THE UNIVERSITY OF UTAH

SCHOOL OF MEDICINE
DEPARTMENT OF PHARMACOLOGY
DIVISION OF RADIOBIOLOGY
BUILDING 351
SALT LAKE CITY, UTAH 84112
(801) 581-6600

REPOSITORY DOE-FORRESTAL
COLLECTION MARKEY FILES
BOX No. 3 OF 6
FOLDER LUSHBAUGH MEXICAN ACCIDENT COBALT-60

704741

February 4, 1985

Dr. James Robertson
Director, Human Health Assessment Division
OHER
US Department of Energy
Washington, D.C. 20545

Dear Jim:

Enclosed is Ed Haskell's trip report about the meeting in El Paso, Texas to plan research on the Juarez cobalt-60 accident.

Ed's conclusion was that measurements in the vicinity of the accident are technically feasible so they can be used to check the theoretical models of doses delivered and can be correlated with biological measurements on people. Although, the political complications are great, they are not insuperable.

I hope you will have had a chance to talk to Dr. Gerald Hanson at the Pan American Health Organization in Washington, D.C. (861-3200).

With best regards.

Sincerely yours,

Ed

McDonald E. Wrenn, Ph.D.
Director and Professor

Encl.

cc Dr. Gerald Hanson

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BUILDING 351
SALT LAKE CITY, UTAH 84112
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Subject: Trip Report
Traveler: E.H. Haskell
Destination: El Paso Texas
Dates: 1/8/85 to 1/10/84(?)

Purpose of Trip: 1) Attend Binational meeting in El Paso, Texas, regarding the Juarez Cobalt-60 accident. The meeting was sponsored by the Pan American Health Organization, El Paso Field Office. 2) Visit site of radiation accident and survey neighborhod for presence of fired brick suitable for TL analysis.

Objective of Meeting: "Present available information and analyze proposals for follow-up studies of the exposed populations."

The meeting began at 9:00 A.M. on Wednesday, January 9th at the Exec-U-Lodge in El Paso Texas. The agenda of the meeting is included in Appendix 1, however a delay in distribution of the agenda to the Mexican participants resulted in a reduction of the scope of the talks scheduled for the morning. Little data was presented, and only summaries given.

The afternoon session included a discussion of the role of P.A.H.O. in the coordination or implementation of any future studies, the role which the DOE/REACTS program could play, and the potential utility of the data to the DOE Radiation Accident Registries and Follow-up Program, and to the EPA Human Health Risk Estimation Program.

Dosimetry information which was obtained upon discovery of the accident was summarized by Dr. Burson together with projected isodose plots (without building attenuation) of the area made using computer models (Appendix 3). A proposal for future modeling was also presented by Dr. Burson. The capabilities of the thermoluminescence laboratory and a brief presentation of the techniques in use. (Outline in Appendix 4) followed.

The remainder of the afternoon was devoted to the identification of scientific areas where human radiobiological data is needed and problems associated with various aspects of the proposed studies.

The main emphasis of the closing summary centered on defining the mechanism through which future studies would be implemented. It was concluded that the various research proposals would have to be presented to the Health Minister before any future action could be taken.

Site Survey: At the suggestion of Dr. Hansen, moderator of the meeting, I approached Dr. Olachea (See participants list, Appendix 2) concerning the possibility of visiting the accident site. Dr. Olachea indicated that he would be happy to have me escorted through the area if I agreed not to approach any of the occupants of the area and did not take any photographs. However, it would be impossible to do it for at least several weeks due the the busy schedule of his department. The morning of January 10th I made a discrete and informal survey of the area by taxi (see attached map in Appendix 5, slides are being developed) and determined that there were numerous buildings in the immediate area built either partially or entirely of fired brick. Many of the buildings appeared to have been built within the past several years. A trip to the *Junke Fenix*, the junk yard where the Co-60 was originally taken failed to reveal any suitable samples. It is possible that ceramic plumbing fixtures are located withing the concrete block building adjacent to the junk yard, however this was not confirmed. Porcelain fixtures in the Juarez neighborhood near Aldema St. were also not personally seen, however, their presence was confirmed by Mexican scientists during the meeting the previous day.

List of Appendicies

Appendix 1

PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION

TEL. (915) 581-6645
FIELD OFFICE 6006 N MESA - SUITE 700 EL PASO, TEXAS 79912

PROPOSED AGENDA

BINATIONAL MEETING IN EL PASO, TEXAS REGARDING THE JUAREZ COBALT - 60 ACCIDENT SPONSORED BY PAHO FIELD OFFICE, EL PASO

9 JANUARY 1985, EL PASO, TEXAS

OBJECTIVE:

PRESENT AVAILABLE INFORMATION AND ANALYZE PROPOSALS FOR FOLLOW UP STUDIES OF THE EXPOSED POPULATION.

I. OPENING OF THE MEETING:

Dr. Herbert H. Ortega. Chief Field Office El Paso.

II. ORGANIZATION OF THE STUDIES IN MEXICO.

Dr. Enrique Piña Garza, Dr. Felipe Hurtado Mendialdua.

A. Available support

B. Responsible organizations

C. Other Aspects

III PRESENT MEDICAL STATUS REPORT, Dr. Rafael Olachea

A. Clinical effects.

B. Reproductive outcome.

C. Epidemiologic roster.

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IV **PRESENT SCIENTIFIC STATUS OF ENVIRONMENTAL AND INDIVIDUAL DOSIMETRY.** Dr. R. Magaña and other Health Physicists.

A) Physical.

B) Biological.

1. Cytogenetics.
2. Molecular genetics.
3. Spermatology.
4. Reproductive performance.

V **FOLLOW-UP AND PERCEPTION OF FUTURE NEEDS FOR ASSISTANCE.** Dr. E. Piña Garza and others.

AFTERNOON

VI **POSSIBILITIES FOR COOPERATION IN THE MEXICAN INVESTIGATION OF THE JUAREZ ACCIDENT.**

A) PAHO - Dr. G. Hanson, Dr. H. Ortega.

B) The DOE/REACTS program and the PAHO — Western Hemisphere Radiation Pathology Center — Dr. C.C. Lushbaugh.

C) The DOE Radiation Accident Registries and Follow-up Program. Dr. S. Fry, Dr. C.C. Lushbaugh.

D) The EPA Human Health Risk Estimation Program - Dr. P. Voytek.

VII **A PROTOCOL FOR A STUDY FOR INDIVIDUALIZING RADIATION EXPOSURE ESTIMATES** — Dr. Z. Burson, Dr. E. Haskell.

VIII **SCIENTIFIC AREAS WHERE HUMAN RADIOBIOLOGY DATA IS NEEDED.**

A) Cytogenetics — Biologic dosimetry — Dr.. R. DuFrain, Dr. A. Carrano.

B) Molecular genetic damage — Dr. R. Albertini.

C) Reproductive outcome — Dr. S. Selevan, Dr. P. Voytek.

IX **OTHER AVAILABLE HELP IN PROBLEM AREAS.**

A) Epidemiology — Problems associated with studying human population. Dr. J. Schull.

1. Follow-up to discern late genetic effects — Dr. J. Schull.
2. Follow-up to discern other late stocastic effects — Dr. S. Fry.

B) Estimation of human health risks — Dr.P. Voytek.

C) Radiation Pathology surgical and necropsy consultation and assistance. Dr. C.C. Lushbaugh.

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X SUMMARY. Dr. E. Piña Garza, Dr. G. Hanson and others.

Generalizations derived from the meeting.

A) Mexican leadership role.

B) What seems possible to do with and without U.S. assistance.

C) What can be realistically hoped for in the near term and distant future?

