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August 22, 2006 SEC 46

Laurie Ishak
SEC Petition
NIOSH-OCAS
4676 Columbia Parkway
Mailstop MS-C47
Cincinnati, OH 45226

In re: Special Exposure Cohort Employees' Application for Fernald, Ohio

Dear Ms. Ishak:

We are writing this letter pursuant to 42 C.F.R. 83. We wish to bring to your attention an issue to be considered in your evaluation of the Special Exposure Cohort Employees' Application for the workers at Fernald, Ohio. filed the application.

Susan Pinney, an epidemiologist at the University of Cincinnati, received a NIOSH grant to study the radon doses that Fernald workers received from Q-11 and K-65. At a recent Radiation and Health meeting in California, Dr. Pinney presented the radon exposure estimates for the Fernald workers. Jim Neton and Doug Daniels, both representatives of NIOSH, attended the presentation and authorized Dr. Pinney to provide the radon findings to the workers. We are enclosing a copy of the slides that Dr. Pinney prepared and gave to us.

What these slides document is that Fernald workers have had exposures to radon from the early 1950s to the present time. While Dr. Pinney's study stops in 1989, the worker exposures have continued because the potential of harm from K-65 residual material is still present at Fernald. The SEC petition should include the entire workforce.

Although we have never had an opportunity to review the Fernald workers' dose calculations being used for determination of EEIOCPA awards, it is our understanding that the radon doses from Q-11 and K-65 have not been included. Further, these radon doses make calculation of an accurate dose almost impossible because no contemporaneous exposure records for workers exist. This study provides a technical basis for concluding that an upper bounds cannot be established for radon exposure.

We understand that in calculating the Fernald workers' doses, the scientists used DOE documents only. There was no input from the workers and none of the evidence from the experts at the Fernald Workers' trial in federal court was considered. Thus, we maintain that the doses being calculated (even without consideration of Dr. Pinney's radon study) are inaccurate.

We also note that Dr. Pinney did not include a dose for thoron, which was also present at Fernald.

Thank you for your consideration of this matter.

If you have any questions, please contact the undersigned.

Sincerely,

Enc.

Methods for Radon Exposure Estimates for Fernald Workers

Susan M. Pinney, PhD
Department of Environmental Health

Richard Hornung, DrPH
Institute for Health Policy and Health Services Research

University of Cincinnati

Events leading to research study

- Excess relative risk for lung cancer was found in a mortality study of workers at the Fernald Feed Materials Plant near Cincinnnati OH in 1996.

- A CDC dose reconstruction project for estimation of exposures to residents within 10 km of Fernald indicated relatively high radon levels off site.

- Sources of radon decay products were determined to be two K-65 silos located on the west side of the plant and used for storing waste materials including radium.

- NIOSH contracted with the University of Cincinnati to estimate radon exposures and cigarette smoking rates among Fernald workers for possible follow-up of the lung cancer mortality study.

- **STUDY OBJECTIVE:** Estimate annual and cumulative exposures to radon decay products among workers employed at Fernald site from 1952 to 1988.

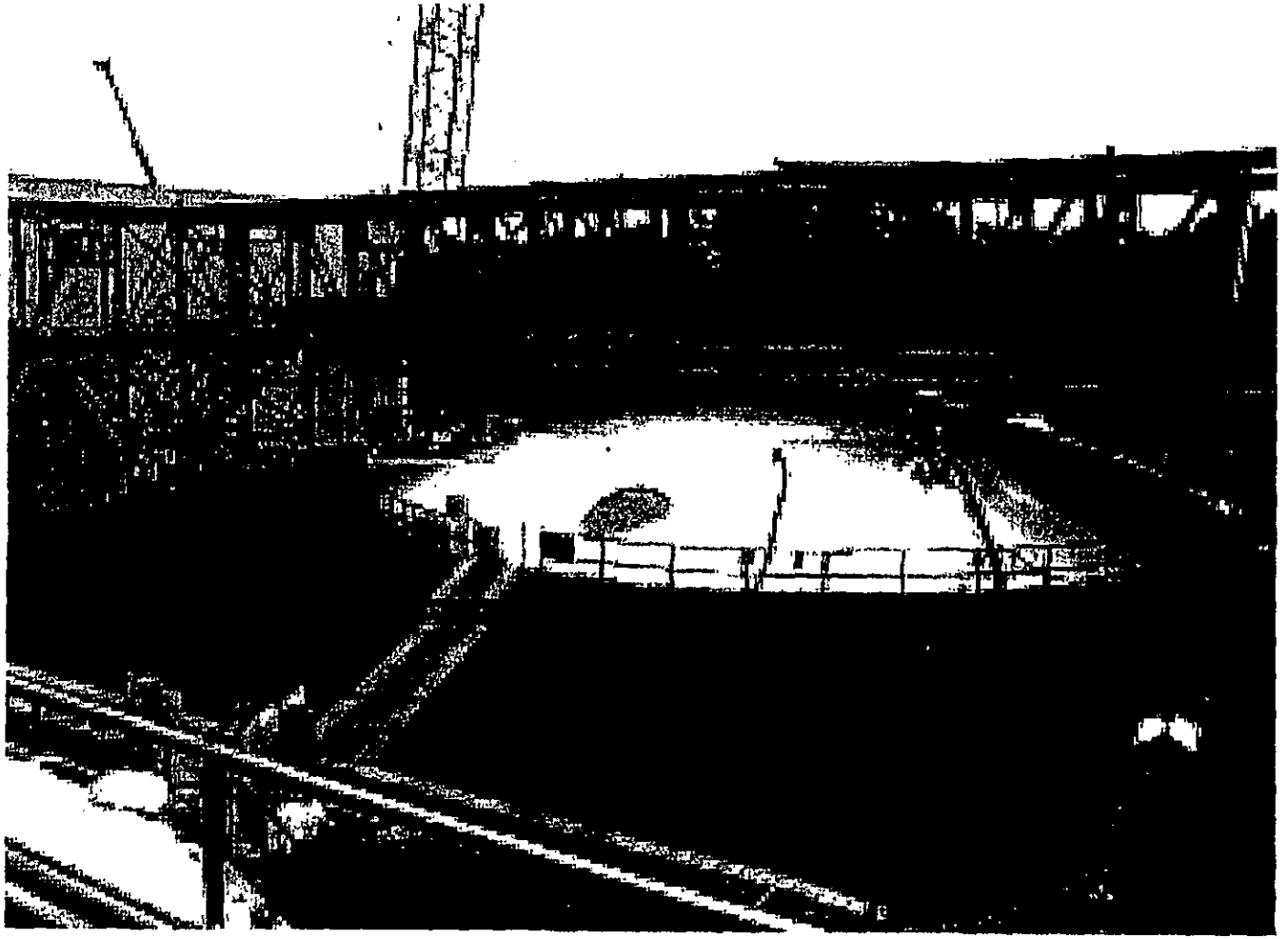
- **STUDY METHODS (at beginning of study):**
- Use deterministic mathematical model developed for the CDC dose reconstruction project to estimate radon levels across the site, arising from the K-65 silos.

- Investigate and estimate radon exposures from secondary sources using CR-39 assay of window glass.

- Assign locations of workers; assign a set of shift probabilities to workers.

- Assign estimated annual radon levels measured in Working Levels (WL) to workers by their shift and working location in each year of employment.

K-65 Silo - 2003



Radon

- Naturally occurring decay product of ^{226}Radium, the fifth daughter of ^{238}Uranium
- Both ^{238}Uranium and ^{226}Radium are found in most soils and rocks
- Radon decays with a half-life of 3.82 days into a series of short-lived radioisotopes that are collectively referred to as radon daughters, radon progeny and radon decay products.

Uranium Decay Chain

Isotope	Half-life	Radiation
Uranium-238	4,500,000,000 years	alpha
Thorium-234	24 days	beta, gamma
Protactinium-234m	1.2 minutes	beta, gamma
Uranium-234	250,000 years	alpha, gamma
Thorium-230	80,000 years	alpha, gamma
Radium-226	1,622 years	alpha, gamma
Radon-222	3.8 days	alpha
Polonium-218	3.05 minutes	alpha
Lead-214	26.8 minutes	beta, gamma
Astatine-218	2.0 seconds	alpha
Bismuth-214	19.7 minutes	beta, gamma
Polonium-214	0.000164 seconds	alpha, gamma
Thallium-210	1.3 minutes	beta, gamma
Lead-210	22 years	beta, gamma
Bismuth-210	5.0 days	beta
Polonium-210	138 days	alpha, gamma
Thallium-206	4.2 minutes	beta
Lead-206	Stable	none

Health Effects of Radon

- When radon progeny are inhaled and release alpha particles within the lungs, the cells lining the airways receive genetic damage, and ultimately lung cancer may result.

