ARGON ACTIVATION EXPERIMENT

Addendum 1

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A Division of General Dynamics Corporation

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FORT WORTH

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Addendum 1

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ABSTRACT

This document, an addendum to Convair-Fort Worth Report MR-N-260 (NARF-60-16T, 27 May 1960), contains additional irradiated argon measurements for the Aircraft Shield Test Reactor (ASTR). It also contains the results of the initial studies performed on the exhaust effluent from the dry-pool environment (Configuration III) of the 3-Mw Ground Test Reactor (GTR).

With the ASTR in the 2π geometry of Configuration II, no detectable amounts of argon-41 were present in the air above the reactor at a power level of 2 Mw. With the GTR in the irradiation closet of Configuration III (4-inch water reflector), an argon activity of 0.5×10^{-10} μc/cc-watt was generated in the dry side of the pool.

TABLE OF CONTENTS

		Page
	ABSTRACT	2
I.	INTRODUCTION	5
II.	EXPERIMENTAL PROCEDURE	9
	2.1 Full-Flow Detection Chamber	9
	2.2 ASTR Open-Air Experiment	10
	2.3 GTR Dry-Pool Experiment	10
	2.4 Analysis	11
III.	RESULTS AND DISCUSSION	12
	3.1 ASTR Open-Air Experiment	12
	3.2 GTR Dry-Pool Experiment	12
	3.3 Dry-Pool Flux Mapping Experiment	13
	3.4 NARF Meteorological Investigation	13
IV.	CONCLUSIONS	17
	REFERENCES	18
	DISTRIBUTION	19

LIST OF FIGURES

		Page
1.	3-Mw GTR Irradiation Environment	6
2.	Air Monitoring System	7
3.	Thermal-Neutron Flux Profile in Dry Pool	14
4.	Atmospheric Diffusion Criteria at NARF	15

I. INTRODUCTION

In this series of investigations, activated air was sampled for analysis from each of the following configurations:

I. ASTR in closed, dry tank, with reactor axis vertical and with tank air exhausting to the atmosphere through a 20-foot stack (Ref. 1).

II. ASTR in open, wet tank, with reactor axis horizontal, with bottom half of reactor submerged and top half in air but covered with experimental shield.

III. GTR in irradiation closet of senior pool, with dry-pool air exhausting to atmosphere through exhaust stack (blower rating, 12,000 cfm; (Ref. 2 and Fig. 1).

This document, an addendum to Convair-Fort Worth Report MR-N-260 (Ref. 1), contains additional argon-41 measurements for the Aircraft Shield Test Reactor (ASTR) in Configuration II. It also contains the results of initial studies performed on the exhaust effluent from the dry-pool (Configuration III) of the 3-Mw Ground Test Reactor (GTR). The Configuration I measurements are given in Reference 1.

The sampling network for the dry-pool effluent was the same as that used in the Dry-Tank Experiment described in Reference 1, the only exception being in the design and use of a new detection chamber. This chamber, the full-flow detection chamber (Fig. 2), was a refinement in that it provides:

