Summary of Critique of
"Infant Mortality and Nuclear Power
Generation" -- Dr. Ernest Sternglass
by
Staff of the Atomic Energy Commission

In developing his hypotheses, Dr. Sternglass first calculated yearly radiation doses to persons around the Dresden plant based on short-time measurements by the U.S. Public Health Service.(1) He then purported to demonstrate that infant mortality rates for the State of Illinois did rise and fall parallel with quantities of radioactive effluent from the Dresden plant (1960-1968) while the infant mortality rates for New York State continued to decline during the same time period. Finally, Dr. Sternglass compared (a) infant mortality rates in Grundy County (in which the Dresden plant is located) and adjacent counties versus "control" counties and (b) variances in infant mortality rates among counties "upwind" versus "downwind" from the Dresden plant.

As the attached Critique documents -- all of Dr. Sternglass' hypotheses are invalid. The calculated annual radiation doses are in error; there is no consistent parallelism between the quantities of radioactive effluents from the Dresden plant and the infant mortality rates in the state as a whole or in individual counties of Illinois; there was a failure to analyze the data sufficiently in depth to realize that the rise to a significant level of infant mortality rates from 1963 to 1965 in the State of Illinois as a whole was due entirely to a rise in rates for the "non-white" population in Chicago only, which was unrelated to radiation exposure; use of incorrect key meteorological data and inadequate statistical analyses of the data on infant mortality rates for selected counties in Illinois led to invalid conclusions as to radiation doses, changes in infant mortality rates and possible relationships between the two.

A similar critique prepared by the U.S. Public Health Service (PHS)(2) reached the same general conclusions as stated here. "In summary, this analysis shows that radiation exposure has been grossly overestimated. In addition, the changes in infant mortality do not correlate with the radioactive emissions from the reactor site."

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In developing his hypotheses, Dr. Sternglass first calculated yearly radiation doses to persons around the Dresden plant based on short-time measurements by the U.S. Public Health Service (PHS)[1]. He then purported to demonstrate that infant mortality rates for the State of Illinois did rise and fall parallel with the quantities of radioactive effluent from the Dresden plant (1960-1968) while the infant mortality rates for New York State continued to decline during the same time period. Finally, Dr. Sternglass compared (a) infant mortality rates in Grundy County (in which the Dresden plant is located) and adjacent counties versus "control" counties and (b) variances in infant mortality rates among counties "upwind" versus "downwind" from the Dresden plant. Each of these three major areas will be discussed.

Radiation Exposures

The highest annual radiation doses (114-350 mr per year) estimated by Dr. Sternglass were based on measurements taken within 10-45 minute periods and made at, or extrapolated to, the area of greatest potential exposure beneath the center line of the plume. Dr. Sternglass then multiplied the dose rates (13 to 40 microroentgens per hour) by 8760 (the number of hours per year) to obtain his 114 to 350 milliroentgens per year. To make such a calculation a valid one would require that a person remain continuously out of doors, that he move around the perimeter of the site in complete synchronization with the shifting meteorology (so as to always be at the spot of highest concentration of radioactive nuclides in the air) and that the annual average concentration under the center line be the same as during the 10-45 minutes during which the measurements were taken. In fact, despite the difficulties as pointed out in reference (1) of estimating annual doses from such limited measurements taken at such low dose rates, the PHS report estimated that the annual (1968 -- the same year used in Dr. Sternglass' calculations) out-of-doors exposure would be about 6 mr per year.

The second highest annual radiation doses (17 to 26 mr per year) estimated by Dr. Sternglass were based on measurements taken with thermoluminescent dosimeters (TLD's) exposed for about 14 days. As the PHS report points out the differences between the readings of the TLD's intended to measure natural background only and those to measure background plus exposure from the effluents from the Dresden plant "are inconclusive." Of the TLD's placed at ten stations, three of these difference measurements were larger than their standard deviations (the ones used by Dr. Sternglass), four were smaller and three negative. Perhaps these results are not surprising considering the following facts. The gross readings of the TLD's were about 21 milliroentgens. From this it was necessary to subtract

an estimated 17 milliroentgens for "internal background." The necessity of "correcting" an observed low measurement by such a large factor, percentage wise, leaves in doubt the validity of the small difference value (4 milliroentgens). Further, the TLD's were transported by air to a laboratory in Las Vegas, Nevada. It was estimated that this and storage could account for 1 milliroentgen. An error in this estimate could increase the difference value (4 milliroentgens) by only 1 milliroentgen but could decrease the difference value to an insignificant amount.