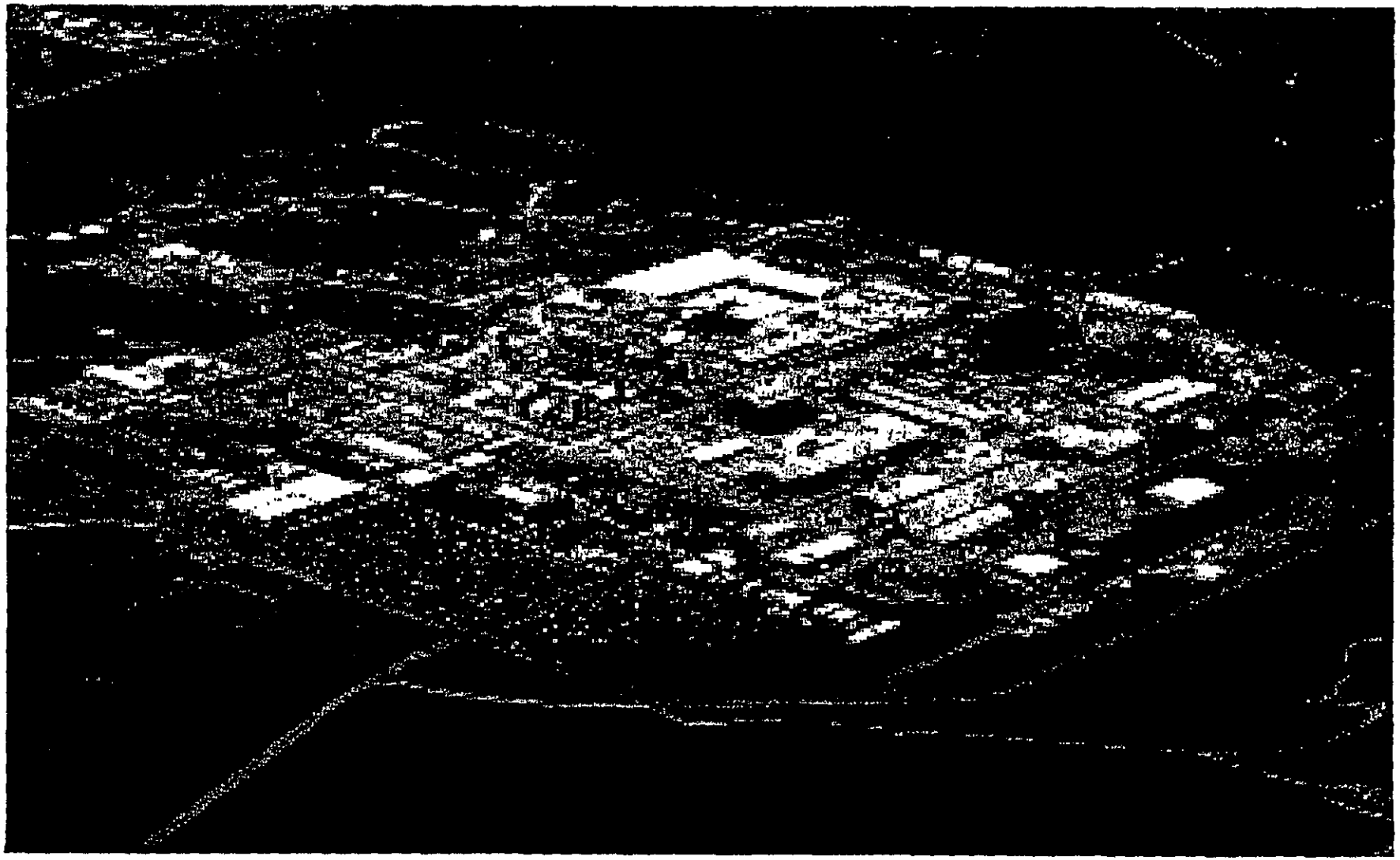
- Combined risk of smoking and radon – more than additive, less than multiplicative.

- Radon also know to increase risk of cataracts

Sources of Radon at Fernald

(At time of grant proposal)

- **K-65 Silos – held raffinate from processing ores rich in uranium, which contained radium**
- **Radium bearing residues from Mallinckrodt Chemical Works and other DOE sites**
  - **Approximately 25,000 barrels – into Silo 1**
- **Processing of pitchblende ores at FMPC**
  - **During 1950's – residues into Silo 2**

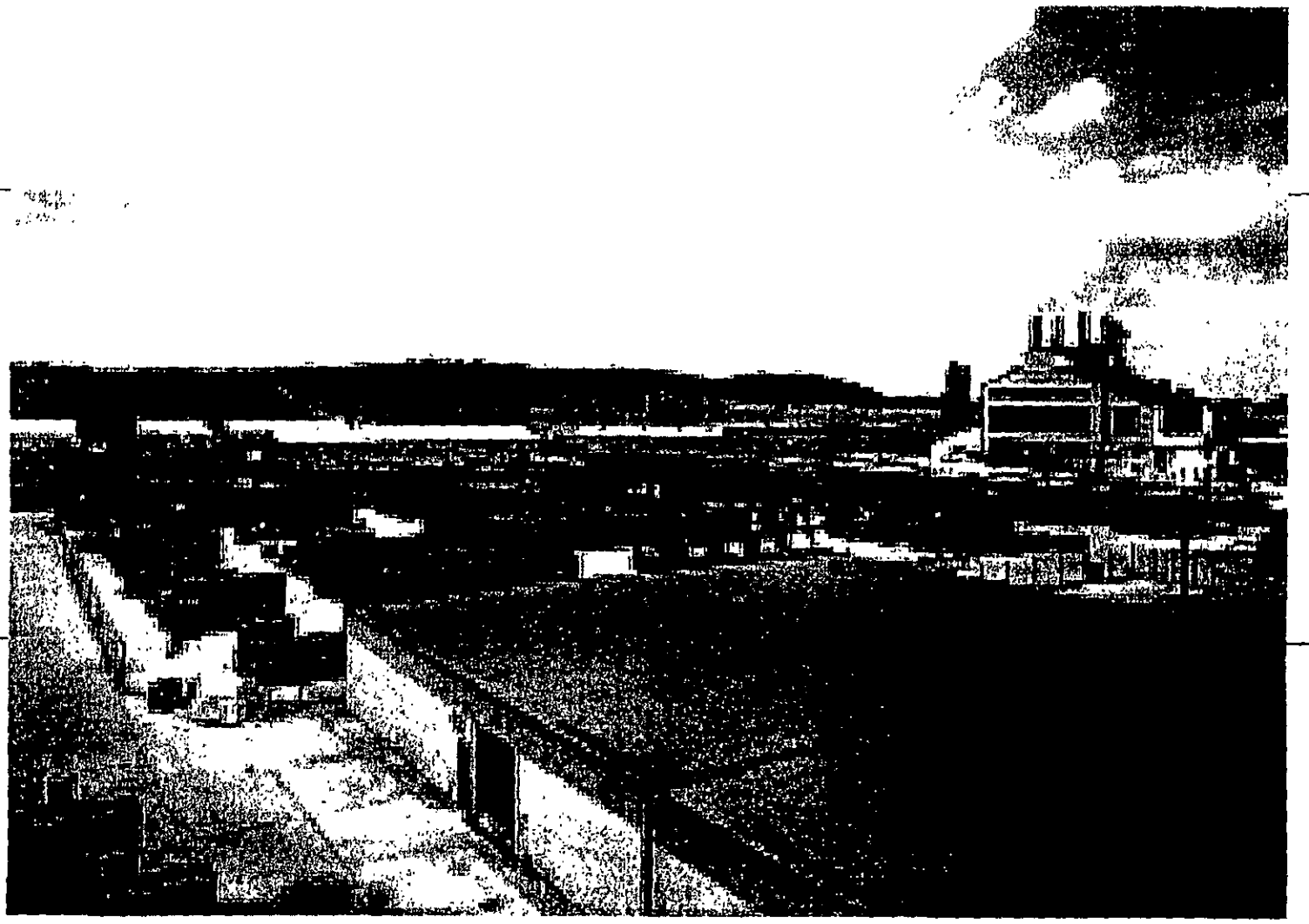


Radioactive Waste Shipped to Fernald

- **Prior to 1953, large amounts of radium bearing radioactive waste were shipped to FMPC from other DOE sites, especially Mallinckrodt Chemical Works in St. Louis (12,997 drums)**

- **Drums stored on a concrete pad near Plant 1 until K-65 silos were completed**

- **Some drums of K-65 material also stored near Plant 8 for longer period of time**

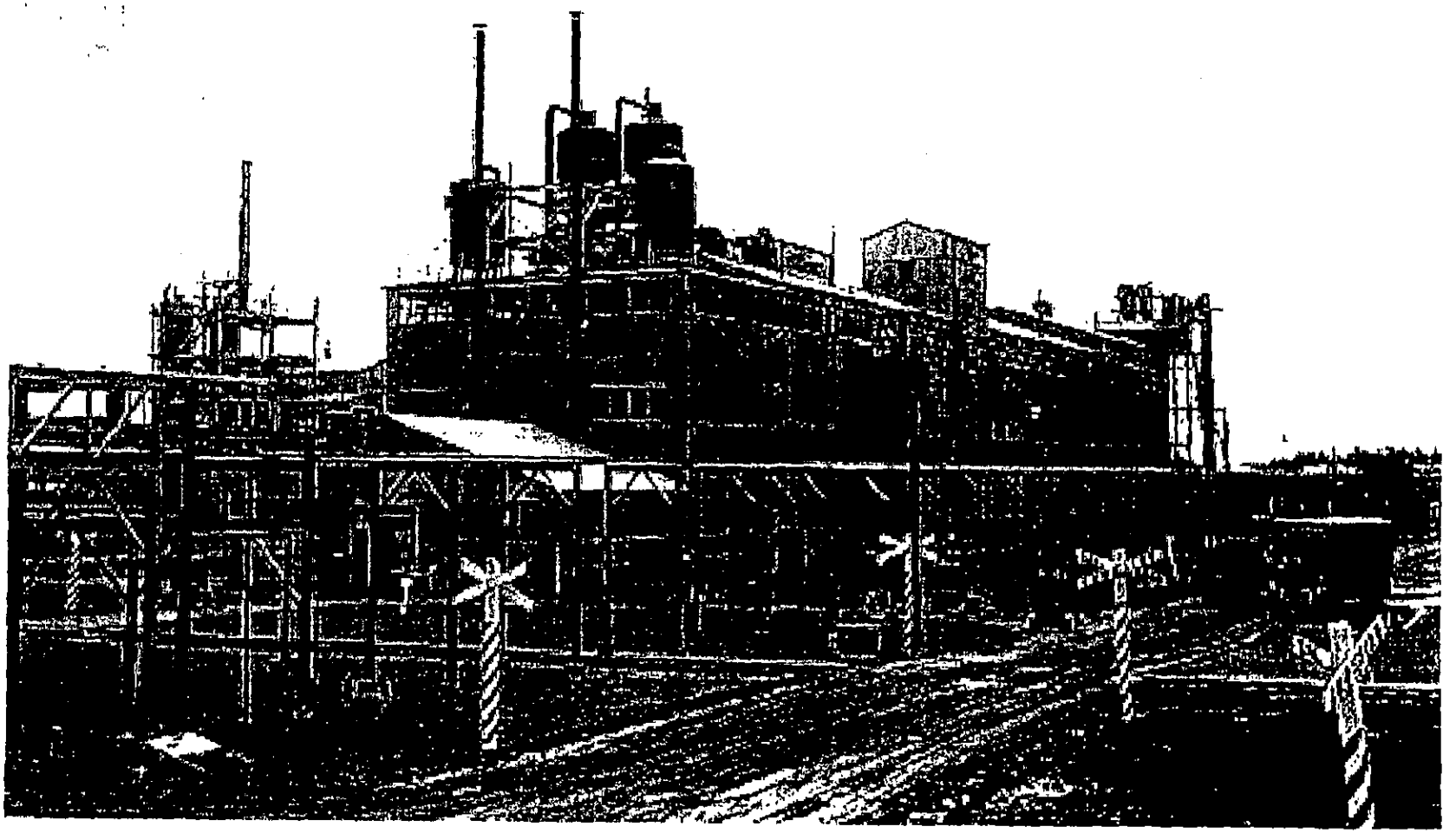


Pitchblende Ore Processed at Fernald from 1952-1958

- Rock containing very high concentrations of uranium and uranium daughter products (including radium).
- Received at FMPC from mine in the Belgian Congo (Shinkolobwe mine).
- Code name Q-11; Stored in Q-11 ore silos near Plant 1

