TID-7677 (p. 392-400)

CONTROLLED ENVIRONMENTAL RADIOIODINE TESTS (CERT) AT THE NATIONAL REACTOR TESTING STATION*

Earl H. Markee, Jr., and C. A. Hawley, Jr.

TID 7677 pp. 392-400

CONTROLLED ENVIRONMENTAL RADIOIODINE TESTS (CERT) AT THE NATIONAL REACTOR TESTING STATION*

Earl H. Markee, Jr., and C. A. Hawley, Jr.

TID - 7677 pp. 392-400

SUMMARY

The CERT project consists of a series of planned releases of radioiodine over different vegetation and during various meteorological conditions, with the prime objective being to measure the amounts of radioiodine through the air-vegetation-cow-milk-human chain. This paper deals with the first, or preliminary, experiment in the CERT series at the National Reactor Testing Station (NRTS) in southeast Idaho. The preliminary experiment consisted basically of releasing radioiodine (iodine-131) gas over a natural Crested Wheatgrass pasture and using the contaminated grass for milk cow grazing. The resultant radioactive milk was fed to seven human volunteers. It was desired from this experiment to establish under known natural release conditions three basic relationships:

(1) The amounts of radioiodine in the air to those on the soil and vegetation,

(2) The amounts of radioiodine on the vegetation to those in the milk, and

(3) The quantities in the milk to those in the human thyroid after drinking the milk.

* The complete details of this CERT experiment will be published in the near future as IDO report number 12034.

Two 11.5 acre pasture areas with an initial grass density of 150 g/m^2 and an average height of 13 cm were established, one for contamination (hot) and one for control and background (cold), (Figure 1). Five iodine 131 generators which used the process of "swaging" the iodine 131 gas with nitrogen gas were oriented along a 150 m line normal to the expected prevailing wind, to simulate a short line source. The source line was 50 m upwind from the "hot" pasture. A dense sampling grid based on pre-test meteorological studies, was established to 300 m downwind (Figure 2). Background activities on soil and vegetation, as well as grass consumption and growth rates, were measured before and after the release. Milk production and activity levels were measured. The six cows used during the test were 1200-1600 pound fresh pure-bred Holsteins, obtained from Montana State College. Arrangements were made to maintain the cows on their normal feed supplements and the cows were acclimated to the natural grass and new surroundings for two weeks prior to placing them on the contaminated pasture. The cows were milked at 6 A.M. and 6 P.M. daily. Milk from the evening and morning milking of one cow was combined, pasteurized, counted, and consumed by seven volunteers over a 39-day period. Human thyroid activities were measured with a NaI crystal, 256 channel analyzer, in a low background whole-body counting vault.

A total of 970 millicuries of iodine-131 gas was released at 1500 MST on May 27, 1963 near ground level over a 30-minute period under moderately unstable meteorological conditions and an average wind speed of 6.6 mps. About 13% of the total released iodine was deposited on the grid, with 1.5% being actually on the grass (Figure 3). The Crested Wheatgrass covered about 15% of the total plot, the remaining surface being soil cover. Deposition velocities ranged from 0.4 to 0.8 cm/sec, with an average of 0.6 cm/sec. The activity on the carbon fall-out plates was found to be representative of the grass measurements.