XI CLOSING REMARKS.
Dr. Herbert H. Ortega.

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Appendix 2

BINATIONAL MEETING REGARDING THE CD. JUAREZ COBALT 60 ACCIDENT

REUNION BINACIONAL SOBRE ACCIDENTE DE COBALTO 60 EN CD. JUAREZ

PAHO/OPS FIELD OFFICE - EL PASO, TEXAS

JANUARY 9, 1985

LIST OF PARTICIPANTS - LISTA DE PARTICIPANTES

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Appendix 3

DEFINITION OF RADIATION FIELDS AND DOSE ASSIGNMENTS

MEXICO ^{60}Co INCIDENT - 1983/1984

By

ZOLIN G. BURSON
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P.O. Box 1912 M/S D-12
Las Vegas, Nevada 89125

Suggestions Made To The
PAN AMERICAN WORLD HEALTH ORGANIZATION
January 9, 1985
El Paso, Texas

1005946

DEFINITION OF RADIATION FIELDS AND DOSE ASSIGNMENTS

MEXICO ^{60}CO INCIDENT - 1983/1984

By

Zolin Burson, EG&G/EM

The subject I would like to discuss concerns the definition of radiation fields and dose assignments subsequent to a medical follow-up study (illustration #1). In order for a medical follow-up of exposed individuals to be meaningful, dose assignments must be as accurate as possible with the least uncertainty. Dose assignments, in turn, depend on defining the radiation fields in areas where individuals lived and worked.

The suggestions I will be making are the same ones I would make if this incident happened in my community in the United States. I am not informed on what has been accomplished or what has been studied to date concerning this incident. Therefore, some of what I am going to suggest or present to you may have already been accomplished. Therefore, please take this into account in my presentation.

The first series of illustrations concern some calculations I did several months ago for Drs. Hubner and Lushbaugh, of the Oak Ridge Associated Universities.

As you know, the pickup containing several ^{60}Co pellets was assumed to be parked at two locations along Ignacio Aldamo Street in North Juarez, as shown in illustration #2. The pickup was assumed to be parked at location 'A' for one week and at location 'B' for 7 weeks.

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Radiation measurements were made by the Mexican officials at several locations in and around the pickup to define the radiation levels, as shown in illustration #3. Note that the radiation levels on the left side of the truck were much higher than along the right side, primarily because concrete slag in the back of the pickup provided shielding in that direction.

Using these measurements, I calculated the integrated exposure isodose contours surrounding the two locations based upon the indicated assumptions in illustration #4. It should be noted that the effective ^{60}Co activity in the pickup is not certain. It could be as low as 65 curies or as high as 110 curies, depending on how one interprets these measurements. Other considerations include measurements made by Greg Yuhas of NRC at a location 80 meters from the truck when it was parked at its temporary storage location. I have chosen 80 curies as the most probable, based on these measurements surrounding the pickup.

The resulting calculations are shown as contours in the next illustration (#5). Note that these contours assume no shielding by structures. Obviously, the presence of structures would greatly modify the contours. Nevertheless, they do show the extent of homes to be tagged for the study.

The next illustration (#6) is a close-up of the contours and structures surrounding the two locations of the pickup. Note the extent of the 175R contour, assuming no shielding of the structures. It extends into the buildings on both sides of the street for nearly a full block.

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I have assumed that the structures have block walls rather than wooden frames. The next illustration (#7) shows the value of the first contour as modified by various kinds of shielding material. The most probable material is a cinder block wall covered with stucco, modifying the first contour to a value of 95R.

The next illustration (#8) shows the integrated exposure as a function of distance from the source with some shielding modifying the curve. The integrated exposure inside the first row of houses on the east side of the street could be between 100 and 700R for the entire block. The exposure inside the houses on the west side of the street would be about the same, although it is more difficult to calculate. The pickup was much closer to the houses but the radiation levels were smaller on that side of the pickup. For exposure inside these houses, we must consider radiation scattered by the air and the wall as well as radiation penetrating directly through the wall (illustration #9).

Based on these calculations, Dr. Hubner and I roughly estimated that there may be 50 people who received 50 rems or more and 200 people who received from 5 to 50 rems (illustration #10).

Certainly, many residents in the area where the pickup was parked received a significant dose of radiation. They were not the only ones, however, as the next illustration (#11) indicates. All exposed persons should be included in the medical follow-up study.

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As I mentioned before, I do not know exactly what has been accomplished to date, but I would recommend the following (see illustration #12): (1) A feasibility study to see if it is possible to carefully define radiation fields and assign accurate doses to individuals. (2) A careful definition of the radiation fields as they existed in time and space; and (3) an assignment of doses to individuals with uncertainties attached. If these three items are successfully completed, then a medical follow-up will be meaningful. I will discuss each item in more detail in the following illustrations.

The feasibility study should determine if it is possible to carefully define radiation fields and assign accurate doses to individuals (see illustration #13). The number of people exposed to high dose levels should be estimated carefully. It should be determined if dose assignments can be made with sufficient accuracy. The feasibility of tracking exposed people and a control group for a long period of time should also be evaluated.

In defining the radiation fields created by the ^{60}Co sources, I recommend that actions be taken as shown in illustration #14. I will discuss each one of these in detail.

It would be desirable to account for the source activity as a function of time and place (illustration #15). For example, it would be desirable to know exactly how many curies remained in the pickup and where the pickup was located every hour of every day. The same concept would apply to the rest of the pellets.

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Since the source strength at different locations is determined by instrument measurements, it would be desirable to trace the instrument calibrations to a common standard, such as the National Bureau of Standards in the United States (illustration #16).

With recent techniques developed in the U.S., it is possible to measure doses as low as 10 rads delivered to bricks or ceramics by thermoluminescent measurements made on the existing building materials which were exposed. If sufficient materials existed and if the technique could be applied, these measurements would contribute greatly in reconstructing the radiation field and source locations. Steps to obtaining the TLD measurements are given in illustration #17.

Perhaps the most important study suggested is a mock-up experiment as shown in illustration #18. It is suggested that a small ^{60}Co source be placed in a Datsun long bed pickup, that it be properly shielded to mock-up the radiation levels around the pickup, and that radiation levels be measured in the homes nearby. Accurate measurements could be made of ^{60}Co radiation levels as low as 10 μR/h. Scaled up from 500 mCi to 80 Ci and integrated over 7 weeks, 10 μR/h becomes about 2R which is sufficient to define any area where a person might have received a 5 rem dose. Illustration #18 outlines the main ingredients of the experiment for the pickup parked in the residential area. Measurements in homes covering several blocks would be required. Similar experiments could be made in the junkyard, foundry, etc. Such experiments should be done carefully and thoroughly with a mock-up as exact as possible and with as few compromises as practical.

It would be desirable to perform detailed calculations of radiation levels using the best known source terms and structural components of the buildings. These calculated results would supplement the TLD measurements and mock-up experiments (illustration #19).

After the radiation fields have been defined as accurately as possible, dose assignments can be made (see illustration #20). An uncertainty should be assigned to each dose.

In summary, for a medical follow-up to be meaningful, dose assignments should be made as accurately as possible with the least uncertainty. These dose assignments, in turn, depend on defining the radiation fields in areas where individuals lived and worked. Defining the radiation fields must be done carefully and thoroughly with as little compromise as possible.