Pitchblende Ore Processing

- Uranium separated from ore by 3-phase Purex process: digestion, extraction and denitration
- Aqueous raffinate or waste contained all daughter products from uranium and impurities including ^{226}Radium (the parent nuclide of ^{222}Radon)
- Assigned code name K-65
- Pumped into large concrete silo for storage (K-65 silo)



CDC Fernald Dosimetry Reconstruction

Radon Release Estimates

Period	Median Estimate	
1952-1953	K-65 Silos	1900 Ci
	Drummed waste	720 Ci
1953-1958	K-65 Silos	4900 Ci/yr
1959-1979	K-65 Silos	6200 Ci/yr
1980-1987	K-65 Silos	940 Ci/yr
1988	K-65 Silos	230 Ci

CDC/RAC Deterministic Model

- Model was developed to estimate radon levels outside the Fernald plant site
- Model was based on physical and mathematical principles, such as emission rates from K-65 silos, plume dispersion from a point source, meteorological conditions, and engineering controls
- Data were only used to calibrate the model
- Output of model was 24-hr average exposures to residents within 10-km radius of K-65 silos

Location of Workers

- Since radon exposure resulted in dispersion of radon gas from a source, location of workers was a key parameter in exposure estimation
- 7143 persons ever worked at the site
- 2158 were participants of the Fernald Worker Medical Monitoring Program, from whom we have collected detailed occupational history information (questionnaires and interviews)

Location Assignment Method

- Personnel records did not include location, except for production workers assigned to a Plant
- General personnel records misclassified location for approximately 1/5 of workers for whom location could be inferred from the records

Location Assignment Method

- Obtained file of job history (multiple record per person file) from NIOSH– each record contained Plant, Department and Job Title information for periods of employment, with beginning and end dates.

- For some workers, no work location could be inferred from information in personnel records:
  - Mechanical Division (electricians, carpenters, machinists, etc.)
  - Laboratory Division
  - Inventory and time clerks who worked in offices in the production plants, and
  - Workers in the Security division

Work Location Assignment

- We developed a series of assumptions regarding work locations for combinations of plant, department and job title, using records such as FWMMP occupational history questionnaire and interview information, union contracts, and position descriptions.

- Each record of the worker's job history was then assigned a location code, indicating one or several work locations for that time period.

Worker Assigned to a Specific Building

ID: 34076

Hire Date	Term Date
11/17/1954	01/17/1957

Date	Plant	Dept Code	Job Title	Location Code
11/17/1954	2	Prod	Laborer	**Plant 2/3**
09/26/1955	3	Prod	Chemical Operator Helper	**Plant 2/3**
04/02/1956	3	Prod	Chemical Operator	**Plant 2/3**
11/09/1956	3	Prod	Laborer	**Plant 2/3**

Worker Assigned a Combination Code

ID: 37444

Hire Date	**Term Date**
08/01/1952	01/01/1983

Date	Plant	Dept Code	Job Title	**Location Code**
08/01/1952	Anal	Tech	Technologist B	**ANDBldg15,P**
10/01/1955	Anal	Tech	Technologist II	**ANDBldg15,P**
08/27/1956	Anal	Tech	Section Leader I	**Bldg15+P**
09/21/1959	Anal	Tech	Section Leader II	**Bldg15+P**
05/01/1972	Anal	Tech	Technologist III	**ANDBldg15,P**

Work Location Code – linked to multiple exposure estimate locations

- "Single location" code - Plant 2/3
  - 66% Building 2A – Ore Refinery Plant
  - 10% Building 2D- Metal dissolver building
  - 7% each Buildings 3C, 3E and 3H – Control Tower, Hot Raffinate Building, Refinery Sump
  - 3% Building 39A – Incinerator Building
- Combination code – ANDBLDG15,P
  - 60% Building 15a - Laboratory
  - 40% P [Production Area]– many buildings in the production area

Overall Area Codes for Some Workers

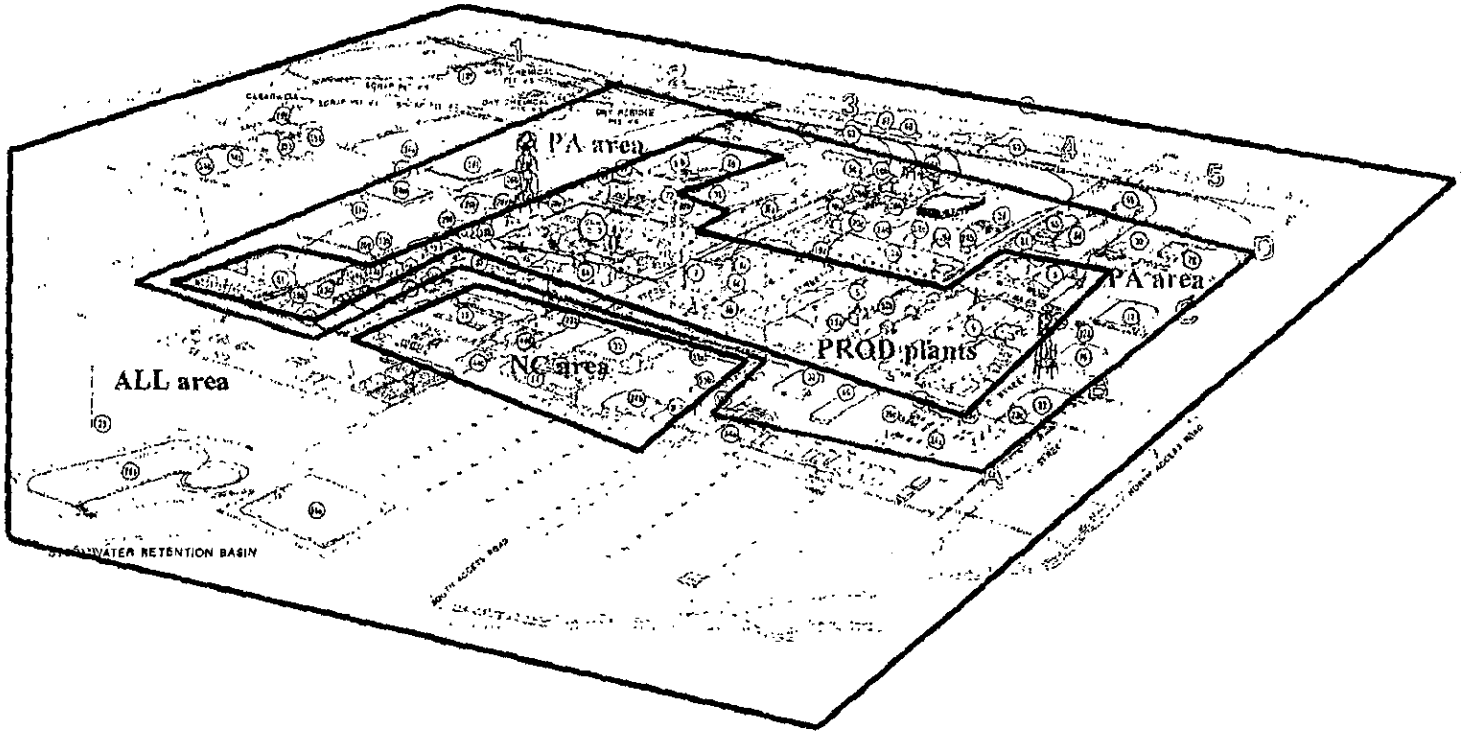
- Some job titles known to work at a variety of areas throughout plant site
- For other job titles, insufficient information to assign them to a specific location.

- Developed "area" codes
- Multiple exposure estimation sites linked to each area, weighted by number of employees, with specific or combination location assignment, assigned to that location in that calendar year.

Overall Area Code - Example

- Overall Area Code – ALL

- 30 location components – with exposure value specific to each calendar year, and weighting, specific to each year



PROD or P (Production plants)

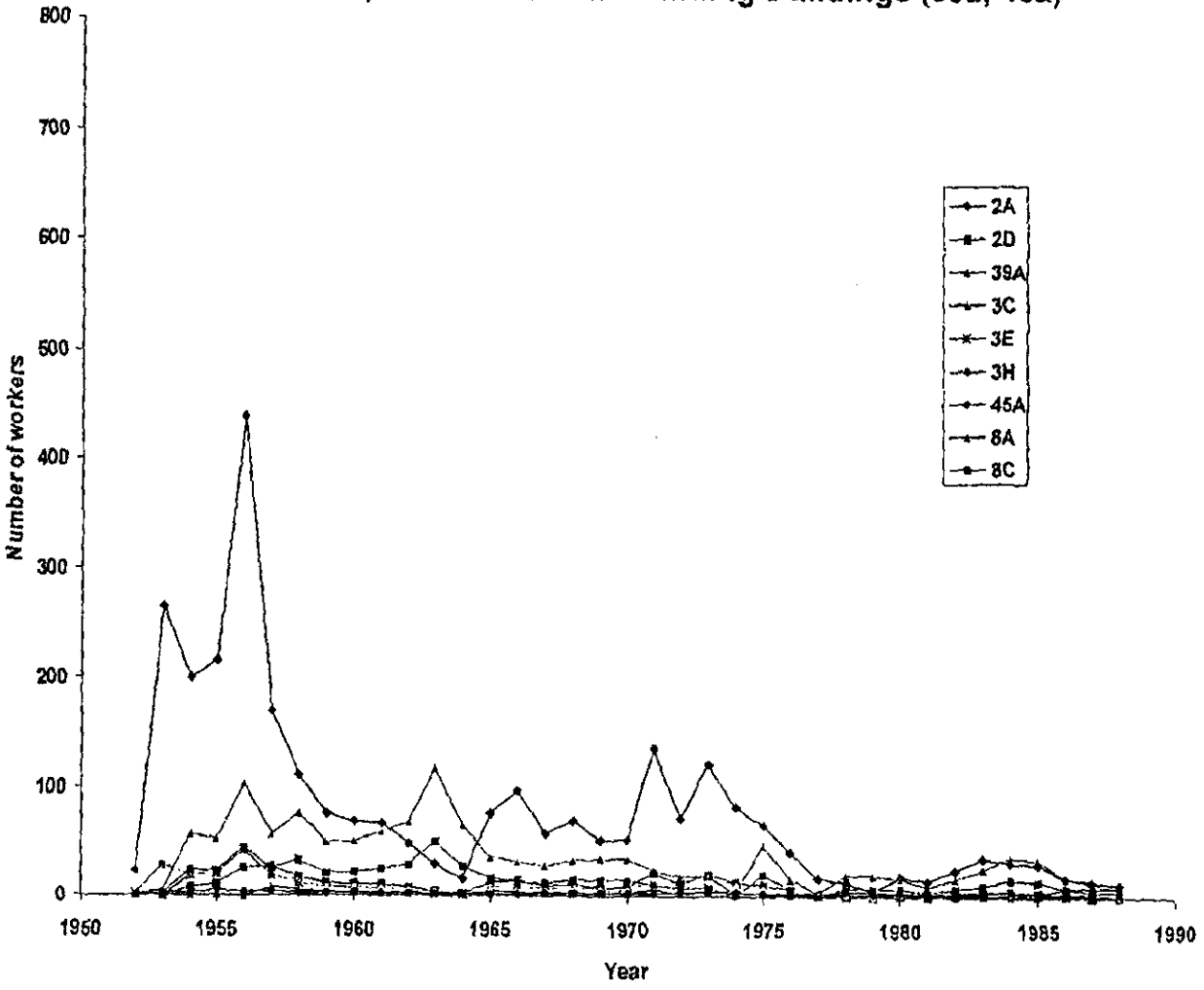
PA (Production Area) includes additional buildings bordering the production plants, representing the "controlled" area.

