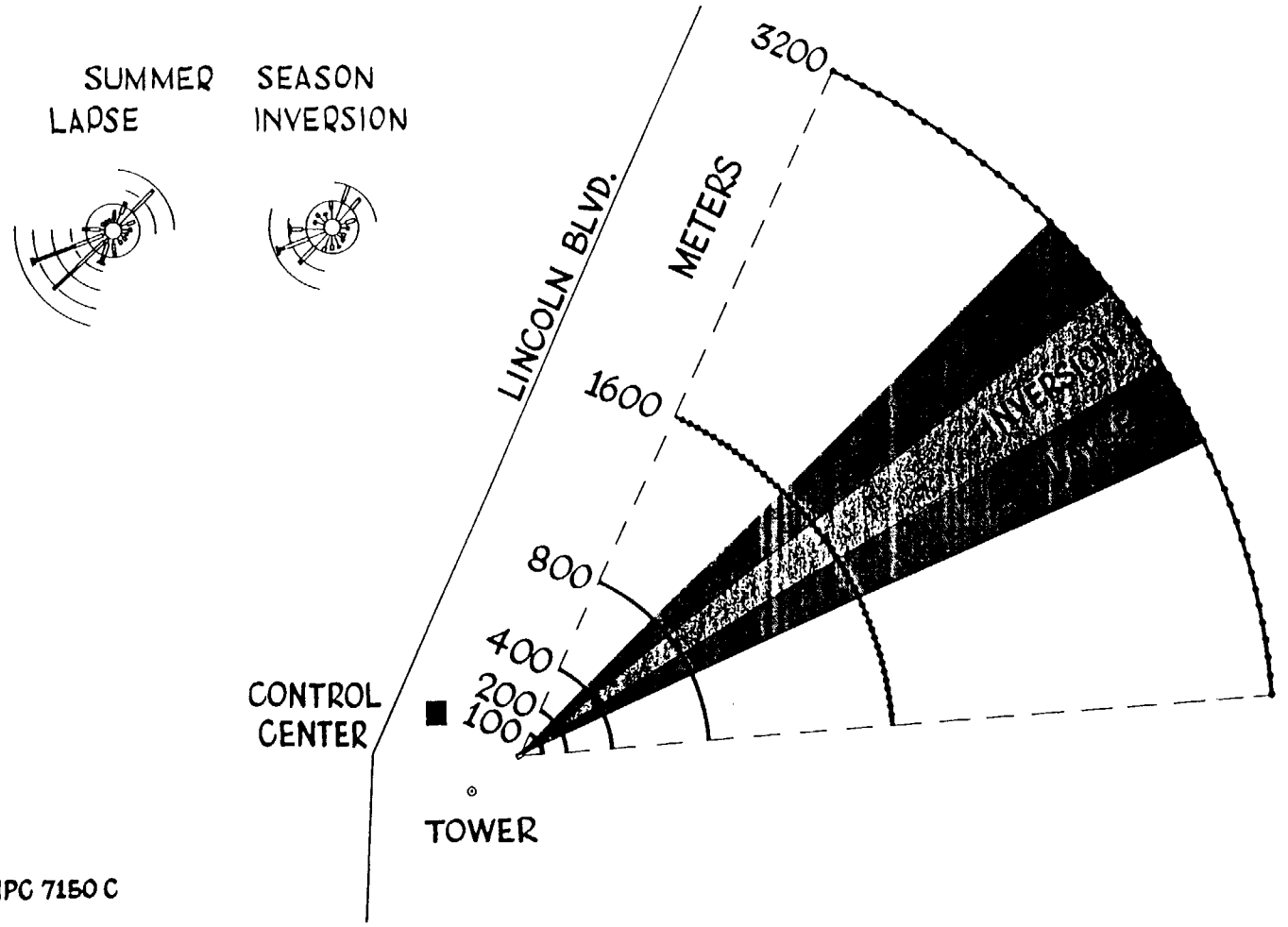



NPC 7141A

The sampling network consists of six instrumented arcs spaced at equal logarithmic intervals from 100 meters to 3200 meters from the release point. Service roads follow the 400, 800, 1600, and 3200-meter arcs and will be treated with a special dust binder to alleviate the problem of wind-blown activity. Controlled access to the grid can be gained from several points on Lincoln Boulevard.

The shaded areas show representative cloud traces for inversion and lapse conditions. The grid centerline ($N55^{o}E$) is oriented such that it corresponds to the most probable downwind direction for lapse and inversion conditions during the summer months.

# GRID LAYOUT




NPC 7150 C

Experimental conditions which are desired for the releases are shown on the opposite page. The lapse rate shown for the typical lapse release lies between isothermal and dry adiabatic, and is generally referred to as "neutral" conditions. A moderate amount of atmospheric stability exists at this time and effluents disperse in the characteristic "coning" pattern, which most nearly typifies isotropic diffusion. This condition was chosen so that experimental data can more easily be correlated with theoretical predictions, as Sutton's diffusion equations apply primarily to neutral conditions. Strong lapse conditions which would cause "looping" will be avoided to obtain more systematic air samples. Lapse releases will probably be made in the early morning.

The lapse rate shown for inversion release corresponds to moderate inversion conditions. These releases will be made in the early morning or late afternoon.

All releases will be subject to meteorological control and will be based on data and forecasts from the Weather Bureau Office.

1253720

# METEOROLOGICAL RELEASE CRITERIA

| | LAPSE | INVERSION |
|---|---|---|
| LAPSE RATE (°C/100m) | -0.5 to -1.5 | +0.5 to +3.0 |
| WIND DIRECTION | 216° to 254° | 209° to 261° |
| WIND SPEED (meters/sec) | 3.6 to 6.7 | 1.3 to 3.1 |

NPC-7282

1255321

The sampling network will be equipped with meteorological instrumentation for determining the conditions which exist before, during, and after the release. The meteorological tower, located 500 feet upwind of the release point, will be equipped to determine vertical wind and temperature profiles up to 150 feet. Higher level data will be provided by wiresonde and pibal operated by Weather Bureau personnel. Wind speed and direction will be measured simultaneously at six points along the grid centerline. Data from the tower and ground field units will be channeled to the Convair meteorological trailer and recorded.

1253278

# METEOROLOGICAL NETWORK

- TOWER

  PRECISION ANEMOMETERS AT 1.5, 3, 6, 12, 24, & 45 METERS
  PRECISION WINDVANES AT 1.5, 12, AND 45 METERS
  SHIELDED-ASPIRATED THERMOCOUPLES AT 1.5, 3, 6, 12, 24, AND 45 METERS