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ILLUSTRATION #1

DEFINITION OF RADIATION FIELDS AND DOSE ASSIGNMENTS

Mexico ^{60}Co Incident - 1983/1984

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ILLUSTRATION #2

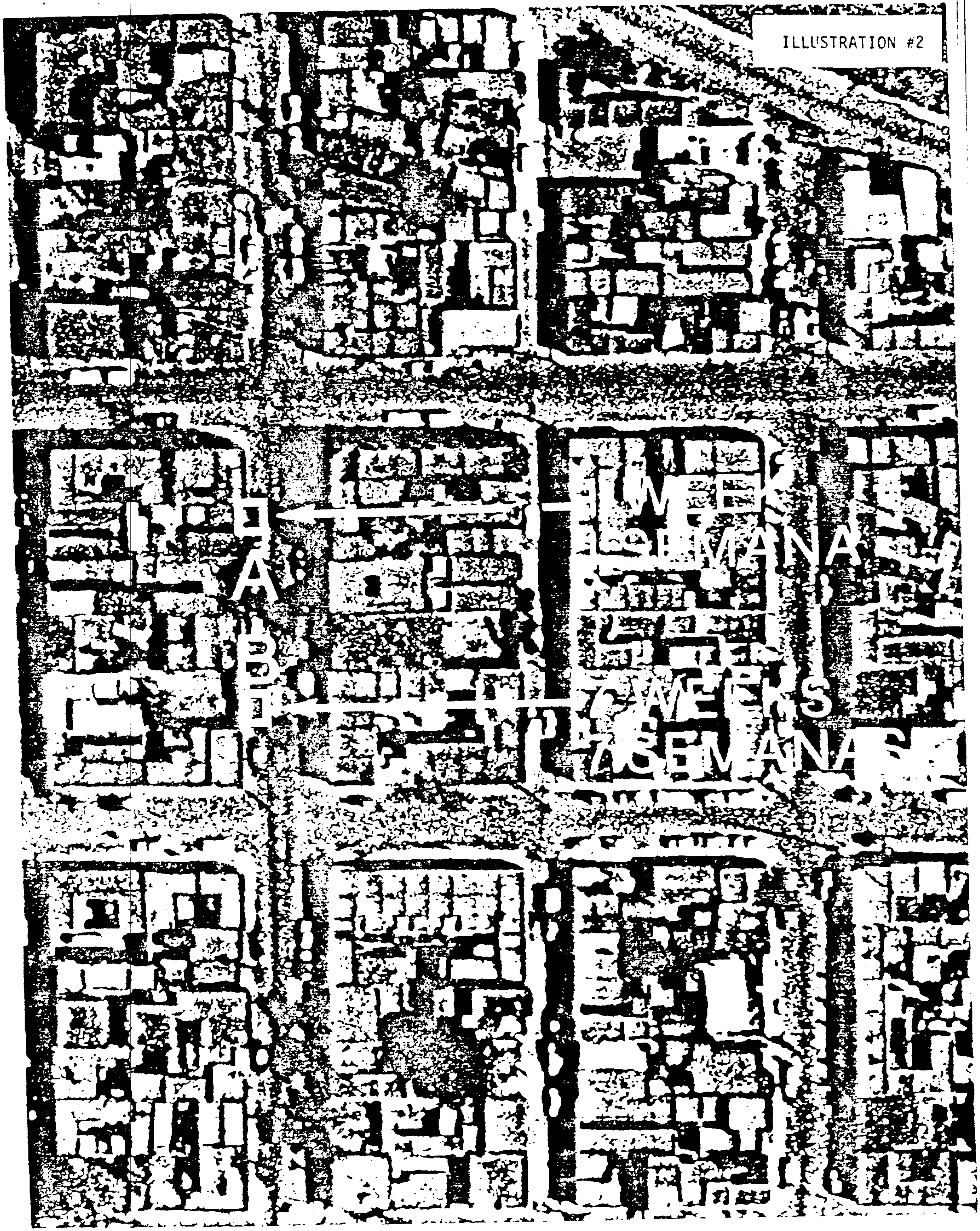

ILLUSTRATION #3

RADIATION MEASUREMENTS IN AND AROUND THE PICKUP

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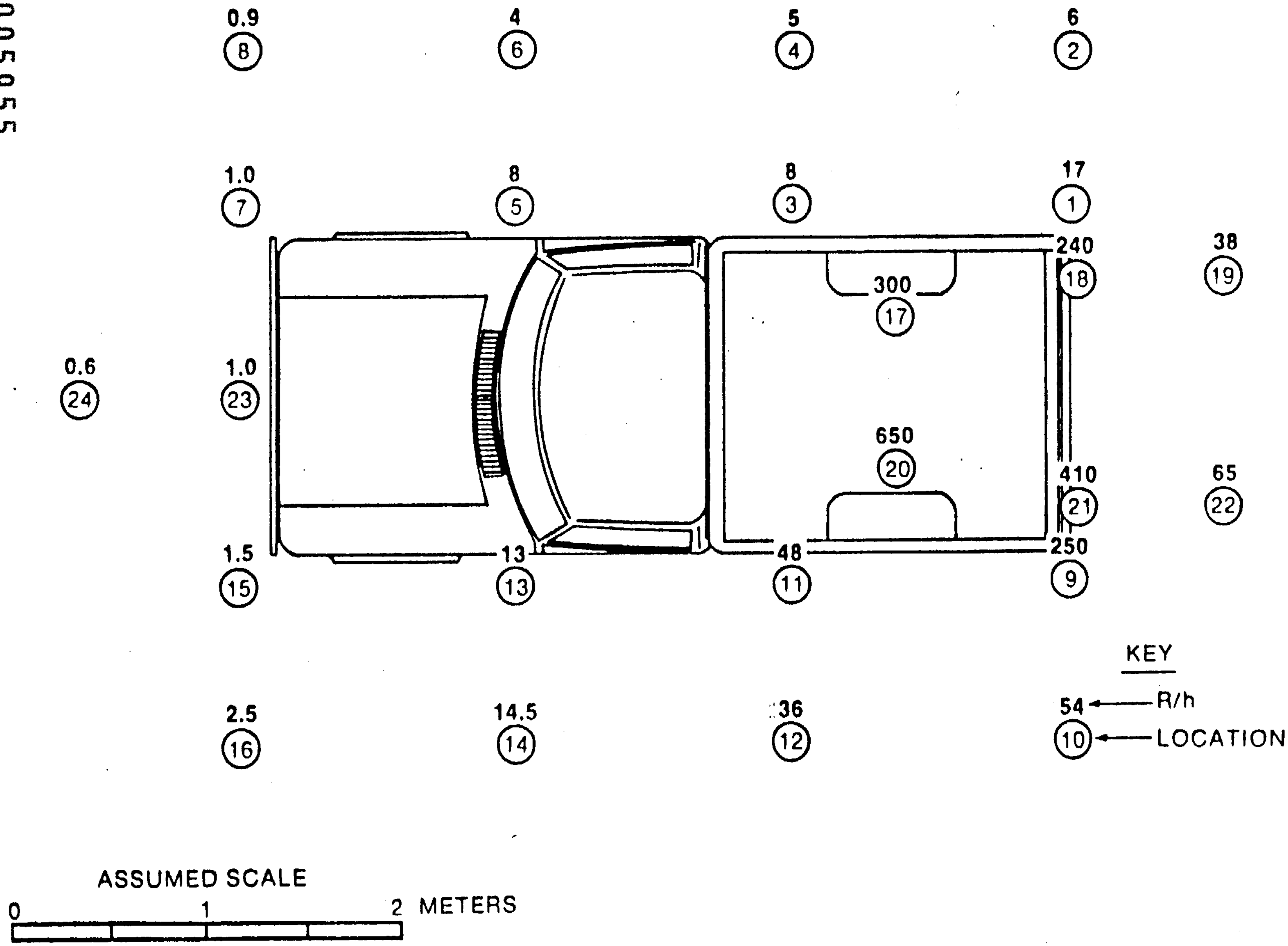