NC (Non-Controlled area) includes non-production buildings.

ALL includes every location on the site and is enclosed within the black box.

Map of Areas in Overall Area Codes (Prod, PA, NC, NC+P, All)

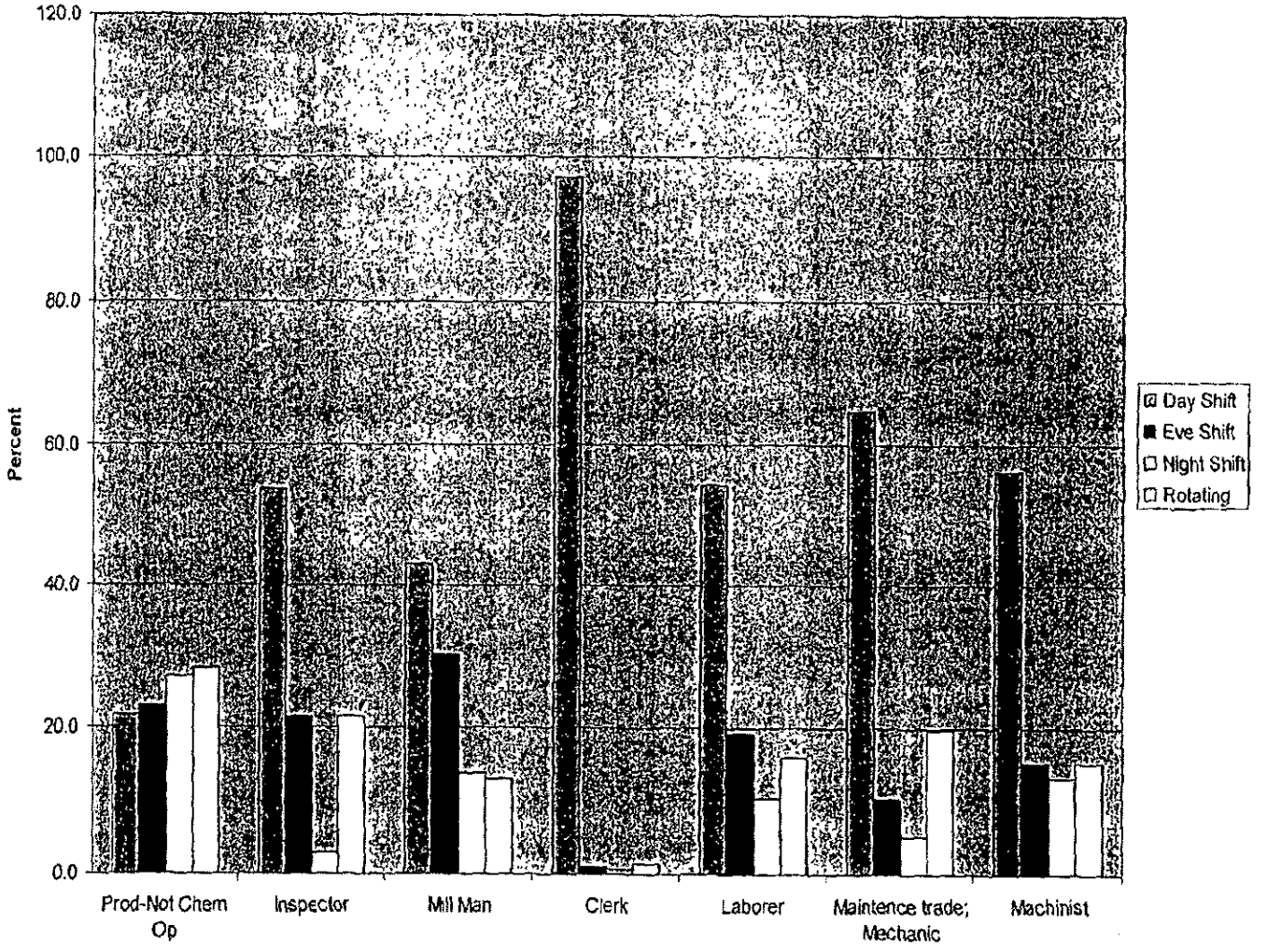
Person-years at Each Exposure Estimate Location 1952-1988
Plants 2, 3 and 8 and Surrounding Buildings (33a, 45a)



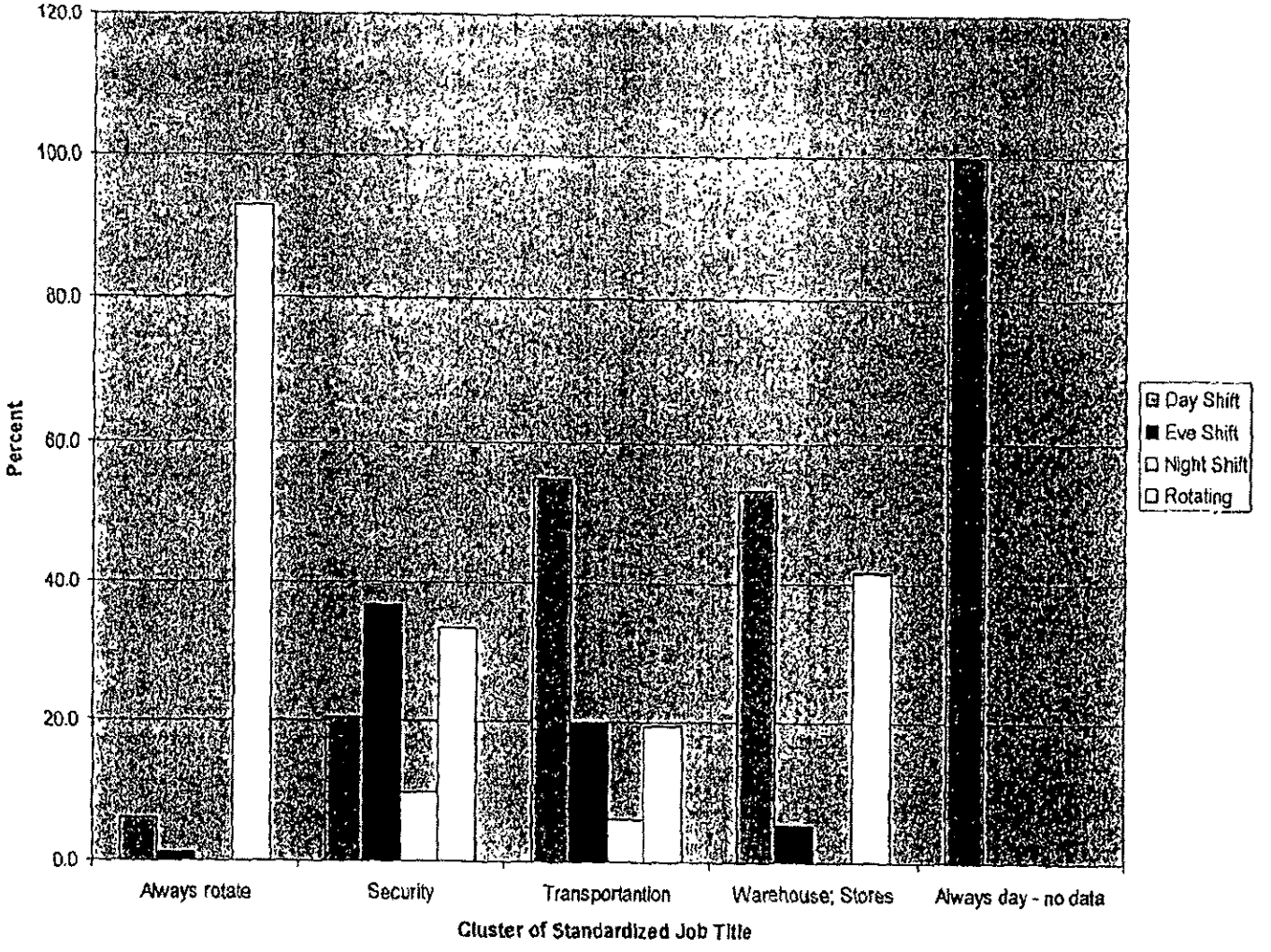
Work Shift – Assumption Development

- Specific questions on work shift included in FWMMP questionnaire modules
- Compiled responses of workers who completed questionnaires
- Used these data to develop assumptions about probability of working evening or night shift for each Jobtitle