- FIELD UNITS ( 4 METER HEIGHT ) ALONG THE CENTERLINE

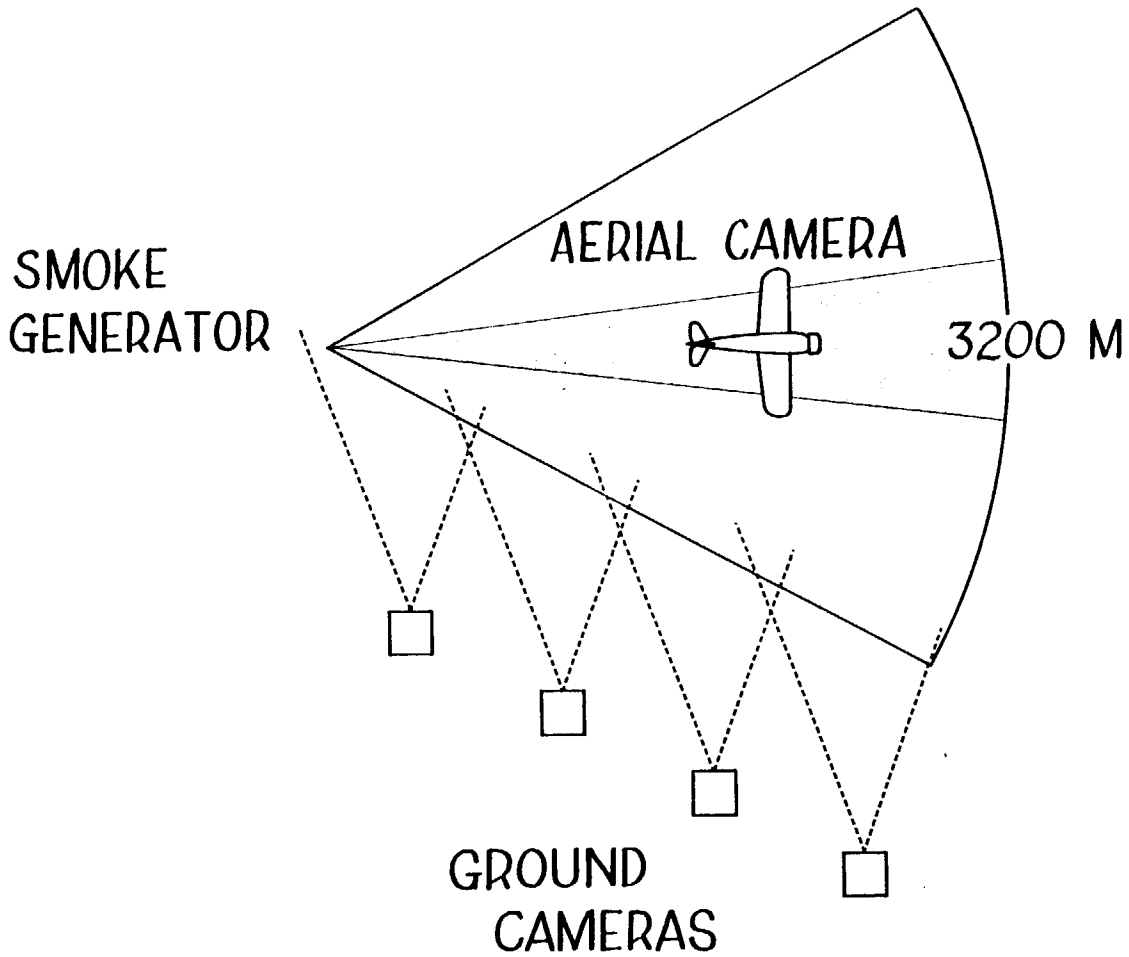
  ANEMOMETER AND WINDVANE AT 200, 400, 800, 1600, 2400, AND 3200.

- CENTRAL INDICATION ON ALL CHANNELS

- WIRESONDE AND PIBAL

A permanent visual record indicating the fission-product-cloud dispersal characteristics will be obtained by taking photographs of smoke releases conducted immediately before and immediately after the fission-product releases. An Army M-2 smoke generator will be used for smoke production. Four K-24 aerial cameras will be stationed at one side of the network in such a manner that their combined fields of view cover the entire network. Photographs from these cameras will provide data concerning cloud height at various distances away from the release point and can, thus, be used to determine vertical diffusion conditions. A fifth K-24 camera will be mounted in an L-20 aricraft and will be used to take aerial photographs of the smoke releases. These photographs will provide data concerning crosswind diffusion, cloud path, and cloud shape. Photography will be accomplished by Air Force Special Weapons Center personnel.

# SMOKE PLUME PHOTOGRAPHY



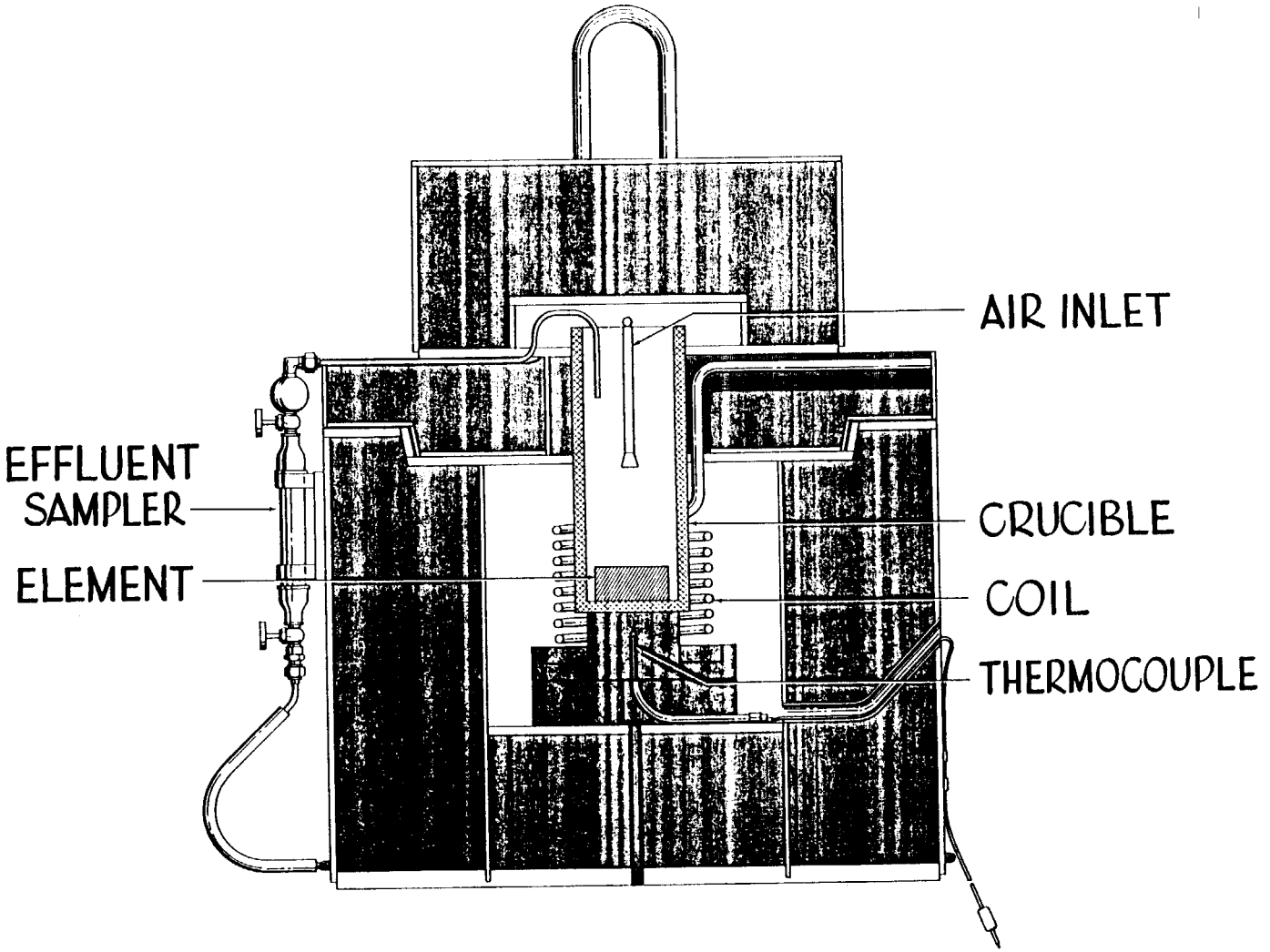

NPC-7286

Fuel element samples will be melted in a specially constructed, shielded, induction furnace. The induction coil will couple to a graphite crucible which will in turn heat the charge. Temperature indication will be by thermocouple. Air will be pumped into the crucible at a low rate to purge the effluent. The furnace will be equipped with a vacuum bottle system for direct sampling of the effluent.