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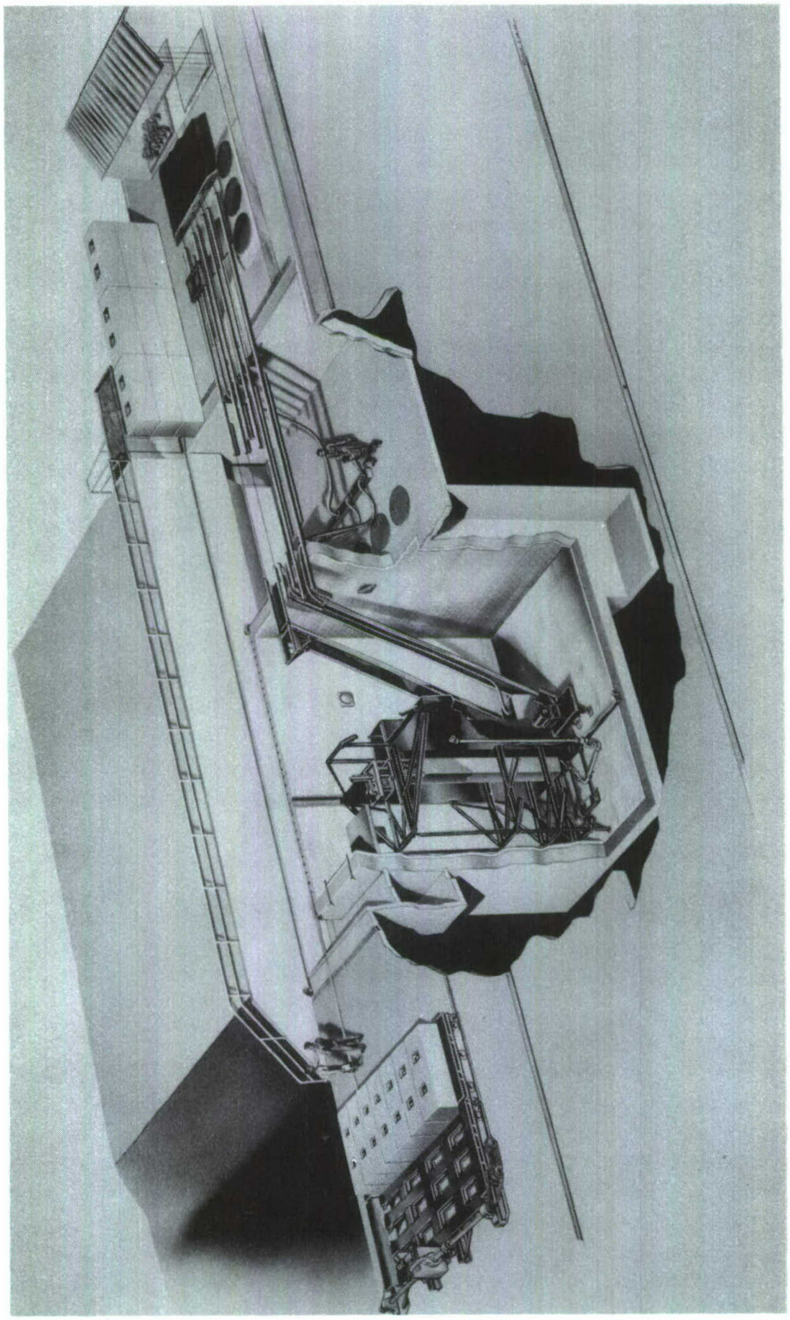