The final annual radiation dose (22 mr per year) estimated by Dr. Sternglass is based on 10 minute measurements in the plume made in one day by NaI (TI) survey meters. As indicated previously, to extrapolate such short-term readings in the plume to annual doses exceed the limits of credibility. Further complications in these measurements were the necessity of calibrating the instrument response to the energies of the radiations from the plume (which do not in themselves remain constant) and distinguishing these radiations from natural background.

The Atomic Energy Commission has developed a computer program to calculate external man-rem exposures due to gaseous effluent releases from nuclear power plants. Attachment A presents the data for the Dresden plant for the years 1964, 1965, and 1966. These calculated out-of-doors annual exposures are considerably lower than those estimated by Dr. Sternglass and are in general agreement with the exposures given in the Public Health Service report(1).

Attachment A indicates out-of-doors annual exposures resulting from the effluents from the Dresden plant ranged from a few millirem in nearby areas to about 0.04 millirem in Chicago. In contrast, the natural radiation background in Illinois varies from 46 to 110 millirem per year.(2)

Attachment A also shows that some key meteorological factors used by Dr. Sternglass in his third series of arguments are in error. This will be discussed later.

Infant Mortality Rate -- State of Illinois

Dr. Sternglass contendsthat infant mortality rates in the State of Illinois rise and fall in parallel with the quantity of radioactive effluents from the Dresden plant. The basis for his contention is summarized in his Figure 1 and reproduced here, except that data for the year 1969 have been added by us. Figure 1 also indicates the steady decline in the infant mortality rates for the State of New York from 1959-1968, which Dr. Sternglass compares with the rates for the State of Illinois.

If excess infant mortality rates result primarily from irradiation <u>in utero</u>, as implied by Dr. Sternglass, then the increase would be expected to be found in recorded data the year following birth. Thus, excess death data should lag the effluent data by about a year. Figure 1 does

not show any consistent trend between the two variables of infant mortality rates and effluent data, i.e., some time periods indicate a parallelism while other periods do not.

The first year that substantial quantities of radioactive effluents occurred was in 1962 yet the infant mortality death rate in that year (as well as 1963) was lower in Illinois than New York State. Dr. Sternglass implies that fallout from nuclear weapons tests caused higher than expected rate in New York State in 1962 but that hypothesis has been completely discredited.(3) (4) (5)

A statistical analyses (using the Chi-square test) of the infant mortality rates for the State of Illinois as a whole in 1963 and 1965 did indeed show a significant increase. The analyses showed, however, that the rise observed statewide was related to a significant increase in Chicago only while the non-metropolitan counties of Illinois including Grundy County in which the Dresden plant is located and Will County that lies between the Dresden plant and Chicago did not show any significant increase between 1963 and 1965. (Infant mortality rates did rise significantly in Grundy County between 1964 and 1966. This will be discussed in the next section.) Further, the analyses revealed that for the years 1963 and 1965 there was no significant increase in infant mortality rates in Chicago for the "white" population while the rate for the "non-white" population did rise significantly.

In short, the significant rise to a significant level in infant mortality rates for the State of Illinois from 1963 to 1965 was related entirely to the increase in the "non-white" population of Chicago. Further, it is to be recalled that the annual out-of-doors radiation dose for the Chicago area as a result of the effluents from the Dresden plant is only about 0.04 millirem per year. Thus, one must look for other causes than radiation for increases in infant mortality, i.e., differences in social, economic, medical, nutritional, etc., factors.

These analyses also indicate the unreliability of comparing infant mortality rates between two states, on a state-wide basis, as Dr. Sternglass did in his paper. Other analyses(2) indicate that the infant mortality rates for rural Illinois and rural New York did not show a significant difference for the period of 1960-1967. The rates for New York City did fall below those of Chicago in the 1964-1967 period but the rates for St. Louis, for example, and Chicago for the same period of time showed no consistent relative trend. Again, one must look for other factors to explain any possible differences in infant mortality rates.

Infant Mortality Rates -- "Adjacent" Counties of Illinois

Dr. Sternglass' last contention is to claim a "clear positive association between radiation dose and effect on infant mortality." He proceeds in his arguments by comparing changes in the rates of infant mortality during 1964-1966 for "adjacent" counties to the Dresden plant sites and "control" counties. His data are summarized in his Table I reproduced here.