The furnace will be loaded and unloaded at the GE Idaho Test Station hot cell and transported to the release site by truck. This system obviates the need for performing remote handling operations in the field.

The furnace is coupled to a 10-kilocycle, 60-kw induction power supply. In pilot runs, samples have been melted in less than 3 minutes from a cold start.

# FURNACE




NPC 7153 A

The accompanying table shows the amounts of activity contained in the aged fuel element segments. The 1-T assembly has the following in-pile history:

470 hrs in MTR producing 250 BTU/sec

35 hrs in MTR producing 200 BTU/sec

2.5 years cooling.

Expected gamma dose rate at one foot from an unshielded specimen will be 10 Rem/hr. The expected release fractions have been assigned on the basis of the work done at Oak Ridge National Laboratory by Parker and Creek. Of the biologically significant isotopes, only Cs-137 is expected to be released in detectable amounts.

# FISSION PRODUCT RELEASE

• AGED ELEMENTS (ASSEMBLY 1-T)

| | CURIE INVENTORY | % RELEASE | EXPECTED RELEASE |
|---|---|---|---|
| $Sr^{90} - Y^{90}$ | 3 | $10^{-3}$ | — |
| $Ce^{144} - Pr^{144}$ | 8 | $10^{-3}$ | — |
| $Pm^{147}$ | 7.8 | — | — |
| $Ru^{106} - Rh^{106}$ | 1 | — | — |
| $Cs^{137} - Ba^{137}$ | 3 | 10 | .3 |
| $Kr^{85}$ | .37 | 100 | .37 |

NPC 7279

125533H

125535

The fission product inventory shown for the fresh element release will be obtained by irradiating the samples in the MTR for 5 days. The opposite table reflects the fission product inventory in each of the irradiated element samples at the time of the first release, which will be performed 21 days after removal from the MTR. Dose rate at one foot from a bare sample at that time will be 5000 Rem/hr. The fresh element tests are primarily for the purpose of studying the release and dispersal of iodine-131 which, in freshly irradiated elements, is the major biological offender having a high release fraction.

# FISSION PRODUCT RELEASE

• FRESH ELEMENT (ASSEMBLY 1-L-1)

| | CURIE INVENTORY | % RELEASE | EXPECTED RELEASE |
|---|---|---|---|
| $Sr^{89}$ | 82 | — | — |
| $Sr^{90}$-$Y^{90}$ | 1 | — | — |
| $I^{131}$ | 57 | 50 | 29 |
| $Cs^{137}$-$Ba^{137m}$ | 0.5 | 10 | .05 |
| $Xe^{133}$ | 66 | 100 | 66 |
| $Xe^{131m}$ | 1 | 100 | 1 |

NPC 7280

A fluorescent tracer will be released simultaneously with the fission products. The information obtained from tracer releases will be used to establish a correlation between tracer concentration and fission product activity. Zinc cadmium sulphide was selected because the techniques for its use have been well developed, both at Dugway Proving Ground and Hanford. The tracer will be dispersed near the release point, using a Todd Insecticide Generator, Model 40-2. The fluorescent tracer will be picked up in the sampling network by the Andersen impactors located on the first four instrumentation arcs.

1255558

# FLUORESCENT TRACER RELEASE

## – ZINC CADMIUM SULPHIDE –

- PHYSICAL PROPERTIES

| | |
|---|---|
| DENSITY | 4 gram/cc |
| MASS MEDIAN DIAMETER | 2 microns |
| DEPOSITION VELOCITY | 1 cm/sec |
| EXCITATION WAVE LENGTH | 3560 Å |

- PARTICLE DISPERSAL

  AEROSOL GENERATOR

  5000 GRAMS/HOUR

  15 MINUTE RELEASE

NPC 7288

Samples of the fission products and fluorescent tracer diffusing downwind from each release will be collected. These samples will provide data concerning the air concentration of fission products and fluorescent tracer in a horizontal plane near ground level; the particle size distribution of airborne fission products and fluorescent tracer as a function of distance from the release point; and cloud depletion by fallout as a function of distance from the release point.

Air samplers, particle sizing samplers, and fallout plates will be arrayed on six concentric arcs about the release point with the outermost arc 3200 meters from the release point. The 60-degree included angle of the network is approximately 3 times greater than the angular dispersion of the fission product cloud expected during lapse conditions and about 8 times greater than that expected during inversions.

# SAMPLING NETWORK

| ARC DISTANCE (METERS) | HI VOLUME (STAPLEX) | LOW VOLUME (PARSONS/ANDERSEN) | FALLOUT-TRAYS (GUMMED PAPER) |
|---|---|---|---|
| 100 | 31 | 31 | 61 |
| 200 | 31 | 31 | 61 |
| 400 | 31 | 31 | 61 |
| 800 | 31 | 31 | 61 |
| 1600 | 61 | – | 61 |
| 3200 | 61 | – | 61 |

NPC-7149

HASL-251

In order to establish an intermediate point for extrapolation of the field data to the effects on man, dogs and rats will be placed in the network along with the sampling equipment. The University of Rochester will conduct these inhalation studies. Correlation between air concentration, particle size distribution, and organ exposure will be made.

Following the aged element melts, those rats suspected of being in the effluent cloud will be sacrificed, decontaminated, and counted in a deep well scintillation counter. Dogs located near the analysed rats will be decontaminated and scanned. Certain of these will be sacrificed, autopsied, and various organs and tissues removed for detailed study.

Following the fresh element melts, the primary emphasis will be placed on iodine-131 metabolism. With the dogs, quantitative values will be obtained for thyroid uptake by external counting with a collimated gamma scintillation detector without sacrificing the animals. Some dogs will be sacrificed immediately for removal of various organs and tissues for detailed study and correlation with external counts. The rats will be handled as before with the exception that more emphasis will be placed on thyroid.

1255342

# ANIMAL INHALATION STUDIES

- DOGS ON EACH ARC AT 5° INTERVALS
  SCAN AND TRACE MIGRATION: CESIUM AND IODINE
  SACRIFICE AND ANALYSE ORGANS:

| | | | |
|---|---|---|---|
| LUNG | CESIUM | IODINE | STRONTIUM |
| KIDNEY | CESIUM | IODINE | STRONTIUM |
| MUSCLE | CESIUM | | |
| THYROID | IODINE | | |
| BONE | STRONTIUM | | |

- RATS ON EACH ARC AT 2° INTERVALS INCREASE NETWORK COVERAGE BY CORRELATION WITH DOG DATA

NPC 7294 A

The AEC will conduct studies of the deposition of activity on soil and vegetation. These data will be compared with Convair sticky paper and air sampler data to determine deposition velocities for various surfaces. Pre and post soil and vegetation samples from the aged element releases will be analysed for cesium-137. If grid samplers indicate that significant amounts of strontium and cesium have been released, the post-release samples will be analysed for those nuclides. Samples from the fresh element releases will be analysed for iodine-131; and, as in the case of the aged element releases, some will be analysed for strontium and barium if significant amounts of these nuclides are found in the furnace effluent samplers or the high-volume air samplers.

After each release, a detailed ground activity survey will be performed with survey meters to obtain a contour plot of the higher activity ground contamination.