FIGURE 1. 3-Mw GTR IRRADIATION ENVIRONMENT

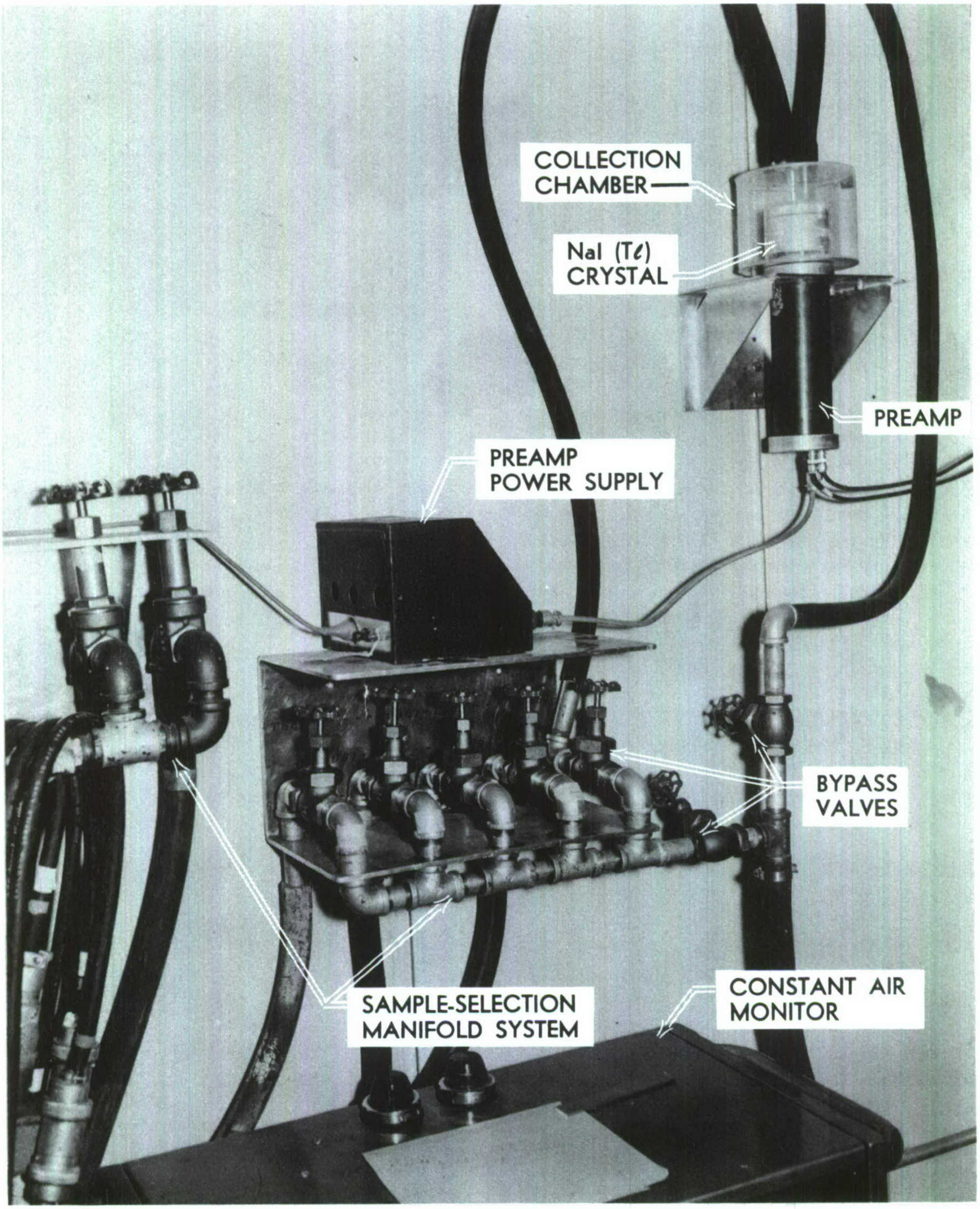

FIGURE 2. AIR-MONITORING SYSTEM

1. Better geometry

2. More unrestricted gas flow

3. More efficient sample collection.

The full-flow detection chamber was used to sample irradiated air in the two experiments that are reported here.

II. EXPERIMENTAL PROCEDURE

A new design of the detection chambers used in the earlier experiments (Ref. 1) was used in these measurements. Consequently, with better flow, larger sample volumes, and better detection geometry, a more accurate determination of the activities could be realized.

2.1 Full-Flow Detection Chamber

The full-flow detection chamber (Fig. 2) consists of two concentric plexiglass cylinders with appropriate inlet and outlet connections attached. The smaller of the two cylinders forms a cavity into which the NaI(Tℓ) crystal of a gamma-ray spectrometer is inserted. A valve system permits selection of the air sample from either the ASTR loading pit (water-regeneration-system location), senior-pool exhaust stack, GTR demineralizer house, or ASTR-tank exhaust system. This valve system also directs the airflow to a constant-air monitor (CAM) that is in continuous operation. Whenever the activity indicated by the CAM exceeds a certain preset level, the air may be bypassed through the full-flow detection chamber, where a more precise spectral analysis can be performed.

2.2 ASTR Open-Air Experiment

With the ASTR in the environment of Configuration II, an intake hose was placed along the top surface of the reactor. Under stagnant-air conditions (wind velocity less than 2 knots) and at a power of 2 Mw, air was withdrawn from the vicinity of the ASTR and pumped into the detection network, where decay measurements were made.

2.3 GTR Dry-Pool Experiment

The senior pool is divided into a wet side (reactor environment) and a dry side (irradiation environment) by a large, rigidly braced aluminum separator. A closet in the center of the separator projects into the dry side and provides an irradiation enclosure into which the GTR can be traversed, thus furnishing a 4-inch water reflector on three sides of the GTR. This environment allows a radiation volume of 20 x 20 x 27 feet or 10,800 ft^3 on the dry side. A 12,000-cfm blower changes the air in this volume approximately once every minute. A one-inch hose take-off from the stack transfers activated air from the dry-pool environment to the full-flow detection chamber in the control room.