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ASSUMPTIONS FOR ISODOSE CONTOURS

- 80 Ci APPARENT ACTIVITY IN TRUCK
- NO SHIELDING PROVIDED BY HOUSES
- TRUCK PARKED AT POSITION 'A' FOR 1 WEEK
- TRUCK PARKED AT POSITION 'B' FOR 7 WEEKS

ILLUSTRATION #5

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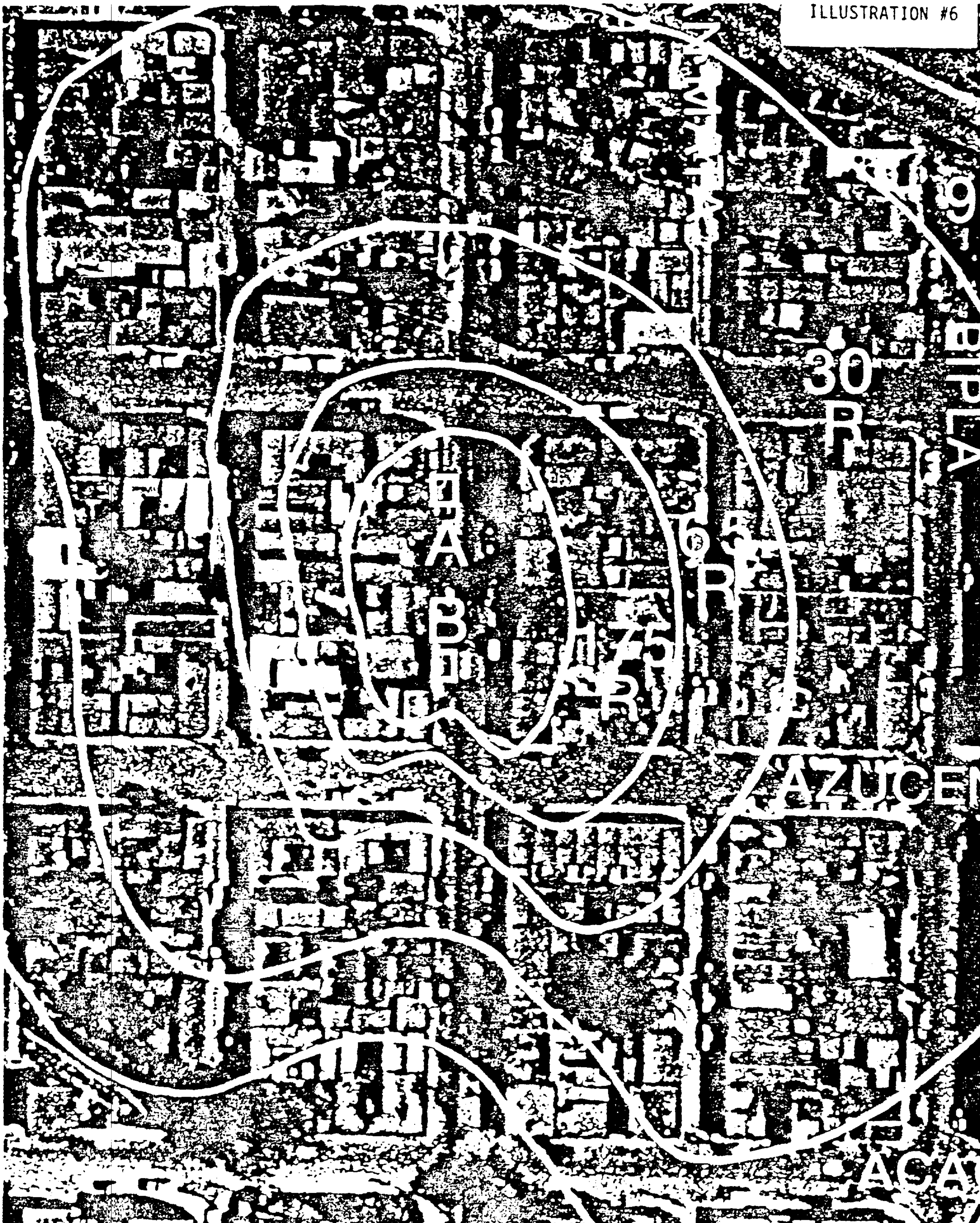
No Attenuation

ILLUSTRATION #6



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CLOSE-IN ISODOSE CONTOUR MODIFIED BY SHIELDING

SHIELDING MATERIAL	CONTOUR VALUE (R)
• NO SHIELDING	175
• 4-INCH BRICK WITH STUCCO	104
• 8-INCH BRICK WITH STUCCO	52
• 8-INCH HOLLOW CONCRETE BLOCK WITH STUCCO	88
• 8-INCH FILLED CONCRETE BLOCK WITH STUCCO	75
• 8-INCH HOLLOW CINDER BLOCK WITH STUCCO	95