TABLE I

Infant Mortality Changes 1964-1966
in Illinois Counties near Dresden*

		1964			1966		Percent Change
		Deaths	Births	Rate 1000	Deaths	Births	Rate 1000	in Rates 1964-66
Adjacent Counties	Grundy (Reactor)	7	442	15.8	18	474	38.0	+141%
	Livingston (S)	6	728	8.2	12	608	19.7	+140%
	Kankakee (SE)	41	1976	20.7	54	1830	29.5	+ 43%
	Will (NE)	109	4920	22.2	100	4294	23.3	+ 5%
	LaSalle (W)	49	2176	22.5	39	1858	21.0	- 7%
	Kendall (N)	11	460	23.9	7	422	16.6	- 31%
Control Counties	Ogle (NW)	16	854	18.7	20	808	24.8	+ 33%
	Winnebago (WN)	122	5002	24.4	122	4788	25.5	+ 5%
	Henry (W)	17	930	18.3	16	862	18.6	+ 2%
	Stephens (NW)	25	978	25.6	20	808	24.8	- 3%
	Knox (SW)	22	1130	19.5	17	946	18.0	- 8%
	Lee (W)	17	658	25.8	9	594	15.2	- 41%

*Source: U.S. Vital Statistics

Dr. Sternglass' second basis of comparison among the counties of Illinois is premised on his belief "it appears that significant increases in infant mortality might be detected in the areas downwind from the prevailing westerly winds that should not be observed in the upwind direction."

These two hypotheses will be considered by examining the relative radiation doses among the pertinent counties and relating these to changes in infant mortality rates and by a statistical analysis of the relative infant mortality rates in 1964 and 1966 within each county.

Even a cursory comparison of Attachment A and Dr. Sternglass' Table I will reveal a lack of correlation between radiation doses and changes in infant mortality rates. For example, the adjacent county of Livingston showed the highest rate of increase (+140%) in infant mortality rate from 1963 to 1965, yet the wind frequency in that direction was only about 7-8%; the wind frequency into adjacent Will County was about 17% yet the increase infant mortality rate was only 5%.

More specifically, statistical analyses were made (using the Chi squared test) of infant mortality rates within each county named in Dr. Sternglass' Table I comparing their rates in 1964 with those in 1966. Only one county (Grundy) showed a statistically significant increase. Two other nearby counties (Bureau and DeKalb) not named in Table I showed negative statistically significant values and the changes in infant mortality rates for all the other counties in Table I were not significant either positive or negative.

The Dresden plant is located in Grundy County where there was a statistical increase in infant mortality between 1964 and 1966. Without further considerations one might erroneously conclude from this that there is a positive correlation between radiation dose and infant mortality rates (although all the other evidence does not support this conclusion). A reexamination of the map in Attachment A will show, however, that Dresden is located in the northeastern part of Grundy County and that the average potential radiation dose to the inhabitants of Grundy County is no more, and probably less than, Kendall and Will Counties which are adjacent to Grundy County. The possible causes of infant mortality are so numerous that there is no obvious explanation for the significant rise in infant mortality rates in Grundy County from 1964 to 1966. Variations in infant mortality from year to year -- both in absolute numbers and rates -- are the common throughout the U.S. The population of Grundy County is small and both birth and infant death rates are small. A high variability is characteristic of such data. In 1969 (the latest data available) the infant mortality rate for Grundy County was higher than those in two adjacent counties but smaller than those for the other three adjacent counties.

Addendum

Another hypothesis proposed by Dr. Sternglass was that a correlation existed between death rates due to respiratory diseases other than pneumonia and influenza for all age groups in Illinois and the Annual releases of gaseous radioactive effluents from the Dresden plant. The U.S. Public Health Service report stated, "Sternglass' proposed relationship between respiratory diseases and radiation exposure is based on a difference in the rate of increase between Illinois and New York. Both

States had similar rates in 1967 (18.6 and 18.7/100,000), but in 1959, Illinois and New York had rates of 10.9 and 13.0/100,000, respectively. The rise in both states is not unique, but is observed in the United States as a whole and is probably related to many factors common to urban life. To resolve this problem would require an analysis of the specific disease categories in several states. Many of the etiological factors are unidentified and it appears extremely unlikely that the radiation is the single causative agent in Illinois . . ."

Finally, Dr. Sternglass alludes to the incidence of leukemia and malignant tumors as related to irradiation of the populations in Illinois. This is discussed in the PHS report with their conclusions, "Neither the death rate from leukemia nor from all neoplasms are correlated with the gaseous discharge from Dresden."

References

1. Radiological Surveillance Studies at a Boiling Water Nuclear Power Reactor, Kahn, B., et al, U.S. Department of Health, Education and Welfare, Public Health Service, BRH 70-1, March 1970.

2. A Critical Review of "Infant Mortality and Nuclear Power Generation," Davis, A. K. and Kahn, B., Environmental Protection Agency, January 1971.