2.4 Analysis

All spectral and analytical procedures, such as spectrometer setup, calibration of detection geometries, data reduction, were performed as described in Reference 1.

Values of p(E) and ϵ(E), the efficiency factors, for the new detection geometry are 0.215 and 0.084, respectively. Table I compares these values with those obtained for the two previous types of detection geometries reported in Reference 1.

TABLE I

COMPARISON OF GEOMETRIC EFFICIENCY FACTORS

Detection-Chamber Geometry	p(E)	ϵ(E)
Bubble	0.260	0.015
Coil	0.287	0.087
Full-flow	0.215	0.084

III. RESULTS AND DISCUSSION

Whereas only one accumulation was made of the data from the open-air experiment, several separate analyses were made of the air being exhausted from the dry-pool environment.

3.1 ASTR Open-Air Experiment

Analysis of the spectral data indicated that no peaks, other than those in the background prior to reactor startup, were present. Only a constant, slight increase above the gamma-spectrum background was recorded after the ASTR had attained 2 Mw.

3.2 GTR Dry-Pool Experiment

It is common practice to make analysis of air samples during periods when the ASTR and/or the GTR are being operated at power levels of 3 Mw. Table II contains results of the activity levels measured during high-power runs of the GTR while it was positioned in the dry-pool-closet environment.

TABLE II

COMPARISON OF MEASURED ACTIVITY LEVELS

Date	Reactor Power (Mw)	Activity (μc/cc)
9 March 1960	3.0	1.24×10^{-4}
27 April 1960	2.6	1.3×10^{-4}
29 April 1960	2.4	1.47×10^{-4}

3.3 Dry-Pool Flux Mapping Experiment

A comparison of the data presented in Reference 1 on the ASTR air activity can be made with that on the GTR activity in Table II if the thermal-neutron flux profile shown in Figure 3 is taken into consideration. This profile was determined during 3.10-Mw (in closet with 4-inch reflector) operation.

ASTR	GTR	
3.00	3.10	Power level (Mw)
10^{10}	3×10^{9}	ϕ_{avg} (n/cm^2-sec)
6×10^{-4}	1.5×10^{-4}	Argon activity (μc/cc)
2000	10,800	Volume irradiated (ft^3)
2200	12,000	Exhaust rate (cfm)

The flux measurements shown in Figure 3 were obtained by exposing bare and cadmium-covered copper foils at the positions where data are presented.

3.4 NARF Meteorological Investigation

In Reference 1, a dilution factor of 300 was assumed from known NARF meteorological data to substantiate the fact that by the time that living organisms ingested the effluent, it would be below AEC tolerance limits. A release experiment conducted in February and March of 1961 utilized uranine dye as a tracer from the ASTR exhaust stack and yielded dilution factors of 5,000 to 25,000, depending upon atmospheric conditions (Fig. 4).