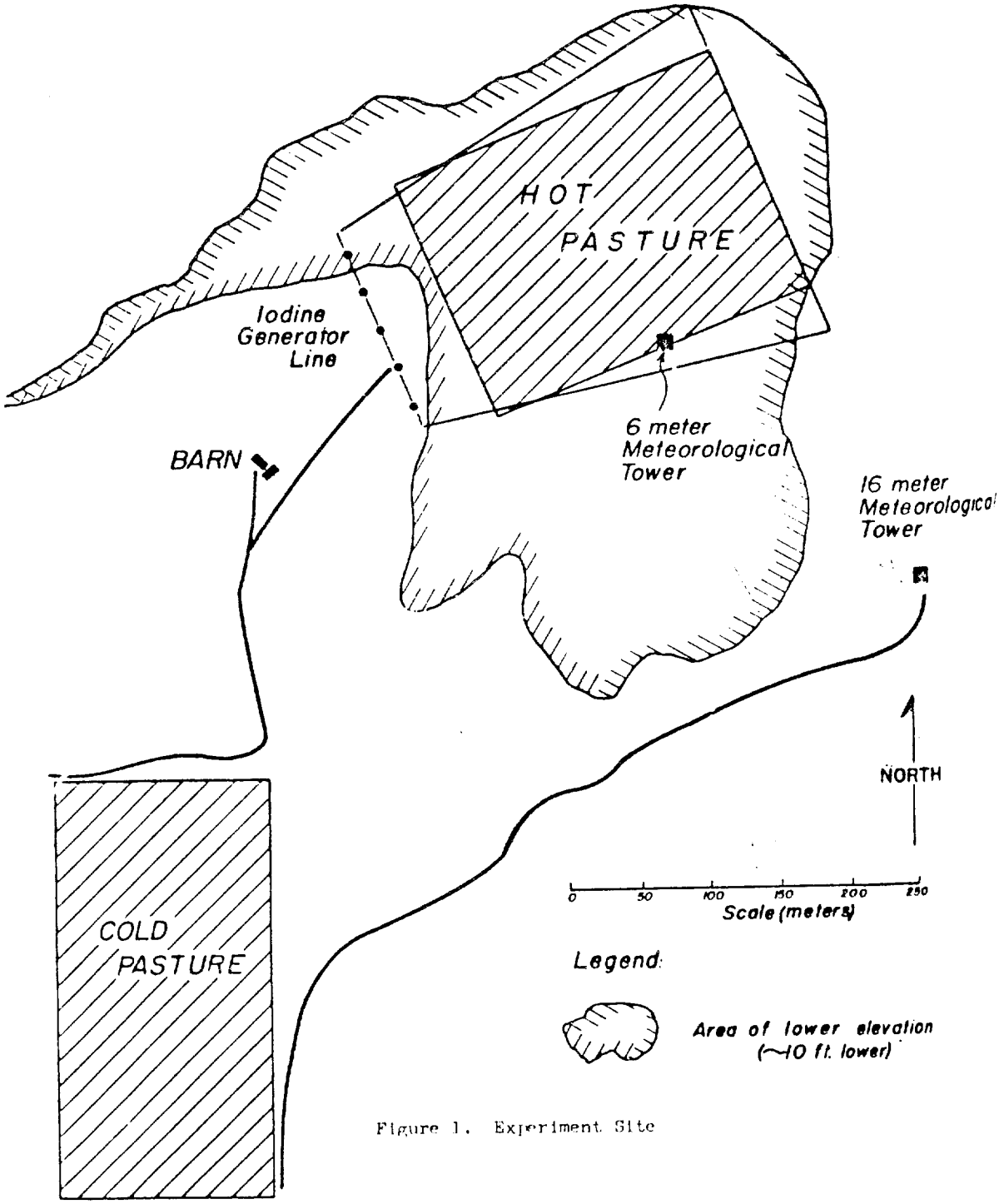


Figure 