ILLUSTRATION #8

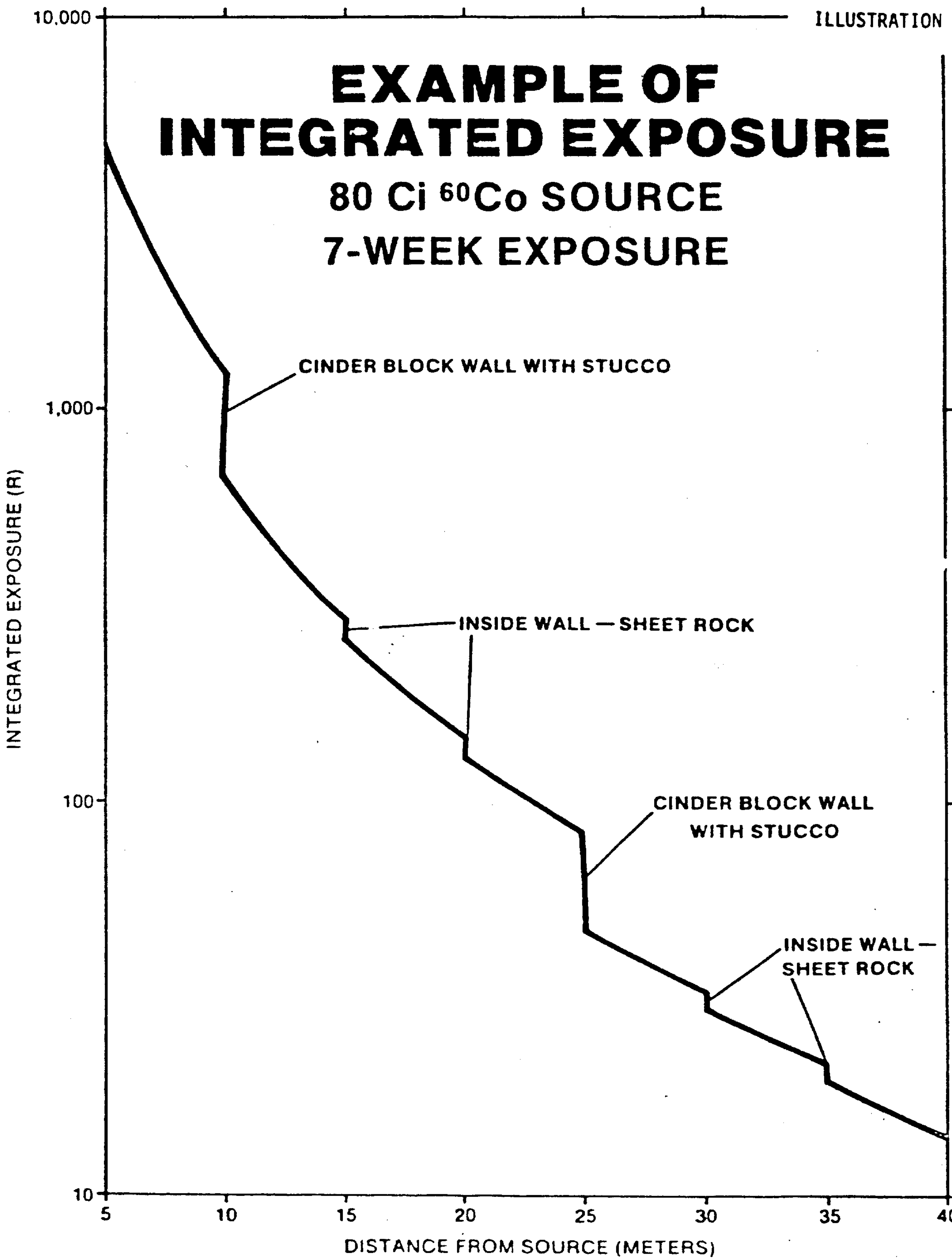

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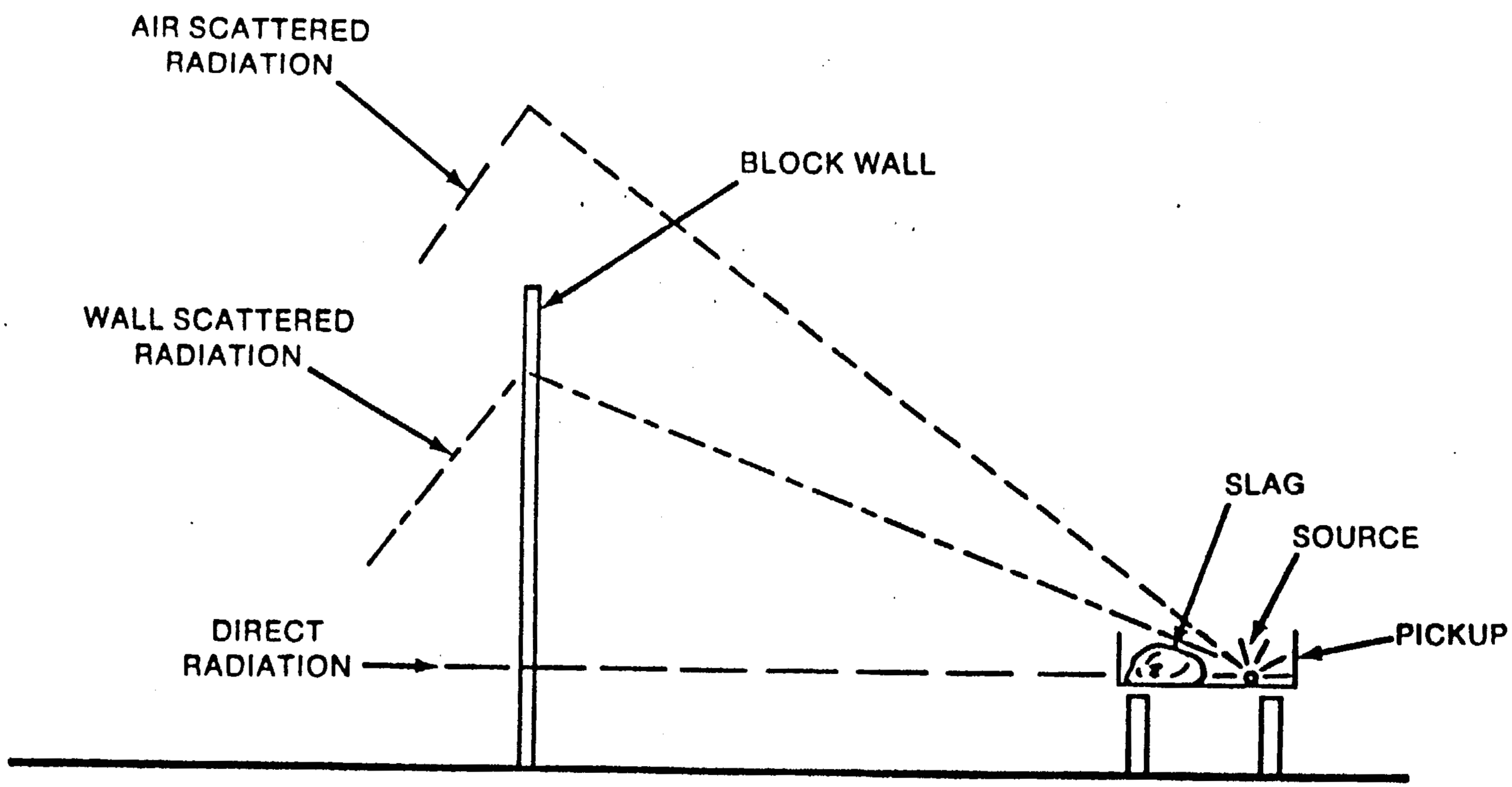
ILLUSTRATION #9

SHIELDING CONCEPTS



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GROSS ESTIMATE OF EXPOSED PERSONS

OVER 50 REM .... 50 PEOPLE

5 TO 50 REM .... 200 PEOPLE

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EXPOSED PERSONS

- CREW THAT REMOVED THE SOURCE FROM THE WAREHOUSE
- RESIDENTS IN THE AREA WHERE THE PICKUP WAS PARKED
- RESIDENTS IN THE AREA SURROUNDING THE TEMPORARY STORAGE LOCATION OF PICKUP
- JUNKYARD WORKERS
- CREWS THAT TRANSPORTED JUNK TO THE FOUNDRIES
- RESIDENTS IN THE AREA SURROUNDING THE JUNKYARD
- RESIDENTS IN THE AREA SURROUNDING THE FOUNDRIES
- FOUNDRY WORKERS
- DECONTAMINATION CREWS

ILLUSTRATION #12

MEXICO ^{60}Co INCIDENT 1983/1984 DOSE EVALUATIONS

- FEASIBILITY STUDY
- DEFINITION OF RADIATION FIELDS
- DOSE ASSIGNMENTS
- MEDICAL EVALUATIONS

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ILLUSTRATION #13

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FEASIBILITY STUDY OUTLINE

- ESTIMATE NUMBER OF PEOPLE EXPOSED AND LEVEL OF EXPOSURE
- ESTIMATE UNCERTAINTY OF DOSE ASSIGNMENTS
  - ACCOUNTABILITY OF SOURCE MOVEMENT
  - TLD MEASUREMENTS IN BRICKS
  - ESTIMATE DOSE LEVELS BY SIMPLE CALCULATIONS
- DETERMINE PROBABILITY OF SUCCESS OF TRACKING PEOPLE FOR 20 YEARS

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DEFINITION OF RADIATION FIELDS

A. DEFINITION OF SOURCE TERM

B. INSTRUMENT CALIBRATION

C. TLD MEASUREMENTS

D. MOCK-UP EXPERIMENTS

E. CALCULATIONS

ILLUSTRATION #15

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A. DEFINITION OF SOURCE TERM

ACCOUNT FOR THE SOURCE ACTIVITY
AS A FUNCTION OF TIME AND PLACE.

ILLUSTRATION #16

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B. INSTRUMENT CALIBRATION

INSTRUMENT CALIBRATIONS SHOULD BE TRACEABLE TO A COMMON STANDARD, SUCH AS THE NATIONAL BUREAU OF STANDARDS.