# SOIL AND VEGETATION MONITORING

- PRE-RELEASE SAMPLES - 12 PER ARC
- POST RELEASE SAMPLES - 12 PER ARC
- AGED ELEMENT ANALYSIS - CESIUM, STRONTIUM
- FRESH ELEMENT ANALYSIS - IODINE
- GROUND ACTIVITY SURVEYS NEAR RELEASE POINT

NPC 7281

Twenty-one external dose monitors will be used. These are battery-powered, portable, recording, scintillation dosimeters. They will give a trace of count rate which will show time of cloud passage. Knowledge of the elements released will enable calibration to dose rate.

For the aged element release, activity probably will be too small to detect. Doses from the fresh elements will be about equally divided between iodine and xenon.

# EXTERNAL DOSE NETWORK

- SCINTILLATION DOSIMETERS ON 400 METER ARC AT 3° INTERVALS
- RELEASE FROM AGED FUEL ELEMENTS

| | |
|---|---|
| TOTAL DOSE | $1.2 \times 10^{-4}$ MREM |
| AVERAGE DOSE RATE | $2.6 \times 10^{-3}$ MR/HR |

- RELEASE FROM FRESH FUEL ELEMENTS

| | |
|---|---|
| TOTAL DOSE | $3.3 \times 10^{-2}$ MREM |
| AVERAGE DOSE RATE | 0.66 MR/HR |

NPC 7135

There are three types of source sampling measurements that will be performed to determine isotopic release: (1) gamma spectrum measurements; (2) chemical analyses of fuel element segments; and (3) analyses of the furnace effluent.

Gamma spectral measurements will be made in the field under controlled geometry of the aged fuel elements before distruction and of the residue after melting. Convair will perform these measurements.

GE-ANP will perform a chemical analysis of a portion of the fuel element prior to melting and an analysis of the residue after melting. The pre- and post-melt samples of the aged elements will be analysed for Cs-137 and Kr-85, whereas the samples of the fresh elements will be analysed for I-131 and Xe-133. Only three samples of each type element will be analysed.

Gamma-spectrum analyses will be performed at Convair-Fort Worth on all effluent samples collected at the furnace. Aged element samples will be analysed for Cs-137 and Kr-85. Fresh element samples will be analysed for I-131 and Xe-133. Should there be sufficient releases, radiochemical analysis will be made for Ru-106 and Sr-90 in aged element samples and for Sr-89 and Ba-140 in fresh element samples.

# SOURCE SAMPLE ANALYSIS

| | FIELD SPECTROMETER | CHEMISTRY |
|---|---|---|
| FUEL ELEMENT | CESIUM | CESIUM – KRYPTON<br>IODINE – XENON |
| EFFLUENT | — | CESIUM – XENON<br>IODINE – XENON<br>RUTHENIUM *<br>STRONTIUM *<br>BARIUM * |
| RESIDUE | CESIUM | CESIUM – KRYPTON<br>IODINE – XENON |

* OPTIONS

NPC 7284

It is unlikely that concentrations of nuclides other than Cs-137 (aged elements) and I-131 (fresh elements) will be high enough to yield measurable concentrations on filters in the outer portions of the network. Therefore, it is expected that analysis of samples from all arcs will be made for only these elements. A smaller number of samples will be analysed for Ru-106 and Sr-90 (aged elements) and for Sr-89 and Ba-140 (fresh elements). If the gamma spectrum of the furnace effluent sample shows that Ce-144 was released, some cloud centerline filters will also be analysed for this nuclide. Maximum use will be made of gamma spectroscopy to minimize the chemical separations. Samples will be analysed at Convair-Fort Worth with check samples being analysed at NRTS.

# NETWORK SAMPLE ANALYSIS

| | AGED RELEASES | FRESH RELEASES | OPTIONS |
|---|---|---|---|
| FILTERS | CESIUM | IODINE | RUTHENIUM<br>STRONTIUM<br>BARIUM |
| CHARCOAL TRAPS | — | IODINE | — |
| STICKY PAPER | CESIUM | IODINE | RUTHENIUM<br>STRONTIUM |
| ANDERSEN PLATES | CESIUM<br>ZN-CD-S | IODINE<br>ZN-CD-S | — |

NPC-7283

The source release will be derived from the results of pre and post chemical and spectral analyses of the fuel elements and analysis of the furnace effluent. Fission product particle size distributions will be obtained from analysis of the Andersen samplers. Meteorological data and photographic data will be used to obtain the diffusion parameters prevailing during each release. Downwind activities will be determined from the high-volume air samplers, Andersen samplers, fallout trays, soil samples, and vegetation samples. Biological exposures will be determined from the animal inhalation studies.

Predictions have been made of the expected activities in the network based on current methods and assumptions. Revised predictions will be made of the downwind activities utilizing the experimentally determined source terms and diffusion parameters. Predictions will be made of biological exposures using experimentally determined exposure integrals. Correlation of predictions will be made with experimental data in each instance. The Convair IBM-704 is presently programmed to curve fit the data and generate predictions with the various release, diffusion, and biological relationships.

# DATA ANALYSIS

- EXPERIMENTAL

| | |
|---|---|
| CHEMICAL ANALYSIS | SOURCE RELEASE |
| SPECTRAL ANALYSIS | |
| EFFLUENT ANALYSIS | |
| MET. OBSERVATIONS | DIFFUSION PARAMETERS |
| PLUME PHOTOGRAPHY | |
| NETWORK ANALYSIS | |
| AIR SAMPLERS | NETWORK ACTIVITY |
| FALLOUT TRAYS | |
| SOIL & VEGETATION | |
| ANIMALS | |

- PREDICTION

ACTIVITY RELEASE

AIRBORNE ACTIVITY

ORGAN EXPOSURES

GROUND DEPOSITION

EXTERNAL DOSE

NPC 7297

General Electric ANP Department has arranged for irradiation of the 1-L-1 assembly in the MTR during cycle 107 (July 7-20). After removal from the MTR, the fuel element assembly will be disassembled in the GE hot cell. Furnace loading will also be accomplished in this hot cell, and transportation to the release point will be provided by the AEC. Radiochemical analysis of pre- and post-melt samples will be performed by GE. Accountability for elements at the test site and during the radiochemical analysis will be retained by GE. Disposal of residual element activity will be accomplished by the AEC.

# FUEL ELEMENT PROCESSING

- IRRADIATION (GE)
- PREPARATION (GE)
- TRANSPORTATION (IDO)
- ANALYSIS (GE)
- DISPOSAL (IDO)
- ACCOUNTABILITY (GE)

NPC 7136

The electrical power required to operate the sampling apparatus will be derived from two sources. The 1600 and 3200-meter arcs will be carried by field generators with the power being distributed via cables along the ground. All other arcs and locations will be served by ground cables tied into a pole system tapped off the nearby 12.5-KV power line.

1295351

All site preparation has been accomplished by the AEC Idaho Operations Office with the exception of the roll-up power distribution system installed by Convair's contractor.

# SITE PREPARATION

1255558

- SURVEYING AND STAKING OF SAMPLING ARCS (IDO)
- CLEARING AND DUST TREATMENT OF ROADS (IDO)
- POWER DISTRIBUTION FEEDER SYSTEM (IDO)
- CHECKOUT OF MOTOR - GENERATORS (IDO)
- METEOROLOGICAL TOWER ERECTION (IDO)
- PROVISIONS TO DECONTAMINATE RELEASE POINT (IDO)

The various support items required for successful completion of the test series will be provided primarily by theIdaho Operations Office. Meteorological control will be based on data and forecasts from the Weather Bureau Office. All persons in the test area will be subject to IDO health physics monitoring control. IDO will provide guard services necessary to enforce security requirements and, in addition, will furnish vehicles for handling personnel and equipment in the field.