1. Experiment Site

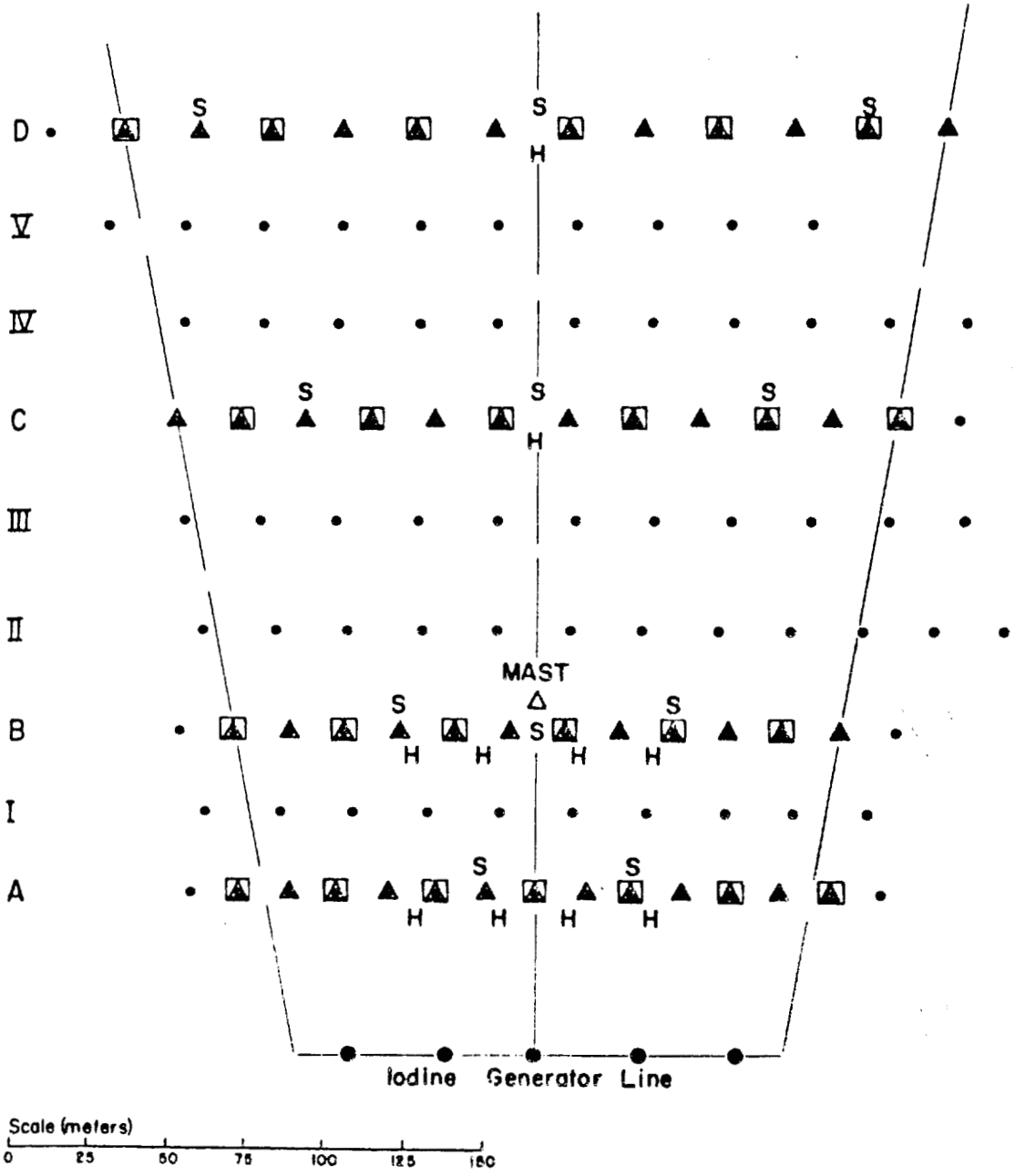