3. Evaluation of a Possible Causal Relationship Between Fallout Deposition of Strontium 90 and Infant and Fetal Mortality Trends, Tompkins, Edythalena and Brown, Morton L., U.S. Department of Health, Education and Welfare, Public Health Service, DBE 69-2, October 1969.

4. "More on Radioactive Fallout," Newsletter Supplement, Committee on Environmental Hazards, American Academy of Pediatrics, April 15, 1970.

5. "The Sternglass Claims -- No Basis in Fact," Editorial in American Journal of Public Health and the Nation's Health, June 1970.

Attachment A

THEORETICAL ESTIMATES OF RADIATION EXPOSURES IN THE VICINITY OF DRESDEN FROM GASEOUS EFFLUENTS DURING 1964, 1965 and 1966

The Atomic Energy Commission has developed a computer program to calculate external man-rem exposures due to beta and gamma emitters released in nuclear power plant gaseous effluents.

The calculations are based on actual population distribution, average wind rose data (direction, speed, and frequency), and average mixes of weather types.* The exposure values are based on annual average effluent releases in terms of percentages of release limits. The results do not take into account the fact that people will not normally be present continually year round and will normally be indoors part of the time and will normally be shielded by building materials. These factors would reduce actual exposures, perhaps by a factor of 2.

The attached Tables I, II and III provide the calculated values of the average annual doses to the populations in annular sectors in the vicinity of the Dresden Nuclear Power Plant for the years 1964, 1965 and 1966, respectively. Each table includes the average annual wind direction frequency and the total gaseous emission for the selected year.

This same data is shown in Figures 1, 2 and 3 which are maps of northern Illinois which includes the individual counties and the appropriate average annual doses in mrem for the annular sectors given in the tables.

*Yearly data do not deviate significantly from the averages used here.

TABLE I Calculated Annual Average Doses (mrem) for 1964
Noble Gas Emission 521,000 Ci (2.37% of limit)

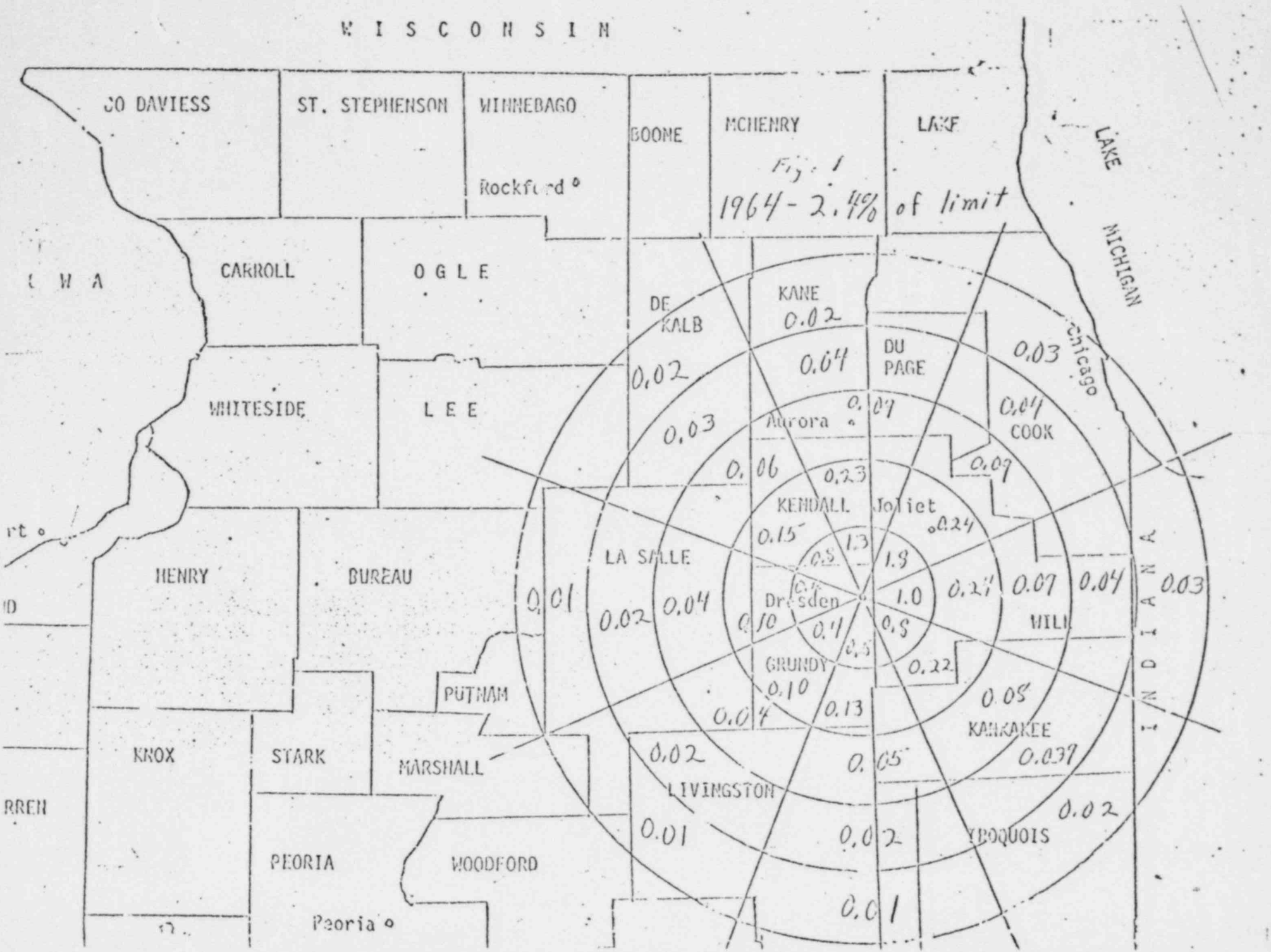
Direction	Wind Freq. %	Distance in Miles				
		0-10	10-20	20-30	30-40	40-50
N	16.3	1.25	0.23	0.09	0.041	0.024
NE	17.1	1.78	0.24	0.09	0.044	0.026
E	17.4	0.99	0.24	0.09	0.044	0.026
SE	15.3	0.84	0.22	0.08	0.039	0.022
S	9.1	0.54	0.13	0.05	0.024	0.013
SW	7.0	0.37	0.10	0.04	0.017	0.011
W	7.1	0.41	0.10	0.04	0.017	0.011
NW	10.8	0.80	0.15	0.06	0.028	0.015