# SERVICES SUPPORT

- WEATHER FORECASTING (WBO)
- HEALTH PHYSICS MONITORING (IDO)
- GUARD SERVICES (IDO)
- VEHICLES FOR EQUIPMENT AND PERSONNEL (IDO)
- CRANE FOR CASK HANDLING (IDO)

NPC 7285

1255361

The decision to authorize a release depends on the existing and predicted meteorological conditions, the amount of the expected release, and the experimental results of previous releases. The meteorological information will be obtained from the National Reactor Testing Station network and meteorological instrumentation at the test site. Forecast of weather conditions will be made by the Weather Bureau Office. If the proposed release is acceptable to the AEC Chief, Site Survey Branch, authorization to release will be given the USAF Program Manager who will in turn give authorization to the Test Director. The Test Director will then proceed with the release.

# RELEASE AUTHORIZATION

- EVALUATION OF PREVIOUS RELEASE
- METEROLOGICAL DATA AND FORECAST
- AUTHORIZATION BY AEC CHIEF, SITE SURVEY
- AUTHORIZATION BY AFSWC REPRESENTATIVE
- DECISION TO RELEASE BY CONVAIR TEST DIRECTOR

NPC 7287 A

The Test Director will be Mr. John C. Gallimore. The Test Director will coordinate with the various experimental groups participating in the test for experimental preparations and test execution. The AEC will monitor the radiological safety of the operations. If at any time conditions should become hazardous, such as a wind shift to an unsafe direction, the release will be terminated.



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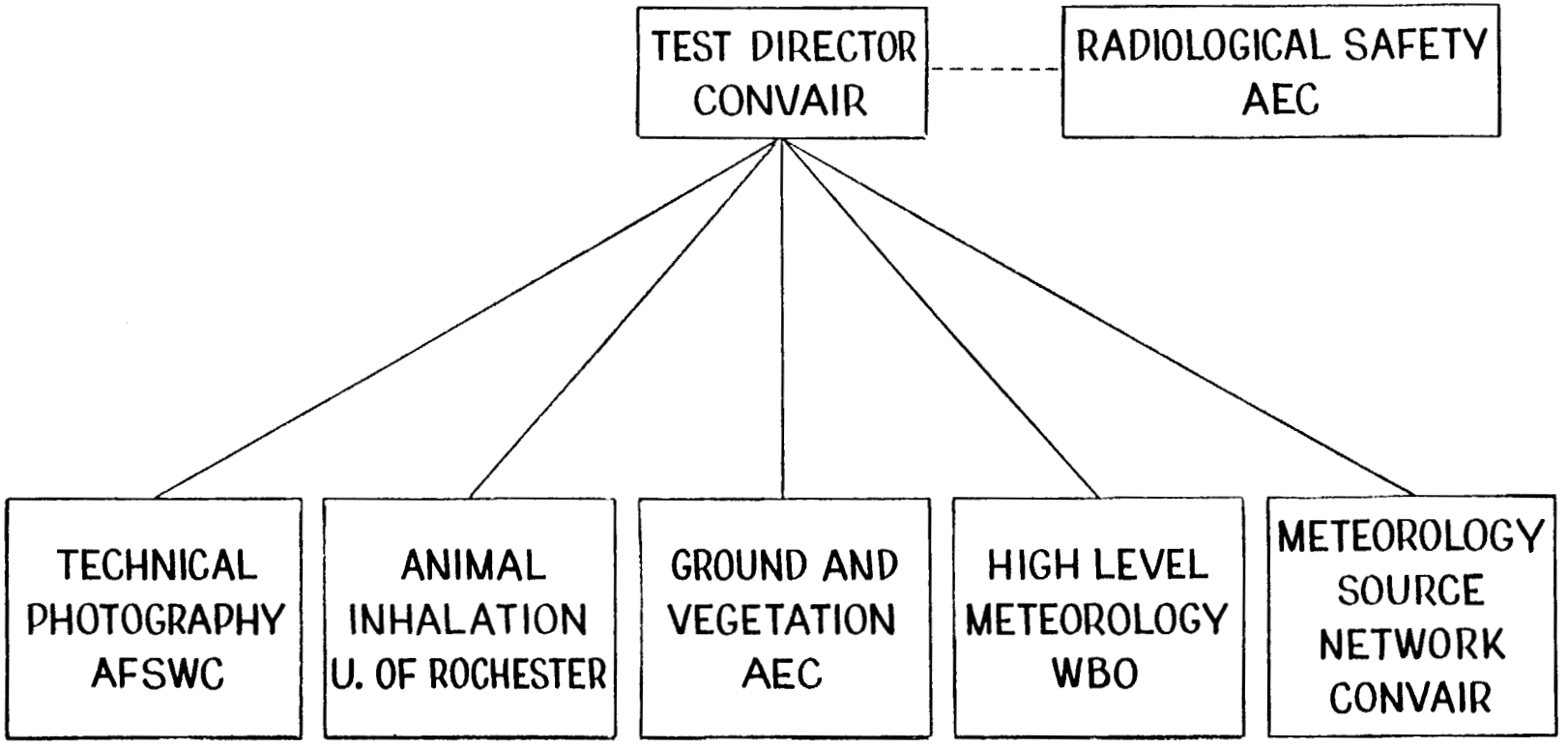
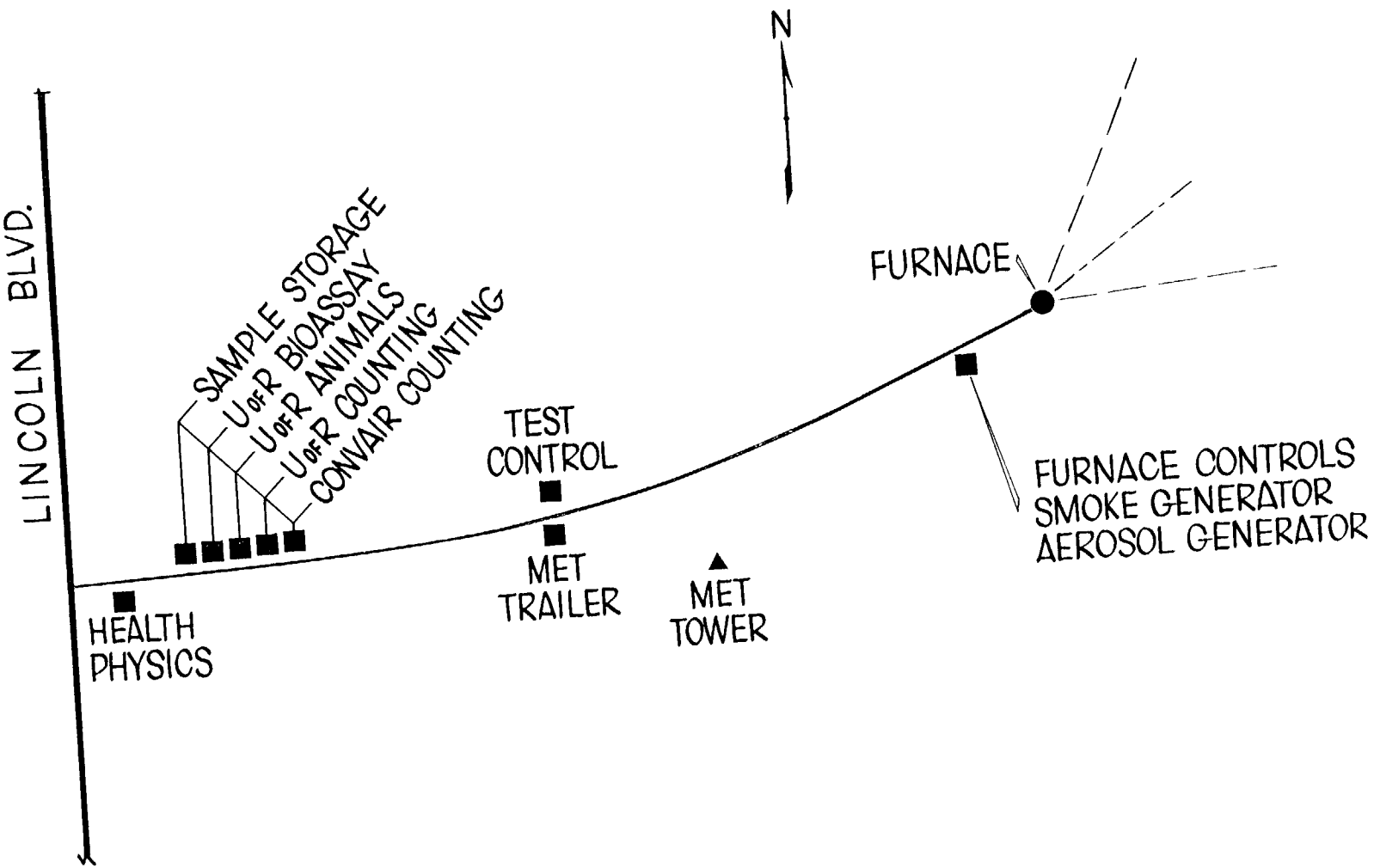
# TEST EXECUTION