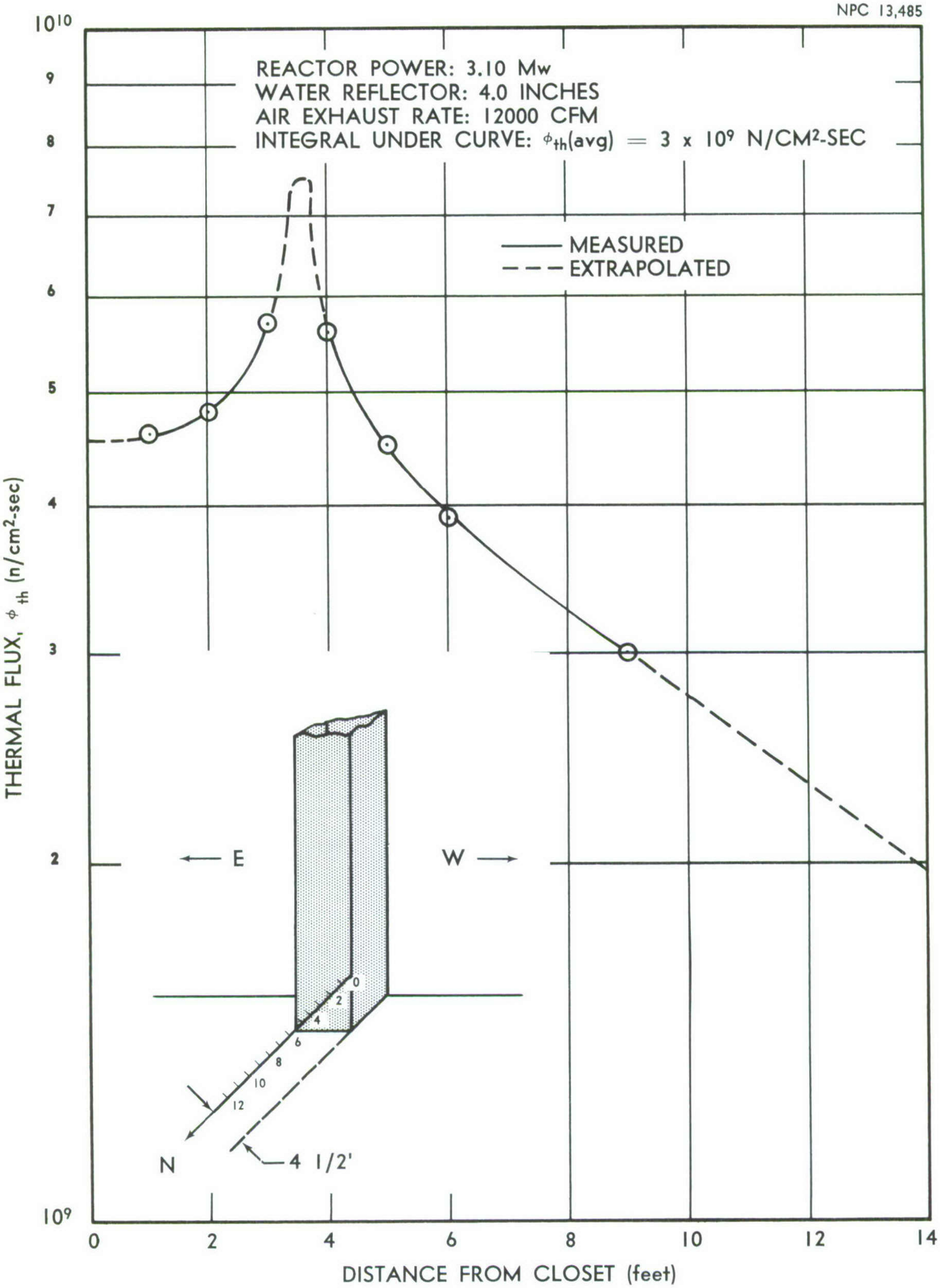

FIGURE 3. THERMAL-NEUTRON FLUX PROFILE IN DRY POOL

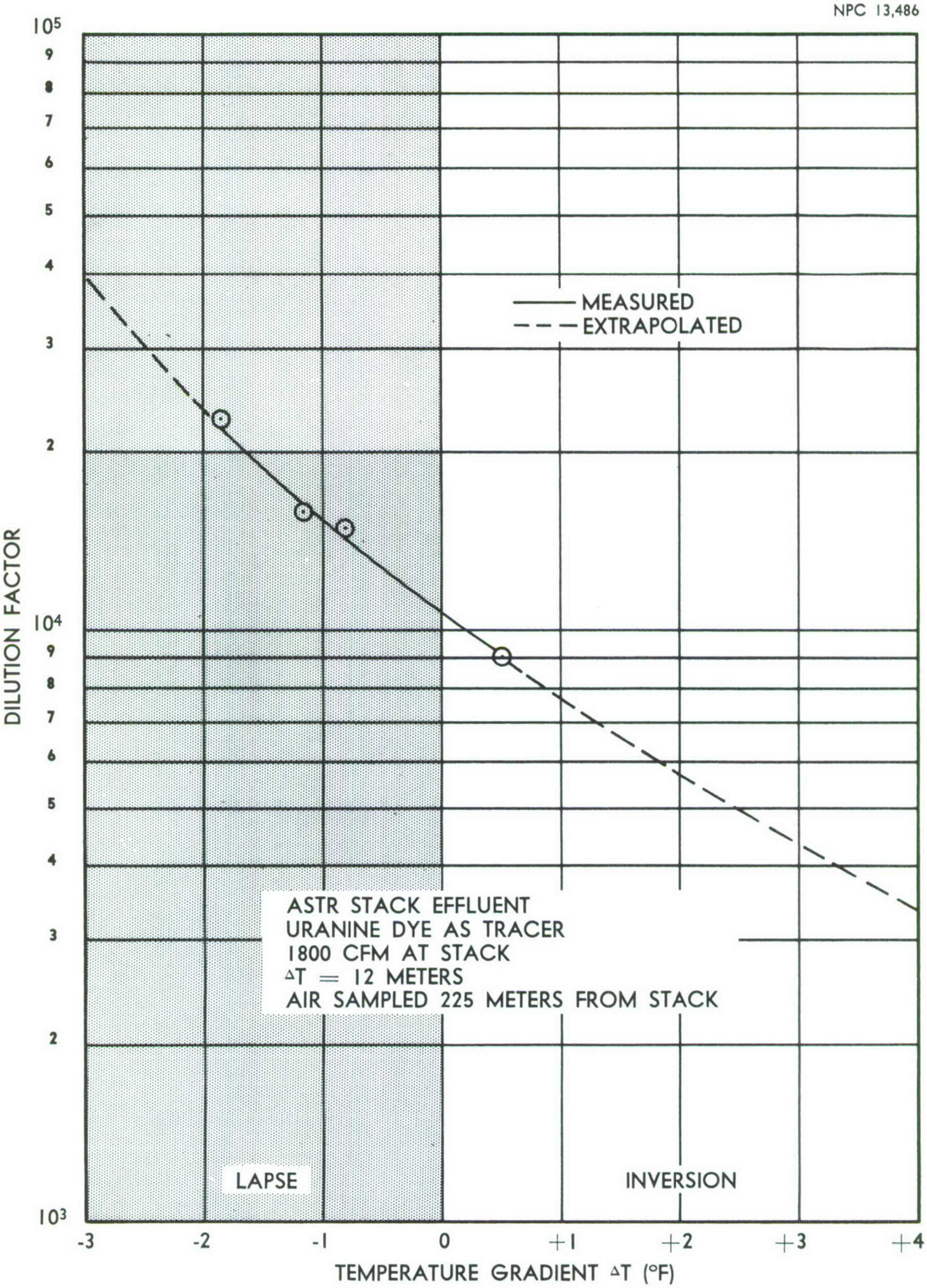

FIGURE 4. ATMOSPHERE DIFFUSION CRITERIA

A network of 250 meters from the release point with samples placed on a 30° arc provided good coverage, since the effluent cloud centerline was always on the arc. The predicted dilution factors were higher than the measured values by factors of from 2 to 8 times as much.

IV. CONCLUSIONS

The new full-flow detection chamber provided better source geometry (Table I) and speed of analysis. (Previous measurements of p(E) and $\in(E)$ for the bubble and coil detection chambers are believed to be in error, since a better method now being used tends to indicate this.)

Because of dilution of the irradiated air above the bare ASTR, no measurable quantities of A^{41} were detected. With the ASTR in the 2π geometry of Configuration II, the conclusion can be reached that there will be no personnel hazard from high concentrations of argon-41.

The results indicate that, although over-tolerance amounts of argon-41 are concentrated in the exhaust stacks of the GTR and ASTR, a highly conservative dilution factor of 1000 will render the effluent to from 3 to 4 times less than the AEC permissible tolerance limit when the cloud effluent reaches a radius of 250 meters.

REFERENCES

1. Anderson, D. G., Argon Activation Experiment. Convair-Fort Worth Report MR-N-260 (NARF-60-16T, 27 May 1960).

2. NARF Progress Report - Operations - 1 June through 30 November 1958. Convair-Fort Worth ANP Doc. No. NARF-58-54P. C.

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