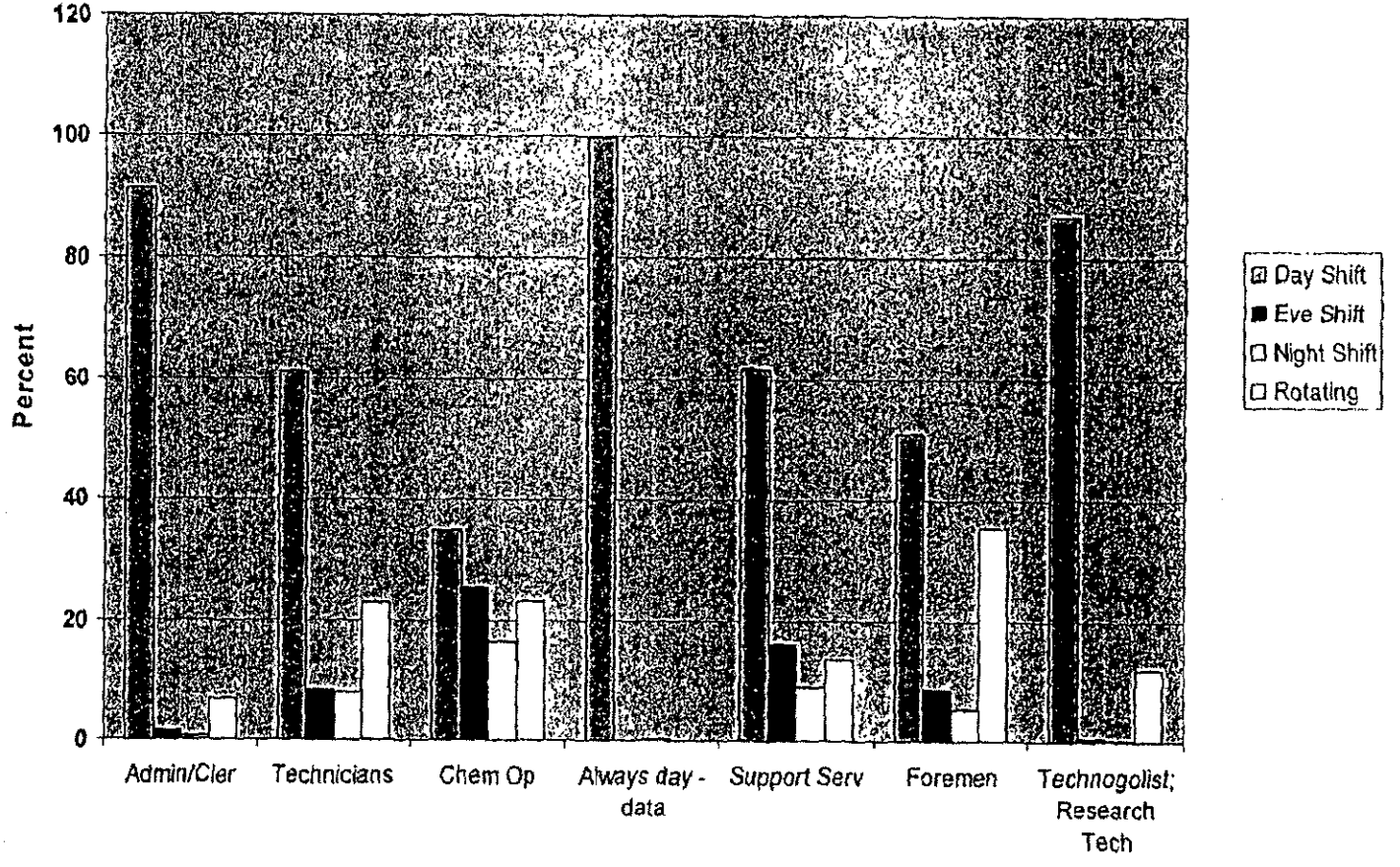
Percent Working Each Shift (Self-Reported) by Standardized Jobtitle Clusters H-O



Percent Working Each Shift (Self-Reported) by Standardized Job Title Clusters R-X



Percent Working Each Shift (Self-Reported) by Standardized Job Title Clusters A - G



CR-39 Assay

- CR-39 is a plastic film taped to window glass for about 3 weeks in buildings on site to record polonium-210 alpha activity, a primary radon decay product.

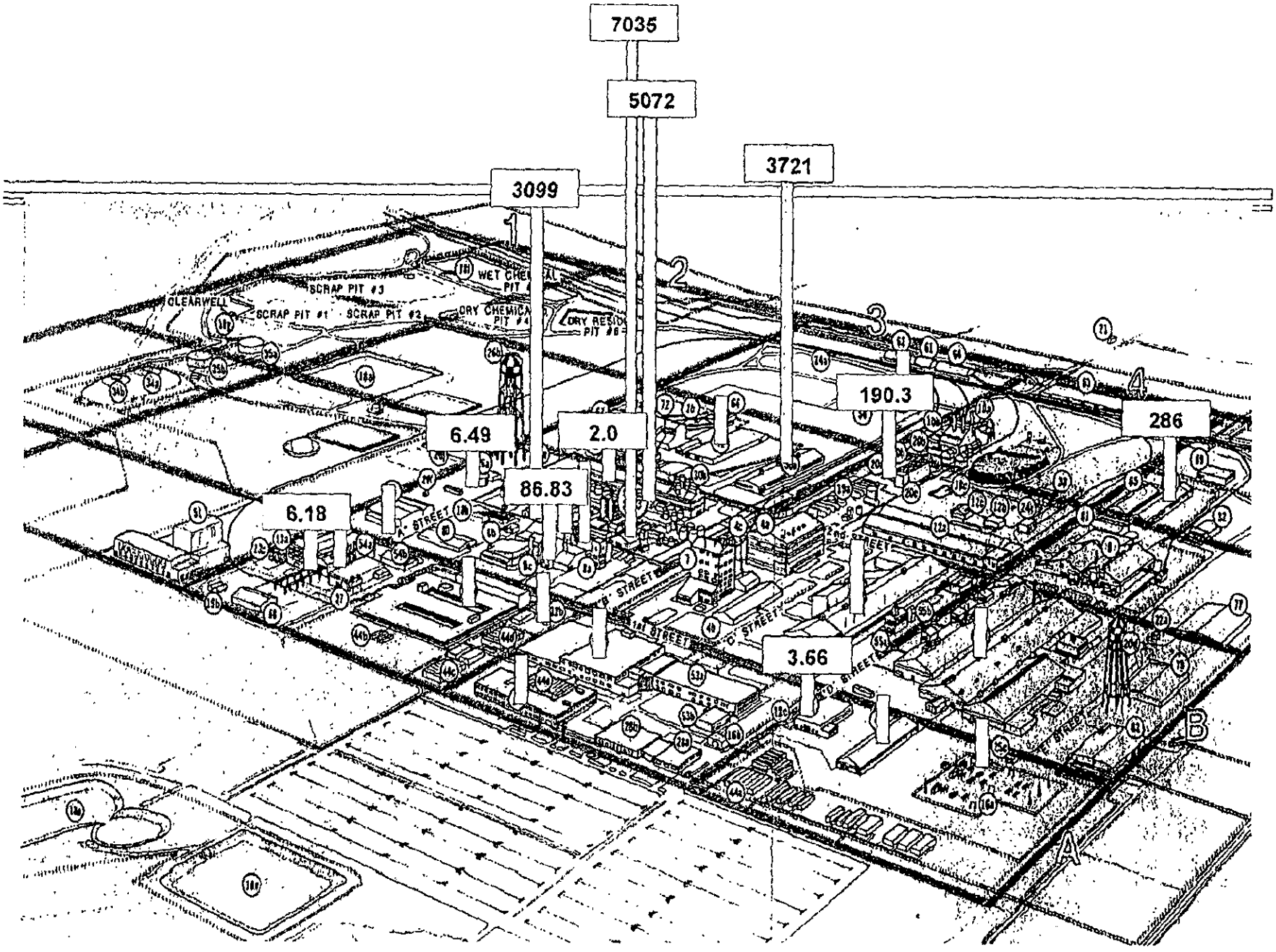
- Glass in place throughout the plant history serves as a cumulative radon dosimeter.

- CR-39 assay was developed at the University of Bristol and used in case-control studies of lung cancer and radon in homes, but never in an industrial, highly contaminated setting.

CR-39 Assay

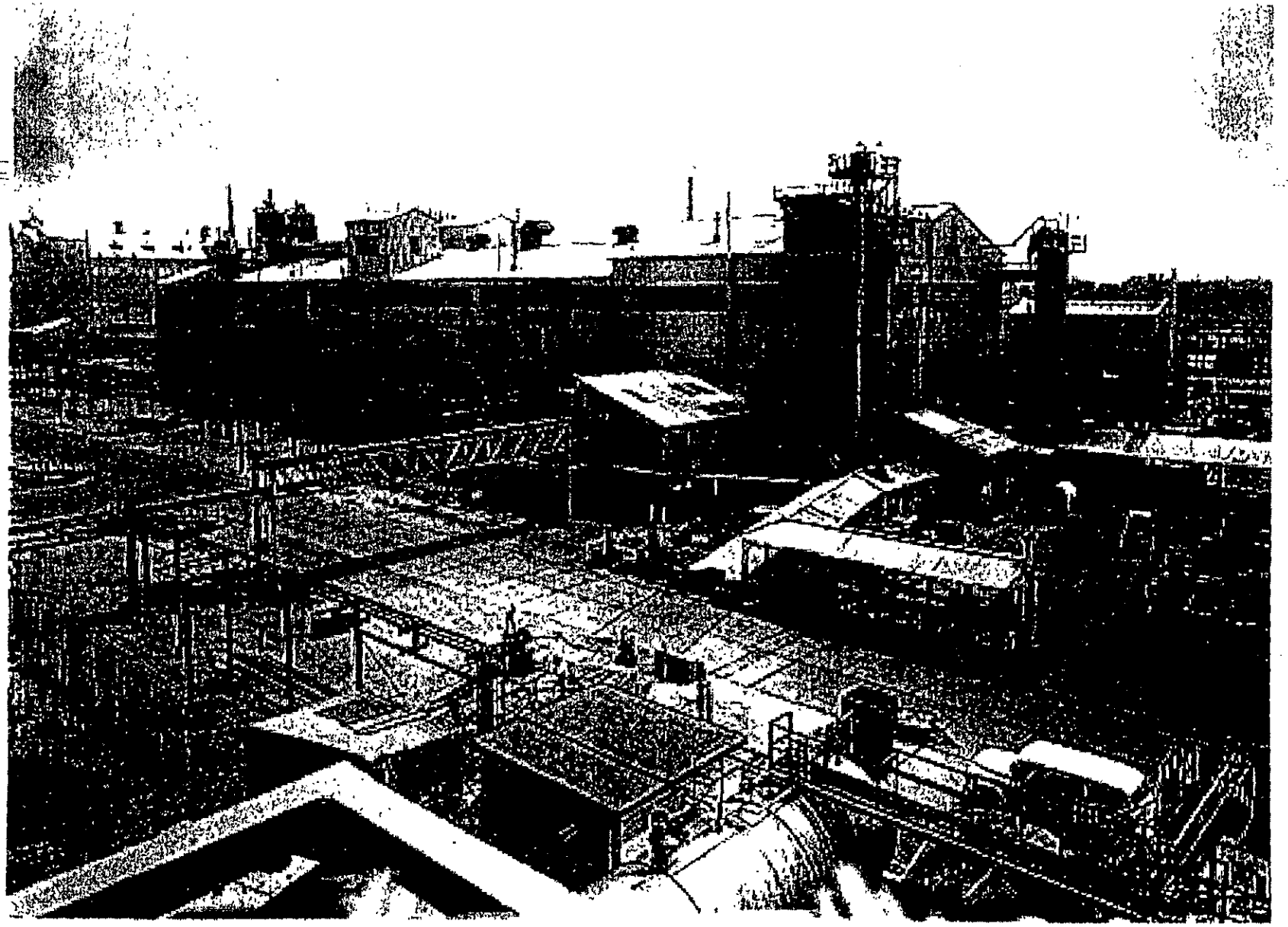
- Decided to use CR-39 assay to validate estimates from mathematical deterministic model.
- Asked NIOSH for funding
- Pilot study – 20 samples
- Main study – 80 samples
- Additional study – another 31 samples