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ILLUSTRATION #17

C. TLD MEASUREMENTS

- DETERMINE AVAILABILITY OF MATERIAL
  - FIRED BRICK
  - CERAMICS
- COLLECT SAMPLES
- DETERMINE BACKGROUND RADIATION IN MATERIAL
- DETERMINE THERMAL/RADIATION RESPONSE OF MATERIAL
- ESTIMATE DOSES TO MATERIAL

D. MOCK-UP EXPERIMENTS

- USE 500 mCi COBALT-60 SOURCE TO MEASURE 10 μR/h LEVELS AND ABOVE
- PLACE SOURCE AND SHIELDING IN PICKUP TO MOCK-UP RADIATION LEVELS AROUND PICKUP
- NBS TRACEABLE CALIBRATION OF SOURCE AND INSTRUMENTATION
- USE HAND-HELD ION CHAMBER AND GERMANIUM DETECTORS TO MEASURE HIGH RADIATION LEVELS
- USE PRESSURIZED ION CHAMBER AND NaI DETECTORS TO MEASURE LOW RADIATION LEVELS
- OBTAIN NET EXPOSURE RATES AND NET SPECTRA

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E. CALCULATIONS

USING BEST KNOWN SOURCE TERMS AND STRUCTURAL COMPONENTS, CALCULATE DOSES TO EXPOSED PERSONS TO SUPPLEMENT TLD MEASUREMENTS AND MOCK-UP EXPERIMENTS.

DOSE ASSIGNMENTS

- DETERMINE RADIATION LEVELS IN AREAS WHERE PEOPLE LIVED AND WORKED
- ESTIMATE TIME OF STAY OF INDIVIDUALS
- ASSIGN DOSES TO INDIVIDUALS

NOTE: FOR MEDICAL FOLLOW UP TO BE MEANINGFUL, DOSE ASSIGNMENTS MUST BE MADE AS ACCURATELY AS POSSIBLE WITH THE LEAST UNCERTAINTY.

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Appendix 4

Outline for El Paso Talk 1/9/85

E.H. Haskell

View Graphs

1. Accident Dose = Total dose (TL) - Background dose
2. D = TL - Age x (Beta + Gamma)
3. Higher Doses, and interlaboratory comparison
4. Lower Doses comparison with background measurements
5. Dose- Depth profile in brick cores

1. Core Drilling
2. Core hole w/ruler
3. Dosimeter Capsules
4. Brass plug installed
5. Brass plug removed showing cap removal
6. Close up of brick cross section
7. Buhler Saw
8. Crusher, sifter, magnetic separator
9. Unetched quartz
10. Etched quartz
11. Vacuum pipette
12. TL reader
13. CRT glow Curve
14. Repaired brick

Cores of Different sizes, Tank tops, Date on Tank Top

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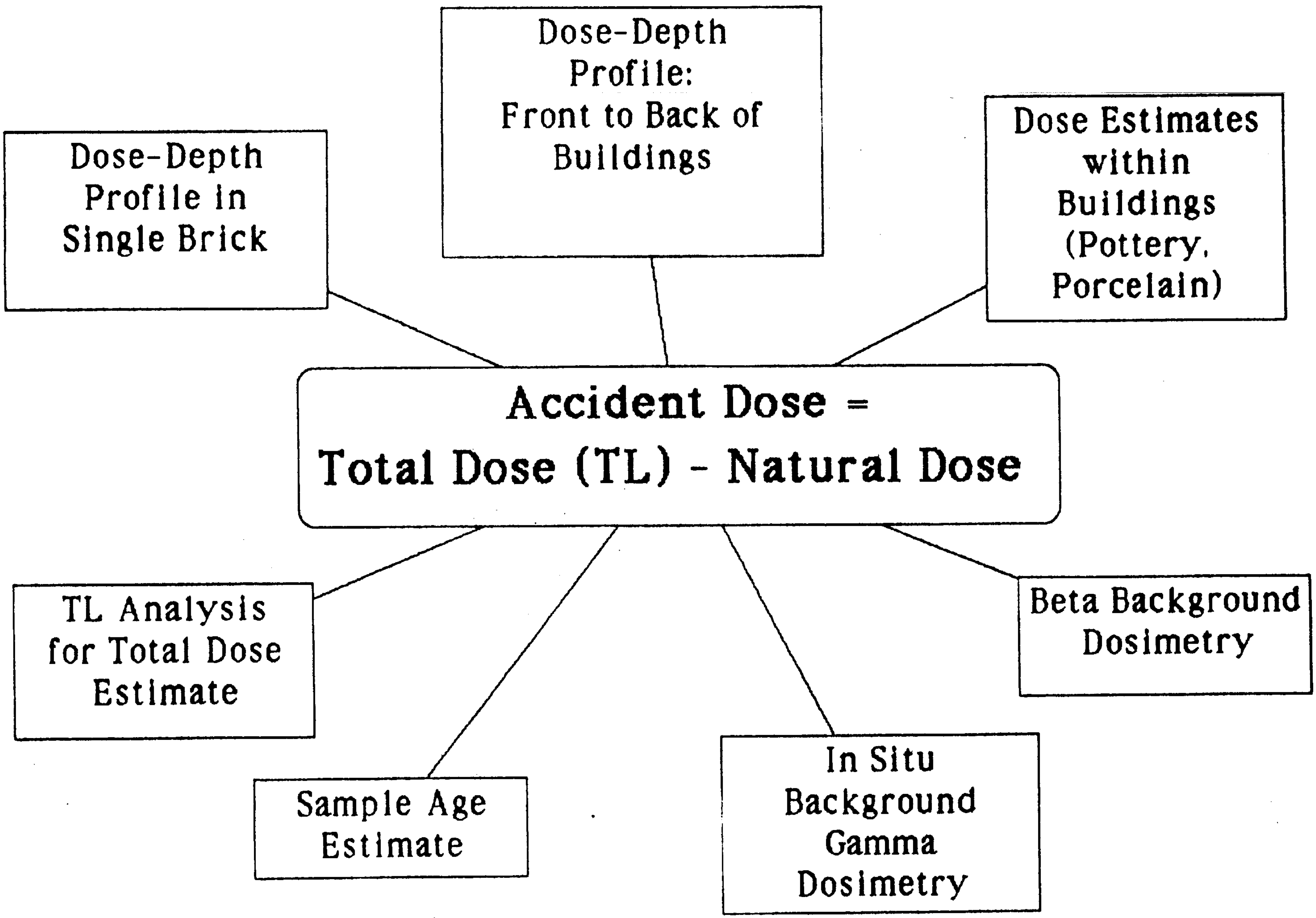
Dose-Depth Profile in Single Brick
Dose-Depth Profile: Front to Back of Buildings
Dose Estimates within Buildings (Pottery, Porcelain)
Accident Dose = Total Dose (TL) - Natural Dose
TL Analysis for Total Dose Estimate
Sample Age Estimate
In Situ Background Gamma Dosimetry
Beta Background Dosimetry