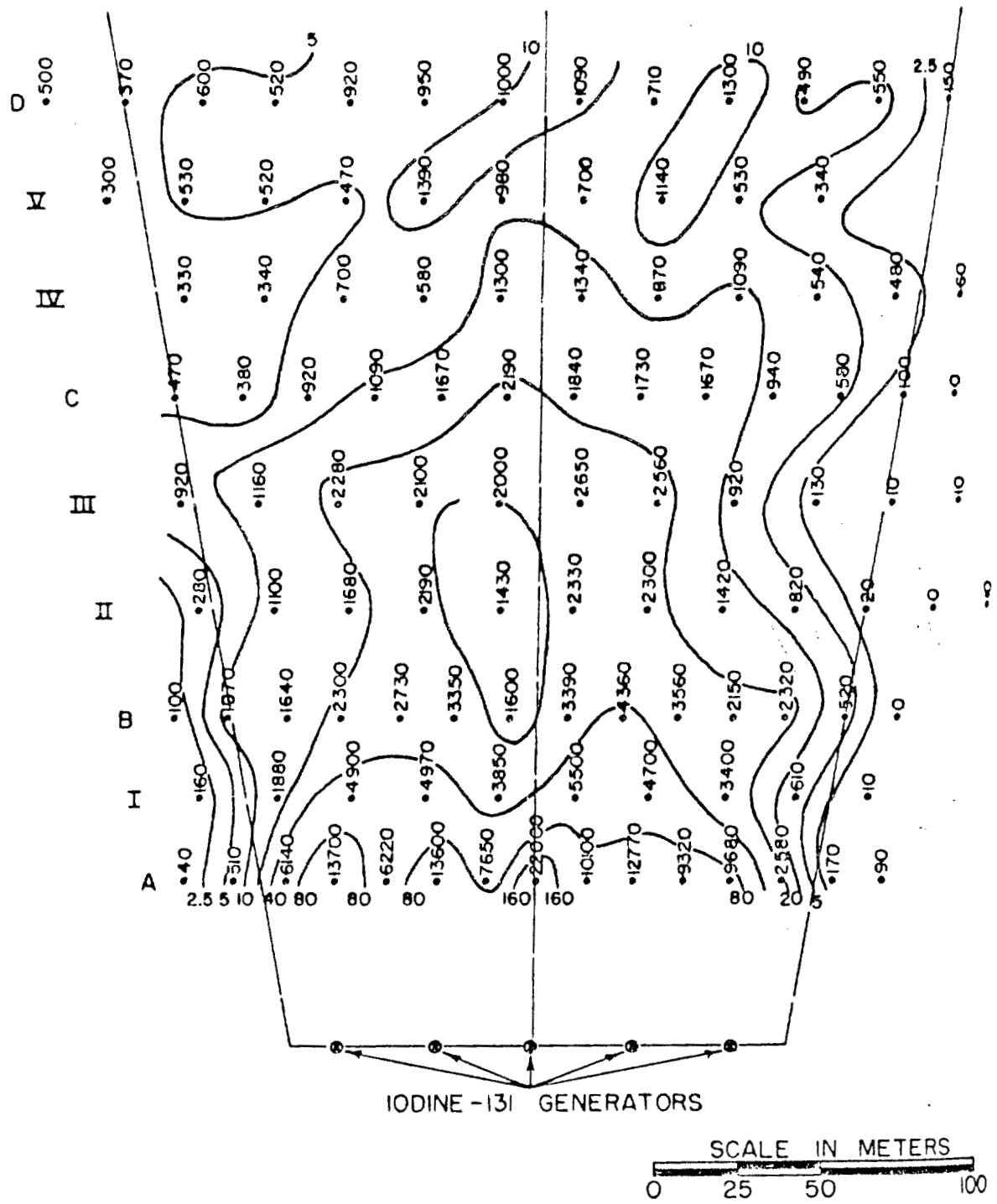