- 131 CR-39 plastics were placed on both inside and outside of glass panes in buildings throughout the plant.


7035
5072
3721
3099
190.3
286
6.49
2.0
86.83
6.18
3.66
SCRAP PIT #3
SCRAP PIT #1
SCRAP PIT #2
CLEARWELL
A STREET
B STREET
C STREET
D STREET
1
2
3
4
A
B

Detective Work

- Inspection of CR-39 data shows very high levels near plant 2/3
- Interviews with Fernald HP's and retired workers identified a potential source
- Q-11 silos near plant 2/3 had been used to store highly radioactive material for later processing
- Several other secondary sources were identified in the same area
- Search of documents reveals that Q-11 silos were filled from 1952-58

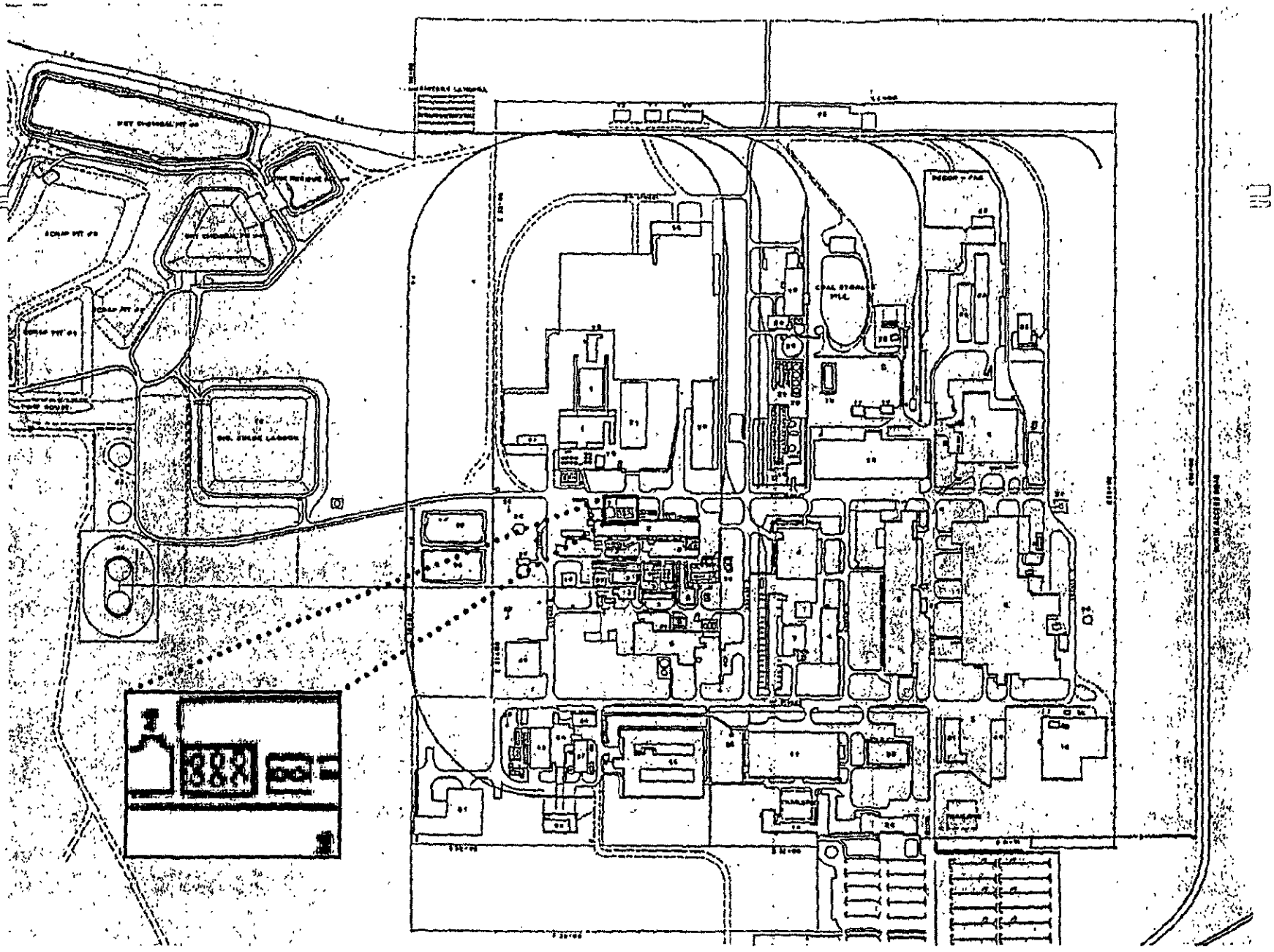


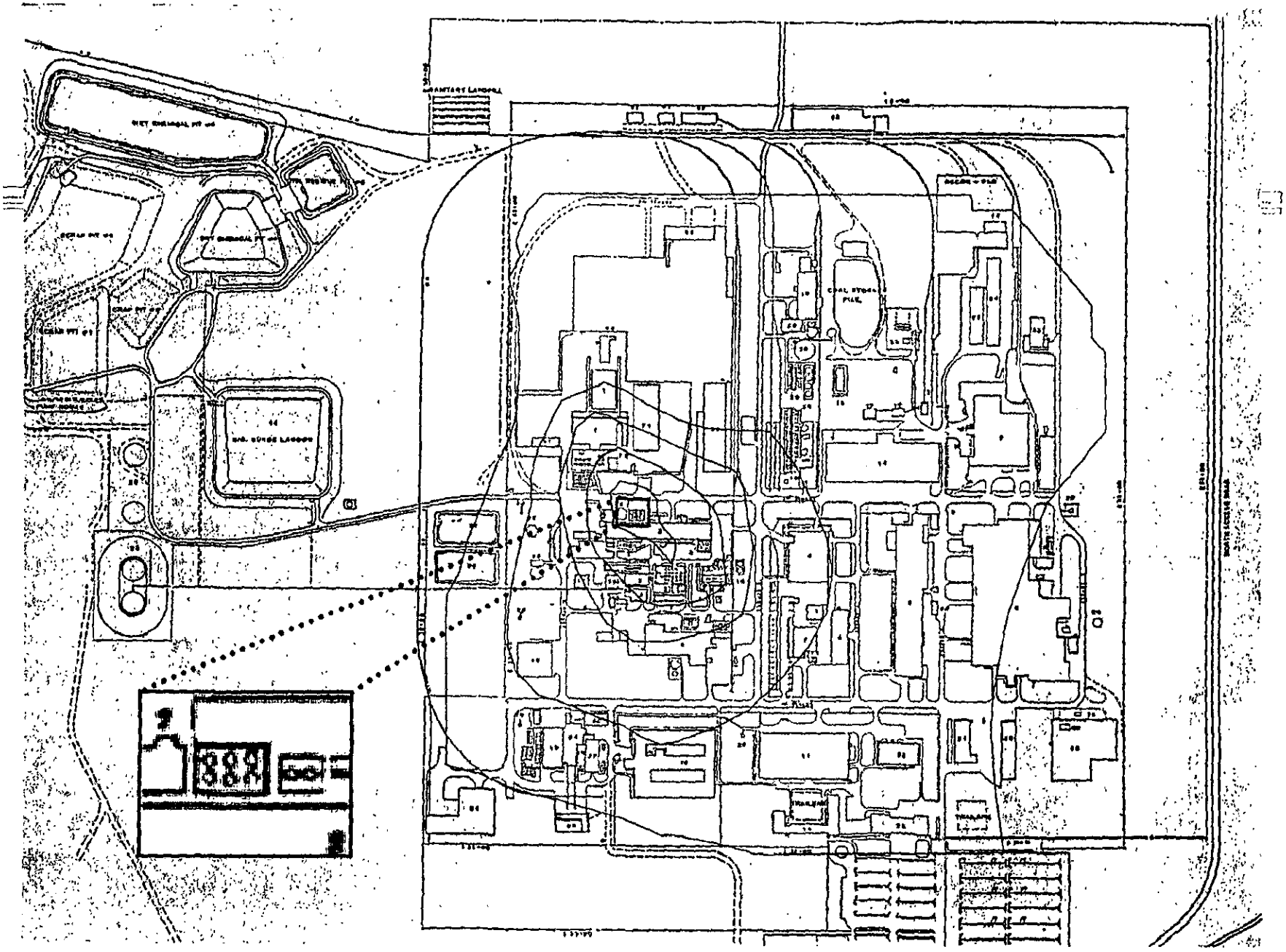
Analysis of CR-39 Data

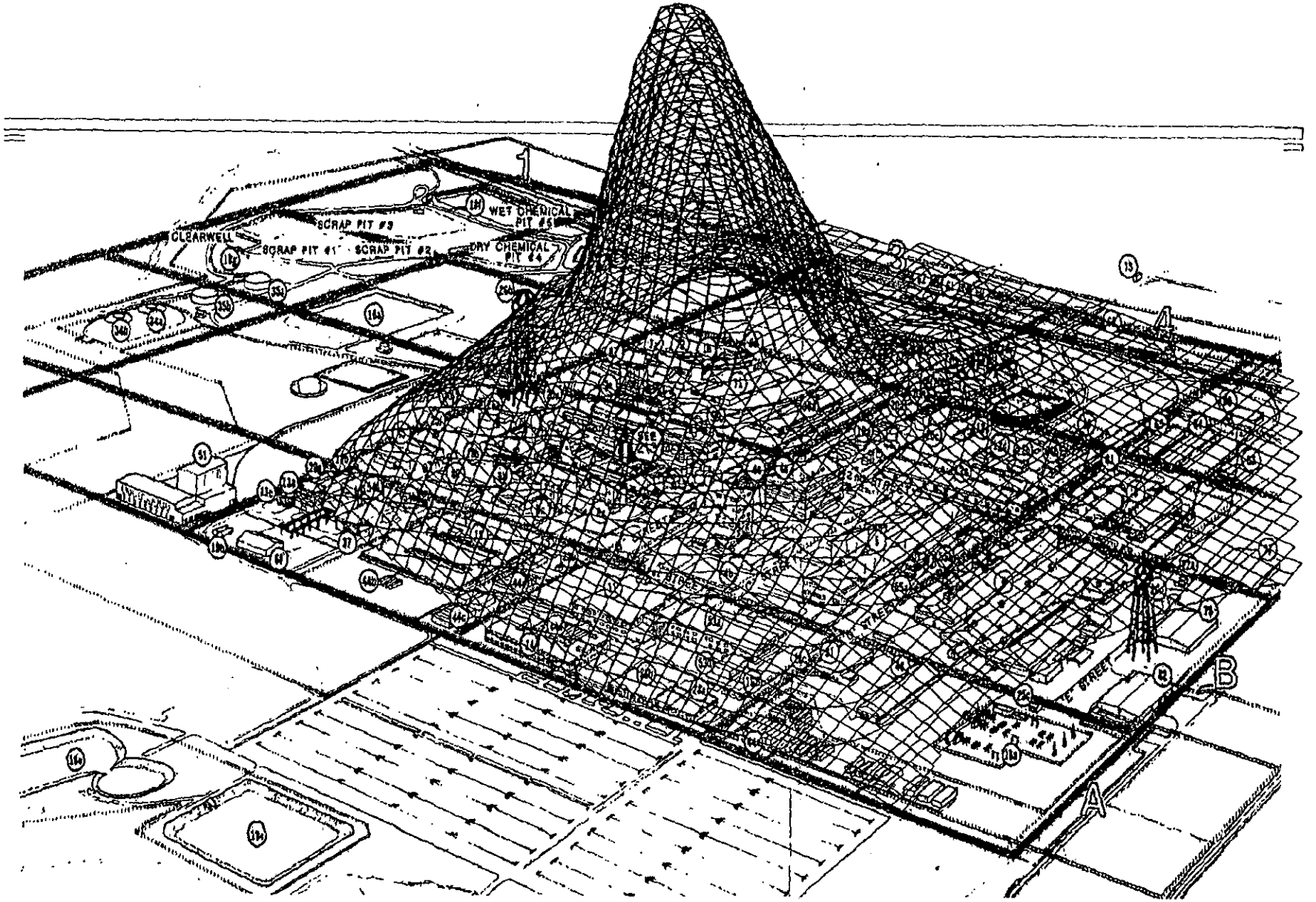
- Po-210 measures were linked to lat/long coordinates of the building
- Weighted multiple regression model was used to estimate Po-210 levels for each building where workers were assigned