1005974

$$D = TL - A(\beta + \gamma)$$

WHERE

D = Dose from transient radiation source

TL = Total dose measured with TL technique

A = Age of sample after firing

β = β component of dose-rate

γ = γ Component of dose-rate

Figure 1. Formula for estimation of transient dose

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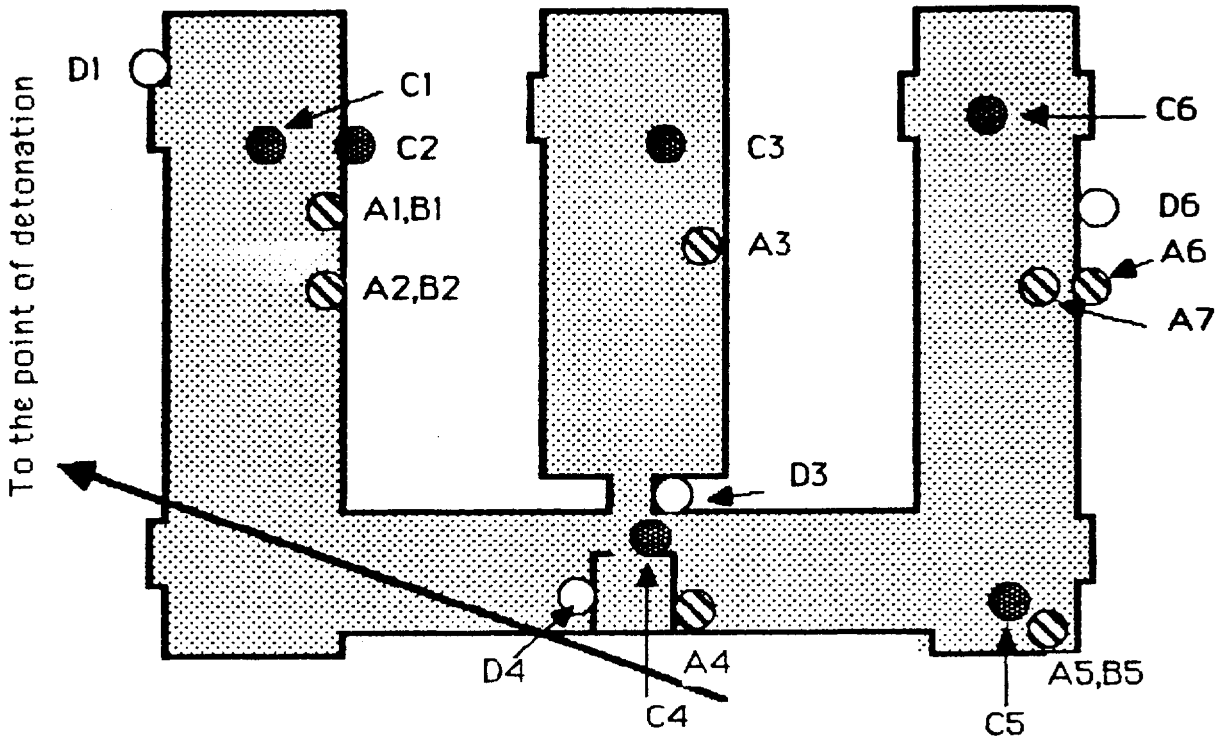
Faculty Of Science Building, University Of Hiroshima



Total Dose Estimates To Quartz Inclusions From The Above Building (Including The Natural Background Dose) As Measured By Various Laboratories

SAMPLE CODE	A UTAH	B OXFORD	C NARA	D NIRS
1	99	102	100	110
2	95	100	101	---
3	83	--	85	20 *
4	15 *	--	80	120
5	71	81	84	---
6	25*	--	84	30*
7	70	--	--	---

* Shielded sample

ALL DOSES IN RADS TO QUARTZ

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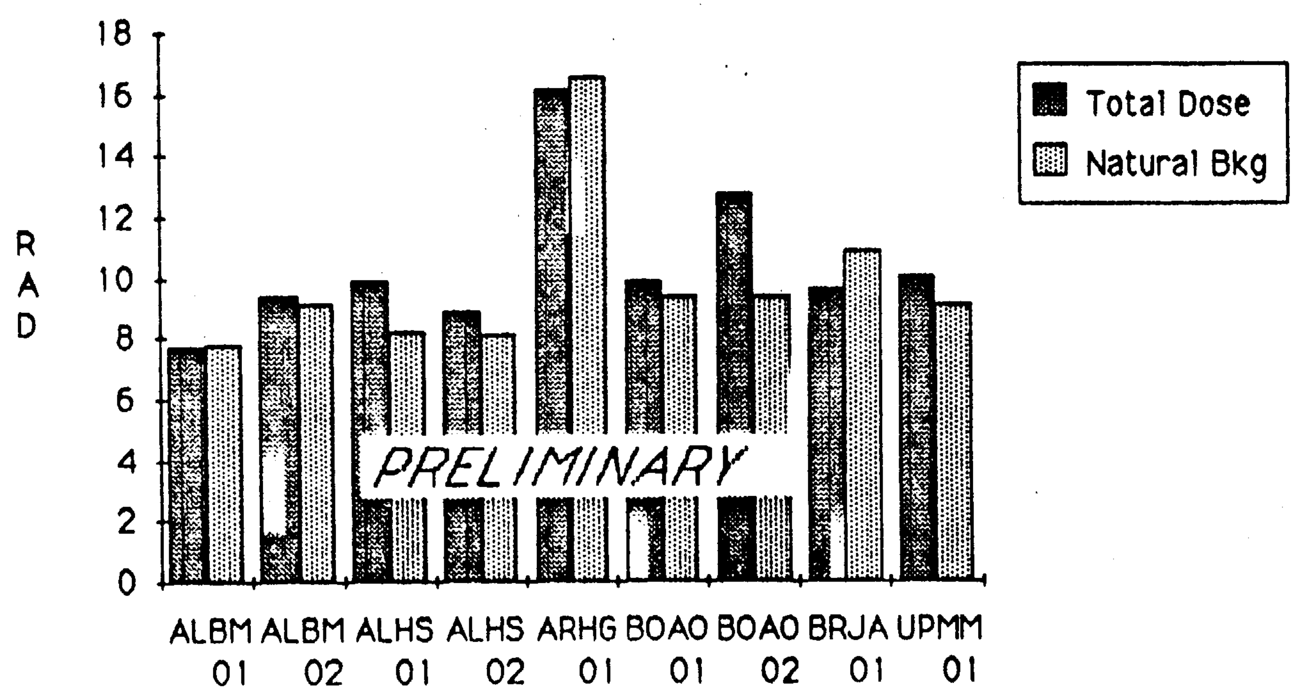
Duchesne County, Utah