NPC 7289

The opposite figure shows the location of the various support items with respect to the release point. The smoke and aerosol generator will be positioned 100 feet upwind of the release point, and the meteorological tower 500 feet upwind. The met trailer and test control will be on opposite sides of the access road approximately 750 feet from the release point. The AEC health physics control point will be situated just off Lincoln Boulevard.

# CONTROL AREA




NPC 7 /5

Careful sequencing is required to avoid interference between the various test events and to insure that all operations are conducted properly. Attempts will be made to forecast each release approximately one hour in advance. When the forecast indicates favorable release conditions, a continuous plume of smoke spanning the entire length of the network will be generated and photographed. When photography is completed, the smoke generator will be turned off for two minutes to enable the plume to be carried downwind. A puff of smoke will then be released and photographs will be taken to provide a record of cloud path and shape. As soon as final authority for the release has been obtained and the puff has moved past the Andersen samplers, network samplers and instrumentation will be turned on. The furnace will then be brought to temperature and will remain there for 10 minutes to effect the fission product release. Immediately following shutdown of the furnace, the aerosol generator will be started and fluorescent tracer material will be released for a period of 15 minutes. As soon as the last of the aerosol passes the 800-meter arc, the samplers on the inner four arcs will be turned off and a second smoke puff released to indicate atmospheric conditions. When the last of the aerosol passes over the end of the network, the remaining sampling arcs will be turned off. Smoke photography will continue until the smoke passes completely off the network.

# TEST SEQUENCE

| | FORECAST RELEASE | RELEASE AUTHORIZED | | |
|---|---|---|---|---|
| SMOKE | 15 - 50 m | | | |
| RADIOACTIVITY | | 10 m | | |
| TRACER | | | 15 m | |
| SAMPLERS | | | 33 - 40 m | 10 - 42 m |
| DOSIMETERS | | | | |

NPC 7298 A

60 5571

Radiation exposure of personnel participating in the release tests will be held within laboratory tolerance values. All entry to the test area will be regulated by AEC Health and Safety personnel and will be made through designated entrances where personnel logs will be maintained and film badges issued.

Because of the large assortment of nuclear activities at NRTS which contribute to exposure of the surrounding population, very conservative off-site contamination levels have been established for the series. Iodine from the fresh element releases will be the controlling off-site factor.