- Weights were a function of wind speed and direction from Q-11 silos as the point source
- Other factors included in the model were building construction year and inside/outside location of film

Model Results

- Polynomial and restricted cubic spline models both fit log Po-210 data reasonably well (R^2 = 0.50-0.53)
- 24% / year decrease for later construction years
- Po-210 levels are 60% less on inside of buildings
- Buildings upwind and at a distance from Q-11 silos were estimated to have exposures one to two orders of magnitude lower than Q-11 area
- Po-210 results were used by the study HP to calculate Rn exposures in WL by year for each bldg






SCRAP PIT #3
WET CHEMICAL PIT #5
CLEARWELL
SCRAP PIT #1
SCRAP PIT #2
DRY CHEMICAL PIT #4
A
B

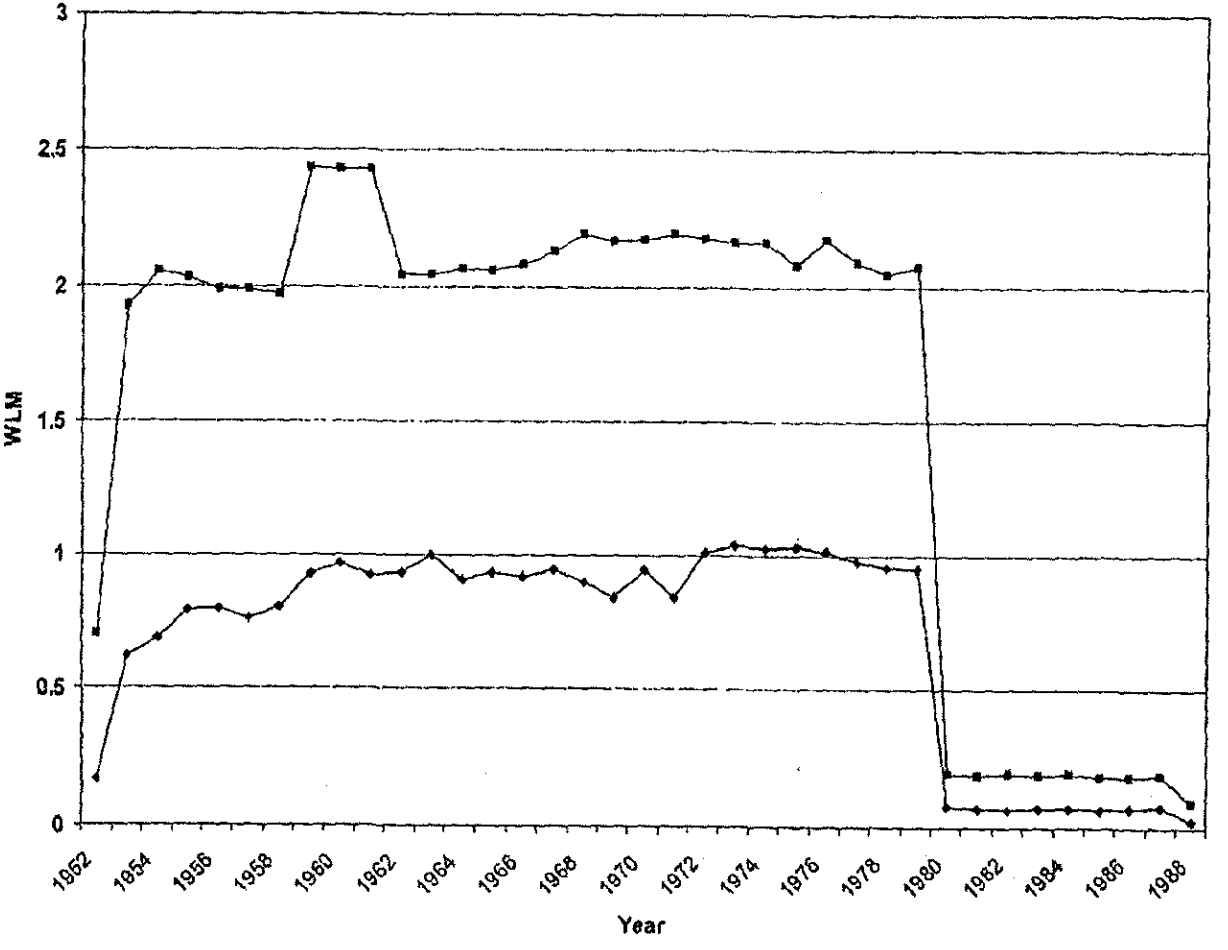
Exposure Estimation Method

- Estimate radon exposure at selected site locations
  - Specific to calendar year
  - Specific to time of day (shift)

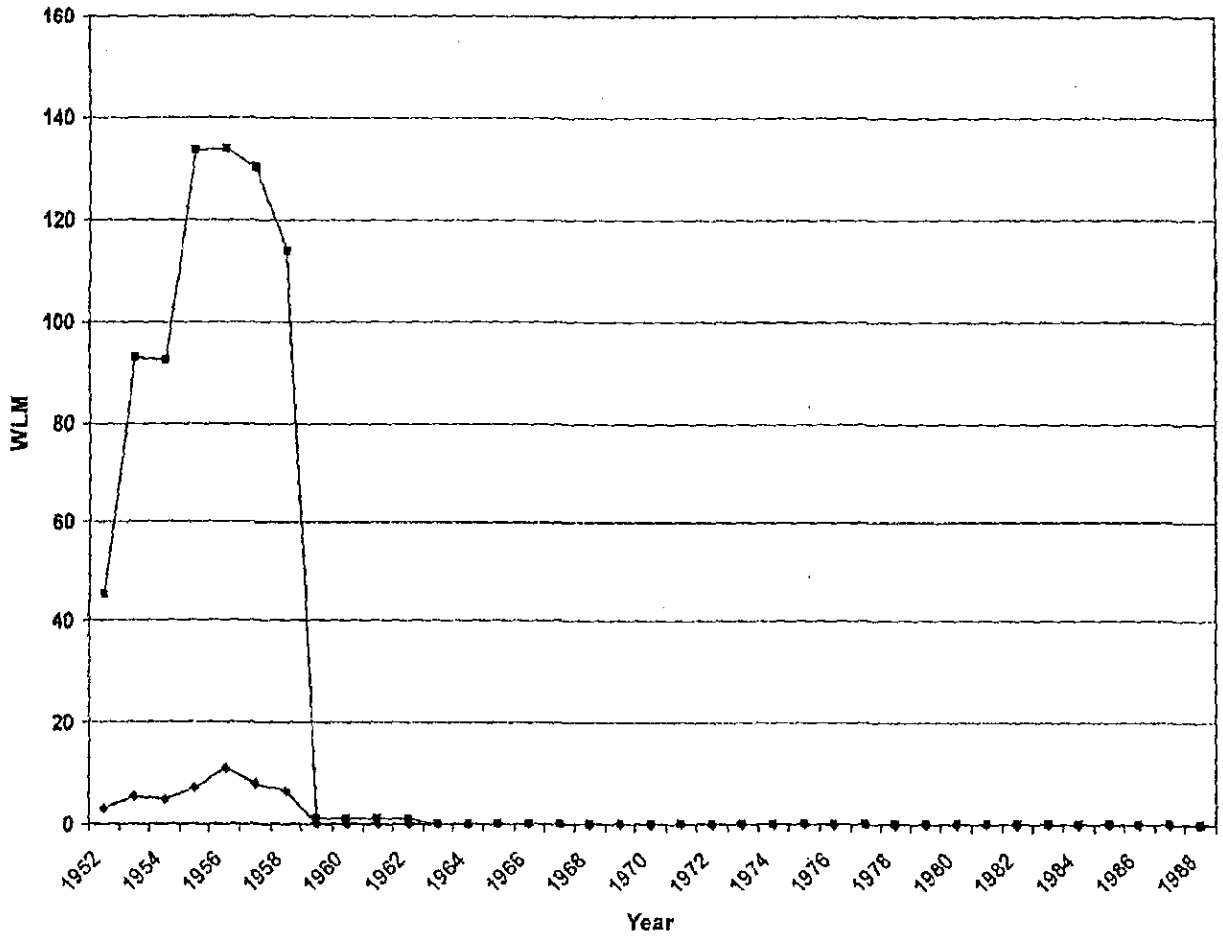
  K65 exposure + Q11 exposure = Total Radon Exposure