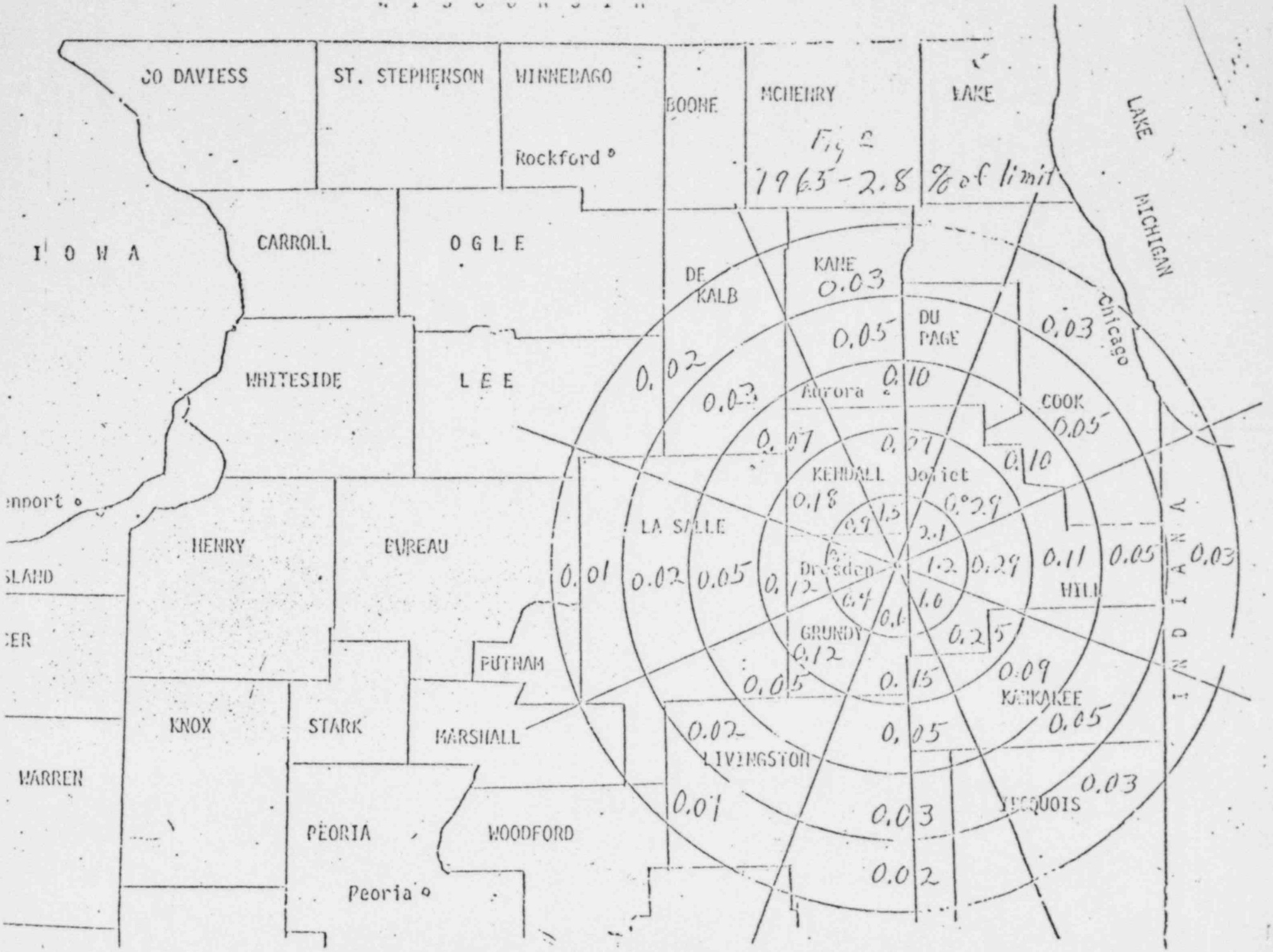
TABLE II Calculated Annual Average Doses (mrem) for 1965
Noble Gas Emission 610,000 Ci (2.77% of limit)