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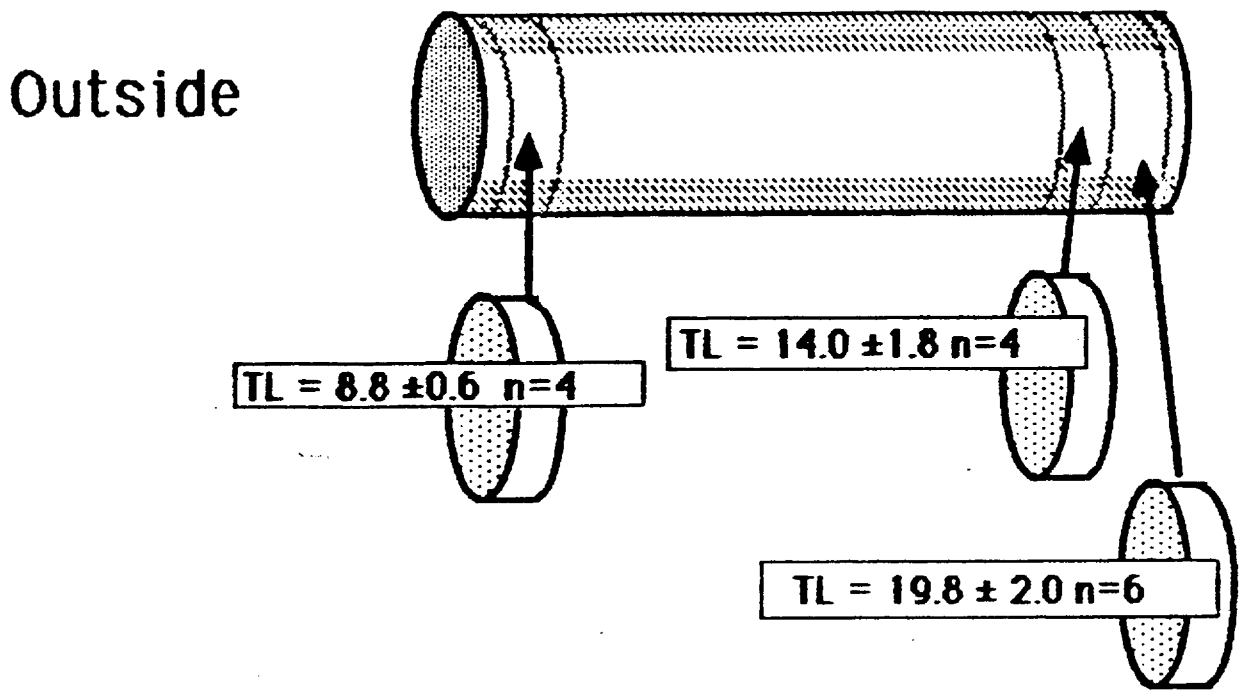
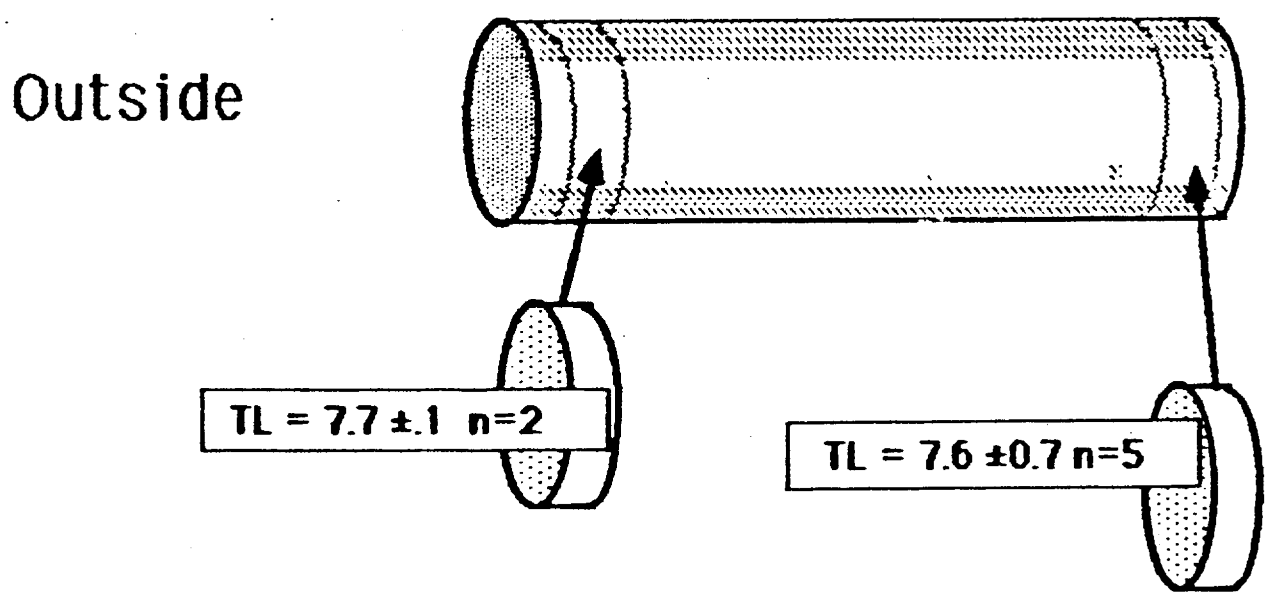


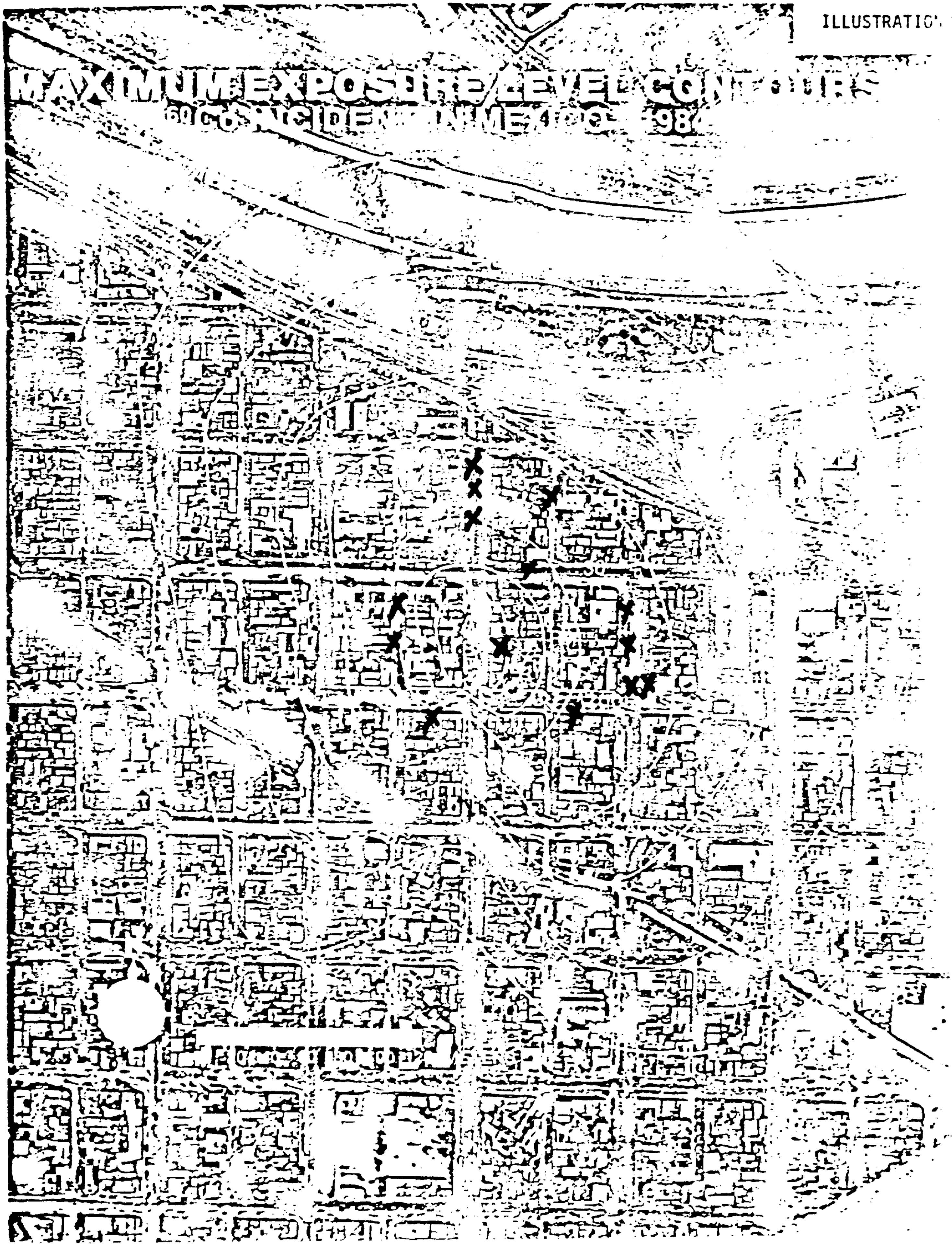
Outside
TL = 8.8 ±0.6 n=4
TL = 14.0 ±1.8 n=4
TL = 19.8 ± 2.0 n=6



Outside
TL = 7.7 ±.1 n=2
TL = 7.6 ±0.7 n=5

Appendix 5

ILLUSTRATION



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1985 FEB 11 PM 3: 23

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