- Place workers at site locations for each calendar year
- Assign a probability of working day, evening, night or rotating shift
- Link radon estimates with annual location assignments for each worker in the cohort

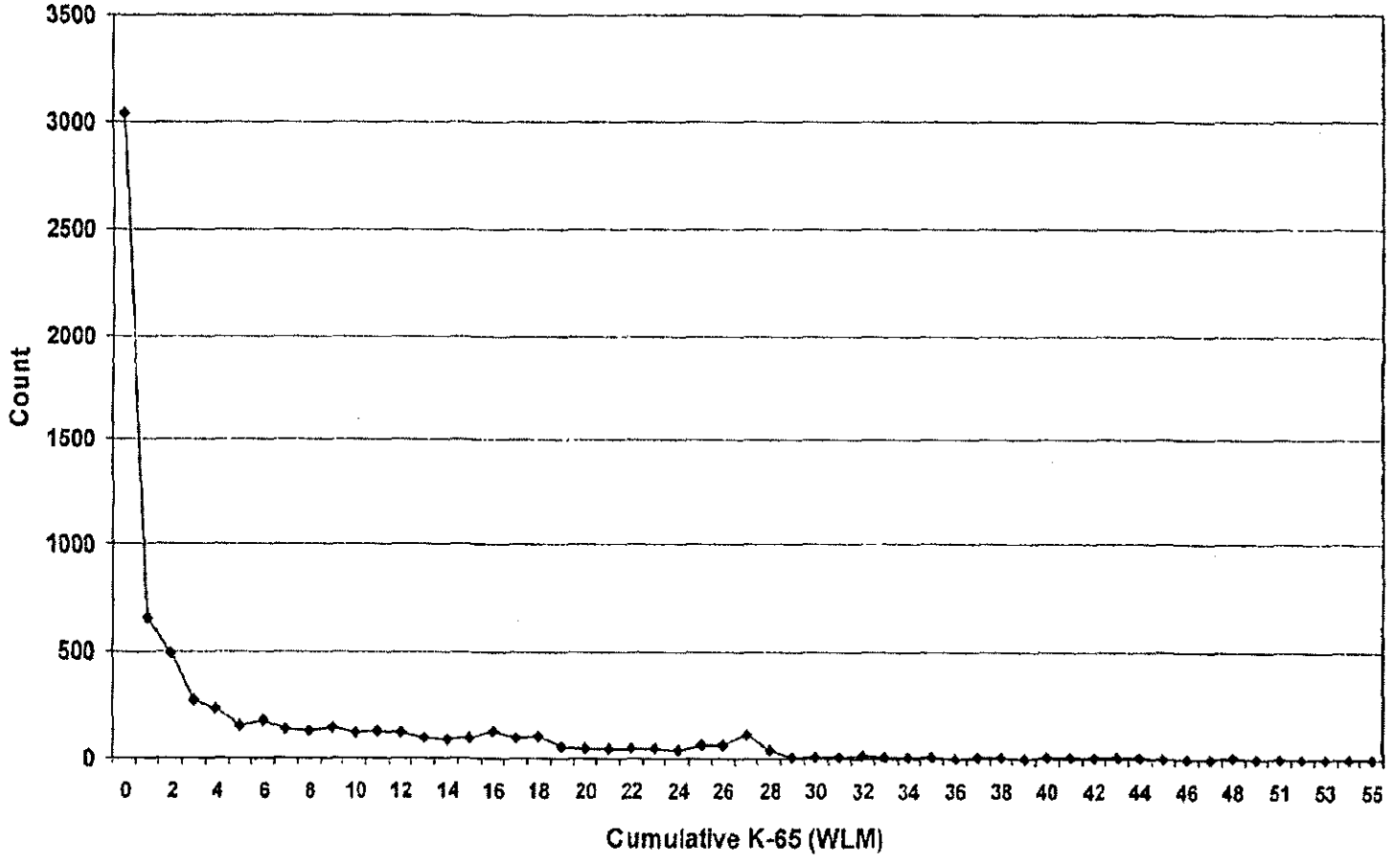
Mean and Highest Yearly Worker Radon Exposure Estimates (WLM) due to K-65 source



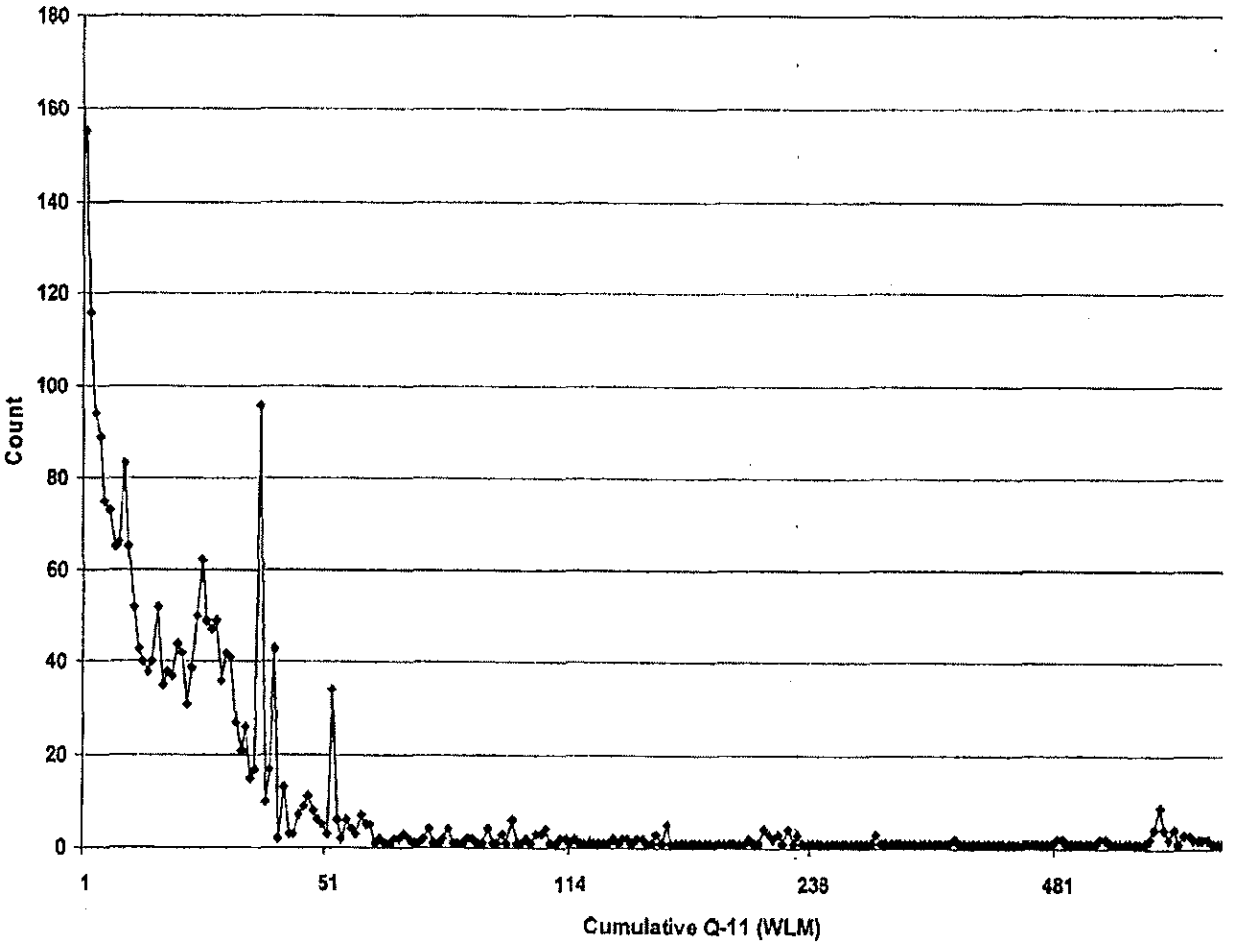
Mean and Highest Yearly Worker Radon Exposure Estimate (WLM) due to Q-11 source



Distribution of Cumulative Total Radon Exposure (WLM) from the K-65 Source



Distribution of Cumulative Non-Zero Radon Exposure (WLM) from the Q-11 Source



Summary

- Deterministic model for K-65 source agrees reasonably well with the 1991 radon measurements (validation study using Carderelli data)
- CR-39 assays indicate a source of radon other than K-65, probably Q-11 silos, stored raffinate, local processing activities
- Final estimates assign high radon exposures to workers in the plant 2/3 area who were employed from 1952 to 1958
- The final product of this study is a matrix of radon exposures for each Fernald worker by year
- Exposures may be used in a future epi study or for compensation purposes under a current DOL / NIOSH program

Value of FWMMP Occupational History Questionnaire and Interview Information

- Use of the FWMMP occupational history questionnaire and interview information allowed us to:

  » Much more precisely assign worker location; workers assigned to multiple buildings rather than a single location

  » Assign a probability of having worked the night shift, when exposures were 2-4 times higher

  » Verify and validate our location and shift assignments

  Resulted in:

  » Wider range of exposures and higher upper bound of the range

  » For compensation: Worker assigned to multiple locations (each with a different exposure estimate) and shift (separate matrix for night shift)