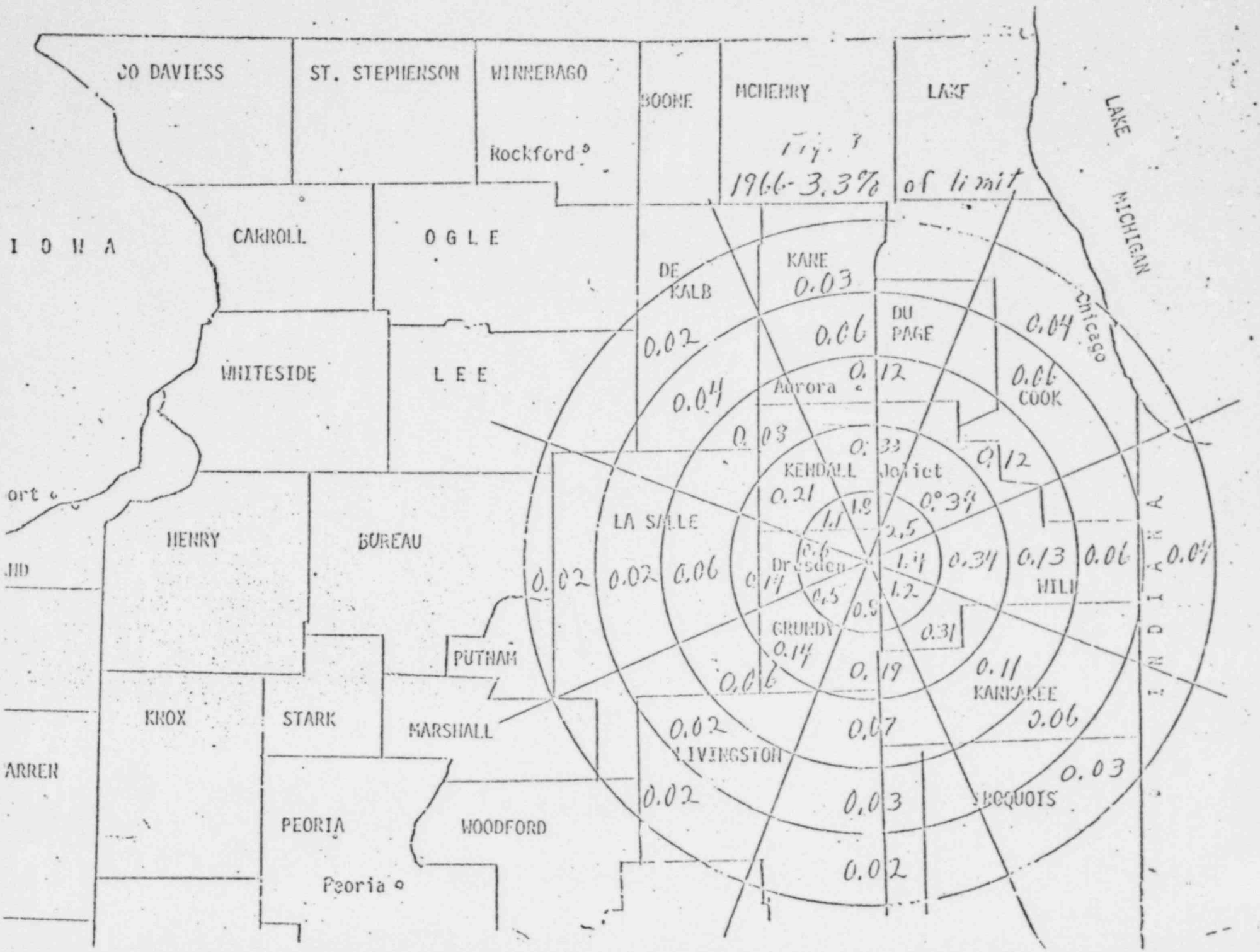
Direction	Wind Freq. %	Distance in Miles				
		0-10	10-20	20-30	30-40	40-50
N	16.3	1.46	0.27	0.10	0.048	0.028
NE	17.1	2.08	0.29	0.10	0.051	0.030
E	17.4	1.15	0.29	0.11	0.051	0.030
SE	15.3	0.99	0.25	0.09	0.045	0.025
S	9.1	0.63	0.15	0.05	0.028	0.015
SW	7.0	0.43	0.12	0.05	0.020	0.012
W	7.1	0.48	0.12	0.05	0.020	0.012
NW	10.8	0.93	0.18	0.07	0.033	0.018