# RADIOLOGICAL SAFETY

- ON-SITE RESTRICTIONS

  TEST AREA ENTRY AT DESIGNATED POINTS

  PERSONNEL IN AREA UNDER MONITORING CONTROL

  PARTICIPANTS: 300 MREM/WK OR $< 3.75$ REM/SERIES

  NON-PARTICIPANTS: STATUS NOT AFFECTED

- OFF-SITE RESTRICTIONS

  PERSONNEL TOLERANCE STATUS NOT AFFECTED

  IODINE-131 IN MILK $< 10^{-6} \mu c/ml$

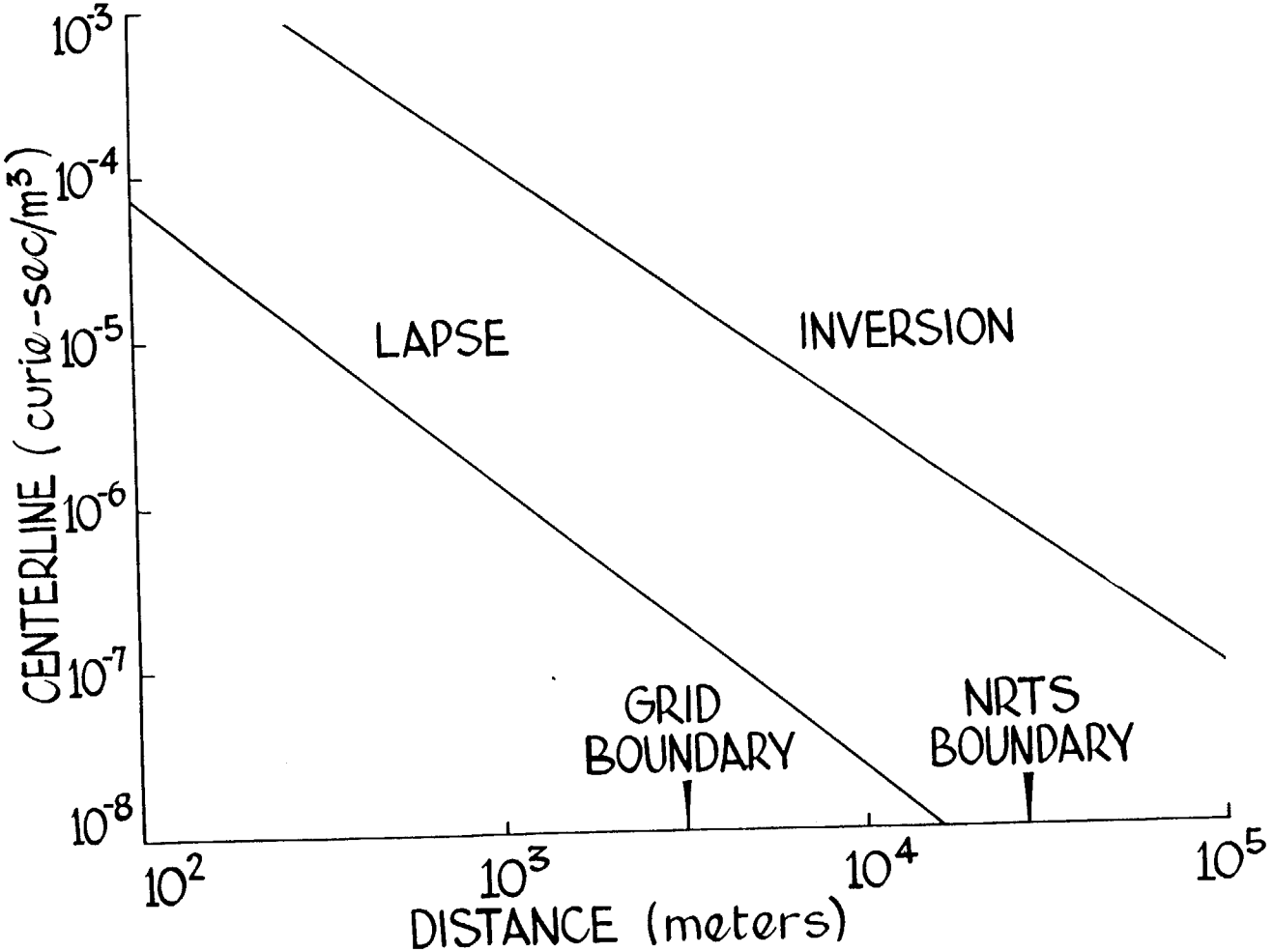
NPC 7296

The expected ground level cloud concentration from the aged element releases is shown on the opposite page. Only Cs-137 was considered, as it is the only biologically important isotope expected from the aged element release. Inversion values are higher than lapse values at all points due to the assumed value of deposition velocity, 0.1 cm/sec. With this deposition velocity, the cloud depletion factor is not significant. This tends to maximize the anticipated cloud concentration, which in both cases is very low. It is expected that no detectable off-site air concentrations will be observed.

1255371

# CLOUD ACTIVITY

• AGED ELEMENT RELEASE

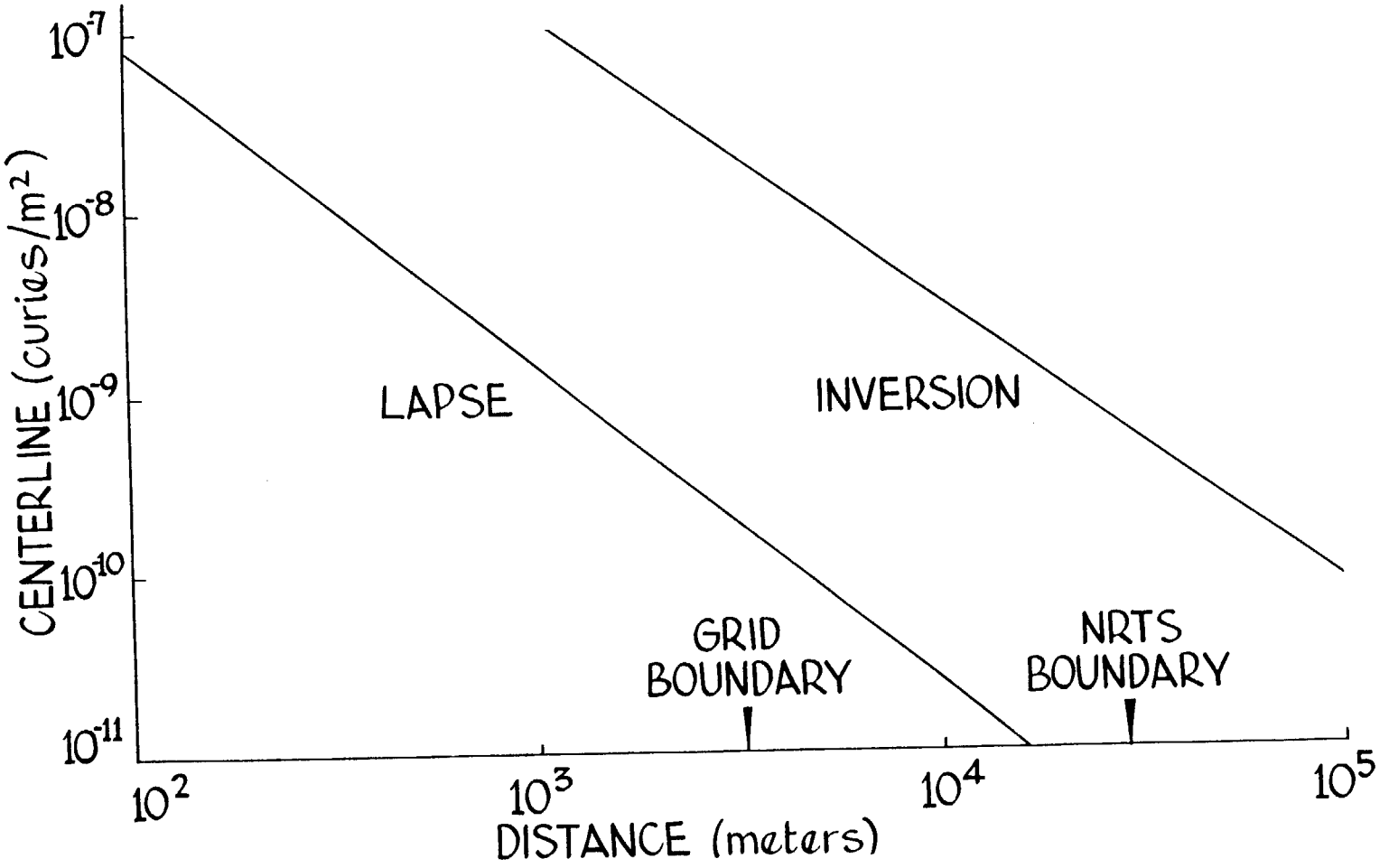



NPC 7290

The ground contamination resulting from the aged element releases are expected to be negligible outside the network. Cesium-137, a muscle seeker, is much less of a problem than iodine-131, due to the smaller inventory, small release fraction, and lower toxicity. No detectable off-site ground contamination is anticipated from the aged element releases.