Figure 2. Sampling Grid

Legend:

- • Vegetation Samples
- △ Air Samples (Hi-Vol)
- □ Fallout (Carbon, Sand, Sticky Paper)
- S Soil Samples
- H Hanford Samplers

Figure 3. Initial Grass Deposition (μμc/gram)



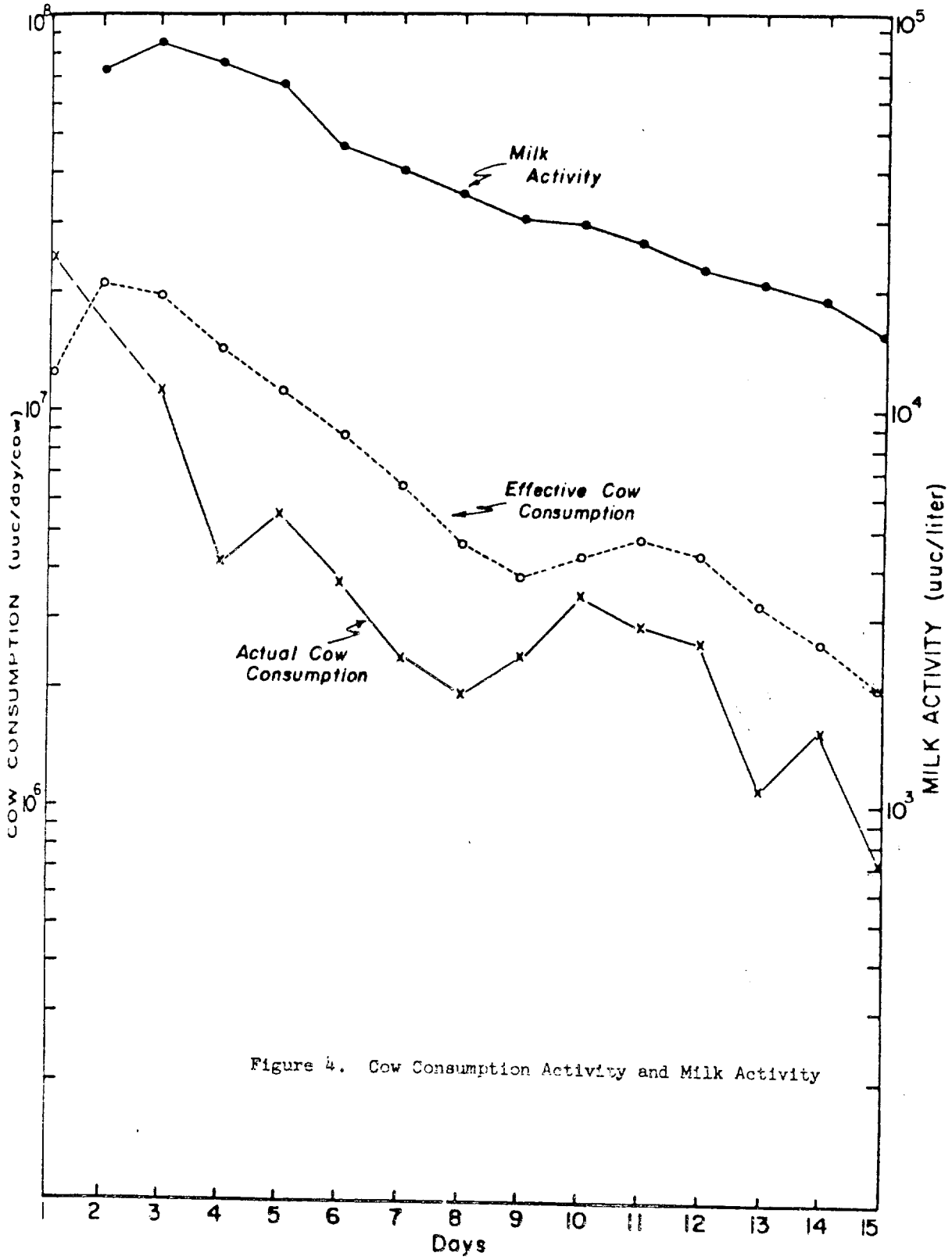


Figure 4. Cow Consumption Activity and Milk Activity

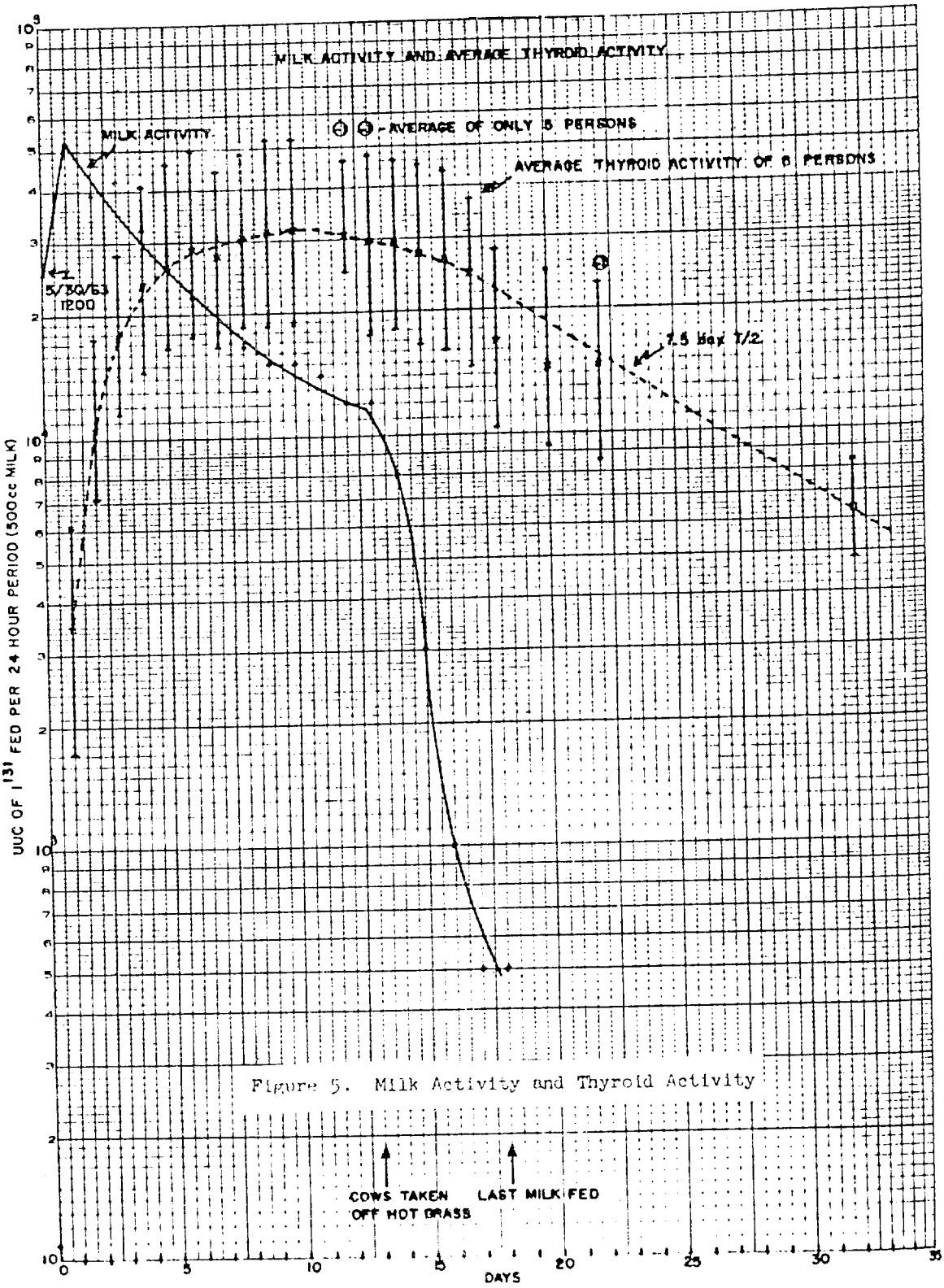


Figure 5. Milk Activity and Thyroid Activity

Controlled grazing which consisted of daily changes of 0.5 acre crosswind grazing strips progressing from 300 m downwind toward the source, enabled the quantitive measurement of grass consumption and activity. The effective half-life on grass was found to be 3.5 days. The comparison between grass activity and milk activity is shown in Figure 4. The effective cow consumption (Figure 4) represents the accumulation of activity within the cow from the current and previous days' grazing based on a one day "half-life" retention factor. The ratio of activities of grass and milk (nc/liter:nc/m) was 20 ± 35. The average thyroid uptake of ingested iodine-131 in milk was 19%. A model to predict thyroid activity levels was developed and shown to be quite accurate. The model is:

$$A_n = f \sum_{i=1}^{n} C_i \exp \left[-\lambda_E (T_n - T_{i-1}) \right]$$

A_n-Activity in thyroid at end of n'th time

f - Uptake factor (0.19)

C_i-Activity ingested at beginning of i'th time interval

λ_E-Effective decay constant (thyroid)

T_n-Total time elapsed

T_{i-1}-Time from 0 to end of (i-1) 'th interval

Thyroid doses to the volunteers averaged 0.39 Rad. A comparison of the milk and thyroid activities is shown in Figure 5.