TABLE III Calculated Annual Average Doses (mrem) for 1966
Noble Gas Emission 736,000 Ci (3.34% of limit)

Direction	Wind Freq. %	Distance in Miles				
		0-10	10-20	20-30	30-40	40-50
N	16.3	1.76	0.33	0.12	0.058	0.033
NE	17.1	2.50	0.34	0.12	0.061	0.036
E	17.4	1.39	0.34	0.13	0.061	0.036
SE	15.3	1.19	0.31	0.11	0.055	0.031
S	9.1	0.76	0.19	0.07	0.033	0.019
SW	7.0	0.52	0.14	0.06	0.024	0.015
W	7.1	0.58	0.14	0.06	0.024	0.015
NW	10.8	1.12	0.21	0.08	0.040	0.021


WISCONSIN
JO DAVIESS
ST. STEPHENSON
WINNEBAGO
Rockford
BOONE
MCHENRY
LAKE
Fig. 1
1964 - 2.4% of limit
LAKE MICHIGAN
CARROLL
OGLE
WHITESIDE
LEE
DE KALB
KANE
0.02
0.04
DU PAGE
0.03
Chicago
0.02
0.03
Aurora
0.07
0.04
COOK
0.06
0.23
0.09
KENDALL
Joliet
0.24
0.15
LA SALLE
1.3
0.5
1.8
HENRY
BUREAU
0.01
0.02
0.04
Dresden
1.0
0.21
0.07
0.04
0.03
0.10
0.4
0.5
0.5
GRUNDY
0.22
0.10
0.04
0.13
0.05
PUTNAM
KNOX
STARK
MARSHALL
KANKAKEE
0.02
0.05
0.039
LIVINGSTON
0.02
0.01
0.02
IROQUOIS
PEORIA
WOODFORD
0.01
Peoria
INDIANA


JO DAVIESS
ST. STEPHENSON
WINNEBAGO
Rockford
BOONE
MCHENRY
LAKE
Fig 2
1963 - 2.8 % of limit
LAKE MICHIGAN
IOWA
CARROLL
OGLE
DE KALB
KANE
0.03
DU PAGE
0.05
0.03
Chicago
WHITESIDE
LEE
0.02
0.03
Aurora
0.10
COOK
0.05
0.07
0.07
0.10
KENDALL
Joliet
0.18
0.29
LA SALLE
0.9
1.5
2.1
HENRY
BUREAU
0.01
0.02
0.05
0.12
1.2
0.29
0.11
0.05
0.03
Dresden
0.4
1.6
0.1
GRUNDY
0.12
0.25
PUTNAM
0.05
0.15
0.09
KANKAKEE
KNOX
STARK
MARSHALL
0.02
0.05
0.05
LIVINGSTON
WARREN
0.01
0.03
IROQUOIS
0.03
PEORIA
WOODFORD
0.02
Peoria
INDIANA