# GROUND ACTIVITY

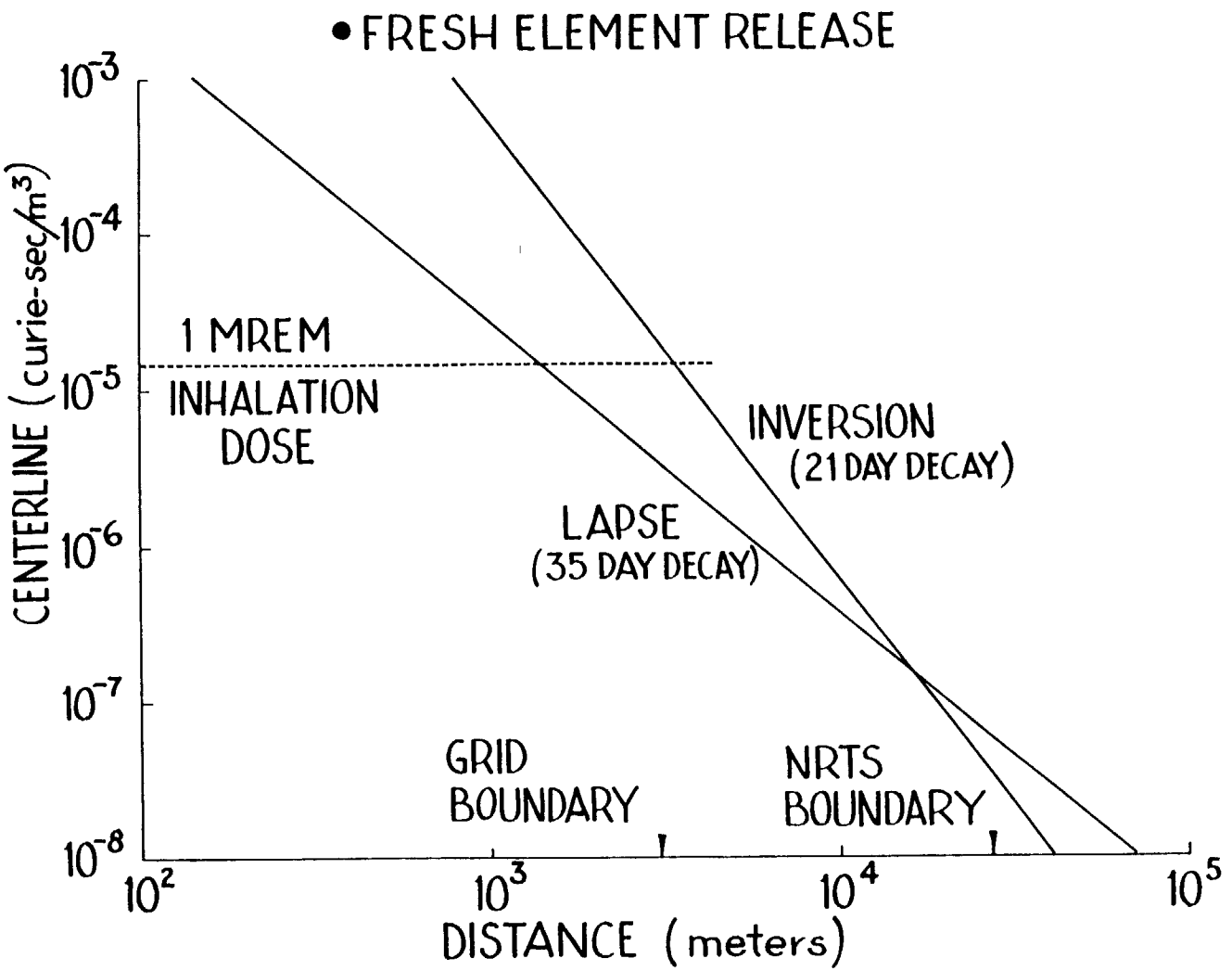
• AGED ELEMENT RELEASE




NPC 7291

The cloud hazard from the fresh element release is considered to consist only of I-131, since it is the dominant biological offender. The values shown are those which apply to the first release under each condition. The first inversion release is planned for 21 days after and the first lapse release 35 days after removal from the MTR. In this way, the shorter-lived iodine isotopes do not contribute to the iodine activity. Due to the assumed value of $V_g$ (2 cm/sec), the inversion case falls off faster than the lapse case. The concentrations under inversion conditions are higher initially, but the effect of the cloud depletion factor is to reduce the concentrations quite rapidly. Exposure of a person to the cloud during its full passage anywhere outside the network would result in a thyroid exposure of less than 1 mrem for any release condition.

# CLOUD ACTIVITY




NPC 7292

Ground deposition from the fresh element releases is considered to be the controlling factor in the determination of allowable off-site radiation hazard. The maximum I-131 release is governed by the thyroid dose delivered to off-site inhabitants by way of the vegetabion-to-milk cycle. Due to the cloud depletion under inversion conditions, off-site contamination levels are more severe for the lapse release than for the inversion release. Accordingly, the release schedule has been adjusted so that the off-site milk contamination level will not exceed the maximum permissible level of $10^{-6}$ $\mu c/ml$. Milk contamination predictions are based on the following relationship suggested by IDO:

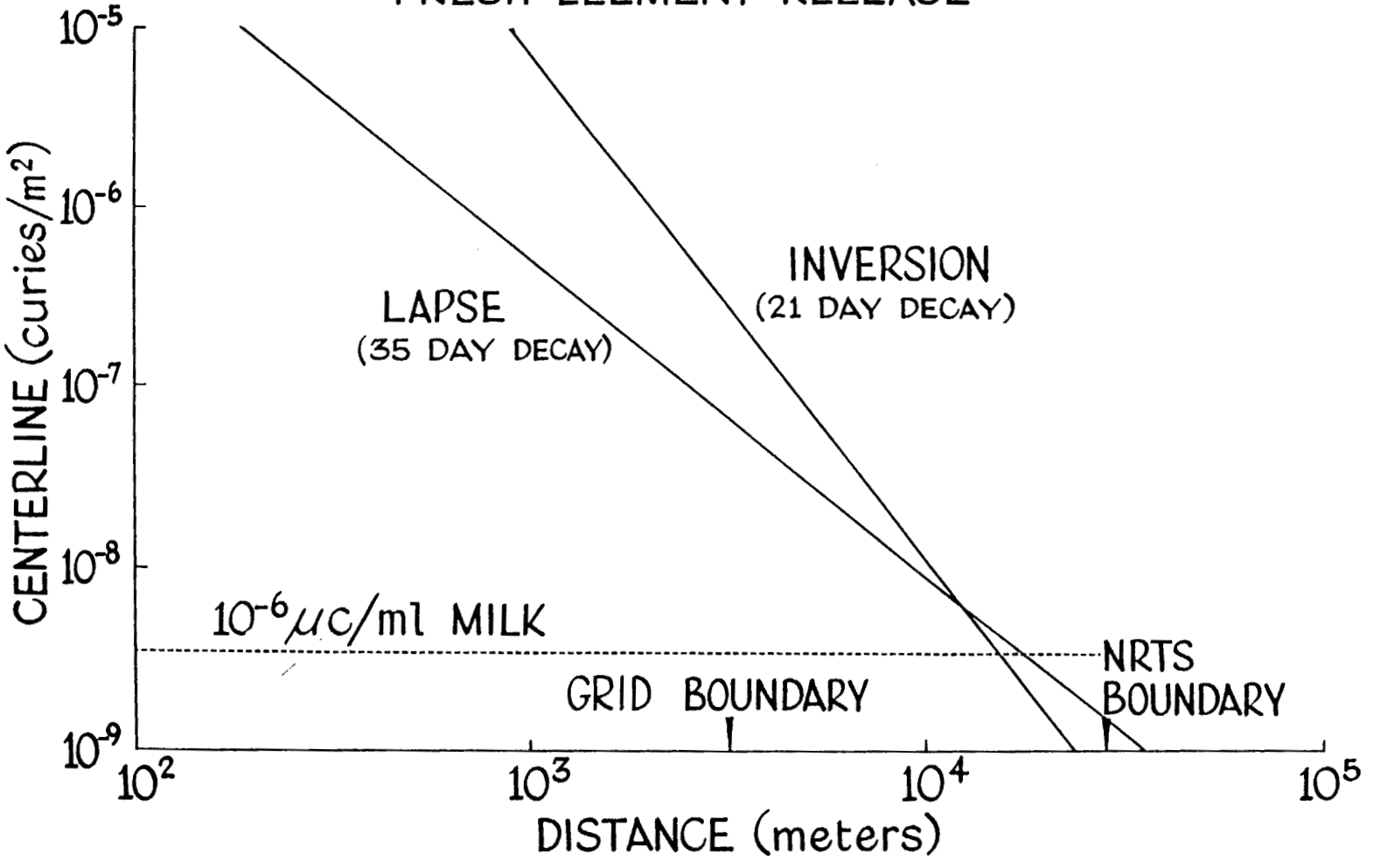
$$\mu c/ml = \frac{\text{ground contamination level}}{\text{vegetation-area factor}} \times \text{vegetation-to-milk factor}$$

where: vegetation-area factor = 50 $gm/m^2$ (vegetation grazed per sq meter)

vegetation-to-milk factor = .02 uc/ml per $\mu c/gm$.

# GROUND ACTIVITY

• FRESH ELEMENT RELEASE




NPC 7293

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