The preliminary experiment showed that the basic experimental procedures were adequate. Further tests in the series will employ the same general procedures in investigating the behavior of radioiodines under various meteorological and physical conditions.

CONCLUDING STATEMENT BY MR. HAWLEY: I should have made it clear earlier that the prime objective of the preliminary experiment was to establish techniques that we can use when we get into the actual irrigated pasture system.

The cows were forced to graze in premeasured strips so that we could get a reasonable measurement of the actual amounts of grass the cows were eating. They were kept on the whole pasture long enough to get an idea as to how much grass would hold these cows for a one-day period. This was adjusted as the grass grew. This is the real trouble with this grass; at various times of the year it grows just like fury, and it was necessary to keep measuring and keep adjusting. We hope with the first test on our irrigated system, where we can actually control the grass measurements much better, we will be able to throw out this one variable. In this thing here, we treated all six of our cows.

We had six 1200 to 1600 pound pure-bred Holsteins, all of which were fresh, which were borrowed from Montana State College. So we took these six cows, and because there was never a factor of 2 discrepancy between the cows, we felt we could treat them as one animal, as far as the data goes. The cows were milked at 6:00 A.M. and 6:00 P.M.

Session Chairman: Thank you, gentlemen, for a most interesting presentation.

The next paper is a substitution which I don't think you will be able to find on your program. Mr. W. J. Megaw, of the United Kingdom Atomic Energy Authority at Harwell, and the topic of this paper is entitled, "The Efficiency of Membrane Filters."