JO DAVIESS
ST. STEPHENSON
WINNEBAGO
Rockford
BOONE
MCHENRY
LAKE
LAKE MICHIGAN
1966-3.3% of limit
IOWA
CARROLL
OGLE
WHITESIDE
LEE
DE KALB
KANE
0.03
DU PAGE
Chicago
0.04
0.02
0.06
0.04
0.12
Aurora
0.06
COOK
0.03
0.33
0.12
KENDALL
Joliet
0.21
0.34
LA SALLE
1.1
1.9
2.5
HENRY
BUREAU
0.02
0.02
0.06
0.14
Dresden
1.4
0.34
0.13
0.06
0.04
WILL
0.5
1.2
0.9
GRUNDY
0.31
0.14
PUTNAM
0.06
0.19
0.11
KANKAKEE
KNOX
STARK
MARSHALL
0.02
0.07
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LIVINGSTON
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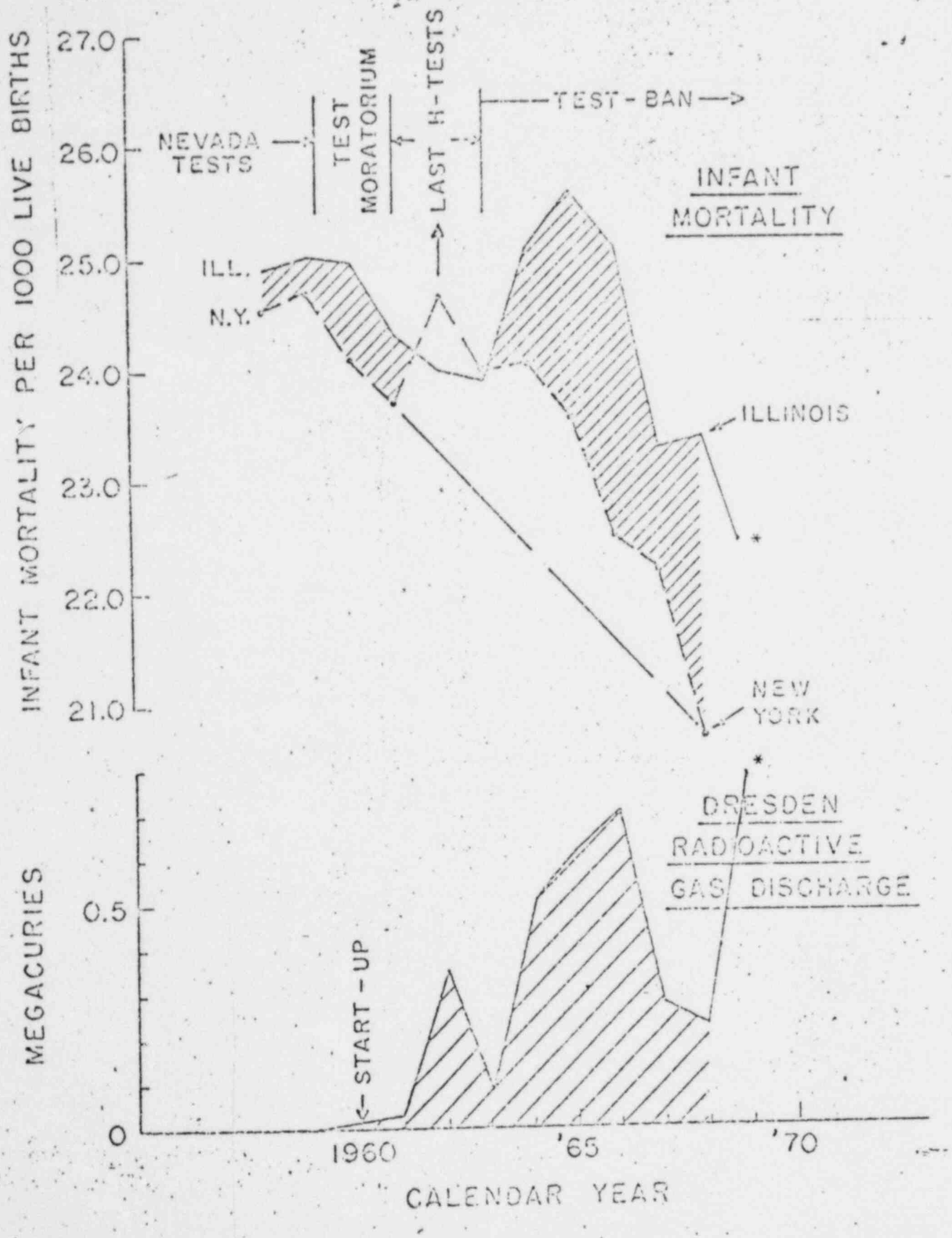

*Data for 1969 added to Dr. Sternglass' Fig. 1.

Fig 1