FORM AEC-2
(3-64)
Previous editions are obsolete.

FORM APPROVED
BUREAU OF BUDGET NO. 38-R002.

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR SOURCE MATERIAL LICENSE

Pursuant to the regulations in Title 10, Code of Federal Regulations, Chapter 1, Part 40, application is hereby made for a license to receive, possess, use, transfer, deliver or import into the United States, source material for the activity or activities described.

1. (*Check one*)
☐ (*a*) New license
☐ (*b*) Amendment to License No. ______
☒ (*c*) Renewal of License No. SUB-526
☐ (*d*) Previous License No. ______

2. NAME OF APPLICANT
Allied Chemical Company
Allied Corporation

3. PRINCIPAL BUSINESS ADDRESS
P. O. Box 430
Metropolis, IL 62960

4. STATE THE ADDRESS(ES) AT WHICH SOURCE MATERIAL WILL BE POSSESSED OR USED

U. S. Route 45, one mile north of Metropolis, Illinois

5. BUSINESS OR OCCUPATION
Chemical Manufacturing

6. (*a*) IF APPLICANT IS AN INDIVIDUAL, STATE CITIZENSHIP
N/A

(*b*) AGE
N/A

7. DESCRIBE PURPOSE FOR WHICH SOURCE MATERIAL WILL BE USED

Chemical conversion of natural uranium ore concentrates into uranium hexafluoride.

8. STATE THE TYPE OR TYPES, CHEMICAL FORM OR FORMS, AND QUANTITIES OF SOURCE MATERIAL YOU PROPOSE TO RECEIVE, POSSESS, USE, OR TRANSFER UNDER THE LICENSE

(*a*) TYPE	(*b*) CHEMICAL FORM	(*c*) PHYSICAL FORM (*Including % U or Th.*)	(*d*) MAXIMUM AMOUNT AT ANY ONE TIME (*in pounds*)
NATURAL URANIUM	Ore Concentrates, UO_2, UF_4 and UF_6	Solid @ ~75% U Liquid & Gas @ 67.6% U	Unlimited
~~URANIUM DEPLETED IN THE U-235 ISOTOPE~~	Cs^{137}	Sealed calibration source.	100 millicuries
~~THORIUM ISOTOPE~~			

(*e*) MAXIMUM TOTAL QUANTITY OF SOURCE MATERIAL YOU WILL HAVE ON HAND AT ANY TIME (*in pounds*)

Unlimited Quantity

9. DESCRIBE THE CHEMICAL, PHYSICAL, METALLURGICAL, OR NUCLEAR PROCESS OR PROCESSES IN WHICH THE SOURCE MATERIAL WILL BE USED, INDICATING THE MAXIMUM AMOUNT OF SOURCE MATERIAL INVOLVED IN EACH PROCESS AT ANY ONE TIME, AND PROVIDING A THOROUGH EVALUATION OF THE POTENTIAL RADIATION HAZARDS ASSOCIATED WITH EACH STEP OF THOSE PROCESSES.

Refer to supplemental application information.

10. DESCRIBE THE MINIMUM TECHNICAL QUALIFICATIONS INCLUDING TRAINING AND EXPERIENCE THAT WILL BE REQUIRED OF APPLICANT'S SUPERVISORY PERSONNEL INCLUDING PERSON RESPONSIBLE FOR RADIATION SAFETY PROGRAM (OR OF APPLICANT IF APPLICANT IS AN INDIVIDUAL).

Refer to supplemental application information.

11. DESCRIBE THE EQUIPMENT AND FACILITIES WHICH WILL BE USED TO PROTECT HEALTH AND MINIMIZE DANGER TO LIFE OR PROPERTY AND RELATE THE USE OF THE EQUIPMENT AND FACILITIES TO THE OPERATIONS LISTED IN ITEM 9; INCLUDE: (*a*) RADIATION DETECTION AND RELATED INSTRUMENTS (including film badges, dosimeters, counters, air sampling, and other survey equipment as appropriate. The description of radiation detection instruments should include the instrument characteristics such as type of radiation detected, window thickness, and the range(s) of each instrument).

Refer to supplemental application information.

(*b*) METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED IN (*a*) ABOVE, INCLUDING AIR SAMPLING EQUIPMENT (for film badges, specify method of calibrating and processing, or name supplier).

Refer to supplemental application information.

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11(c). VENTILATION EQUIPMENT WHICH WILL BE USED IN OPERATIONS WHICH PRODUCE DUST, FUMES, MISTS, OR GASES, INCLUDING PLAN VIEW SHOWING TYPE AND LOCATION OF HOOD AND FILTERS, MINIMUM VELOCITIES MAINTAINED AT HOOD OPENINGS AND PROCEDURES FOR TESTING SUCH EQUIPMENT.

Refer to supplemental application information.

12. DESCRIBE PROPOSED PROCEDURES TO PROTECT HEALTH AND MINIMIZE DANGER TO LIFE AND PROPERTY AND RELATE THESE PROCEDURES TO THE OPERATIONS LISTED IN ITEM 9; INCLUDE: (*a*) SAFETY FEATURES AND PROCEDURES TO AVOID NONNUCLEAR ACCIDENTS, SUCH AS FIRE, EXPLOSION, ETC., IN SOURCE MATERIAL STORAGE AND PROCESSING AREAS.

Refer to supplemental application information.

(*b*) EMERGENCY PROCEDURES IN THE EVENT OF ACCIDENTS WHICH MIGHT INVOLVE SOURCE MATERIAL.

Refer to supplemental application information.

(*c*) DETAILED DESCRIPTION OF RADIATION SURVEY PROGRAM AND PROCEDURES.

Refer to supplemental application information.

13. **WASTE PRODUCTS:** *If none will be generated, state "None" opposite (a), below. If waste products will be generated, check here* ☒ *and explain on a supplemental sheet:*

(*a*) Quantity and type of radioactive waste that will be generated. See supplemental application information.

(*b*) Detailed procedures for waste disposal.

14. IF PRODUCTS FOR DISTRIBUTION TO THE GENERAL PUBLIC UNDER AN EXEMPTION CONTAINED IN 10 CFR 40 ARE TO BE MANUFACTURED, USE A SUPPLEMENTAL SHEET TO FURNISH A DETAILED DESCRIPTION OF THE PRODUCT, INCLUDING:

N/A

(*a*) PERCENT SOURCE MATERIAL IN THE PRODUCT AND ITS LOCATION IN THE PRODUCT.

(*b*) PHYSICAL DESCRIPTION OF THE PRODUCT INCLUDING CHARACTERISTICS, IF ANY, THAT WILL PREVENT INHALATION OR INGESTION OF SOURCE MATERIAL THAT MIGHT BE SEPARATED FROM THE PRODUCT.

(*c*) BETA AND BETA PLUS GAMMA RADIATION LEVELS (*Specify instrument used, date of calibration and calibration technique used*) AT THE SURFACE OF THE PRODUCT AND AT 12 INCHES.

(*d*) METHOD OF ASSURING THAT SOURCE MATERIAL CANNOT BE DISASSOCIATED FROM THE MANUFACTURED PRODUCT.

CERTIFICATE

(*This item must be completed by applicant*)

15. *The applicant, and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 40, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.*

Allied Chemical Company
Allied Corporation
(*Applicant named in Item 2*)

Dated July 1, 1982

BY: A. J. Cipolla
(*Print or type name under signature*)

A. J. Cipolla
Plant Manager - Metropolis Works
(*Title of certifying official authorized to act on behalf of the applicant*)

WARNING: 18 U.S.C. Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

U.S. GOVERNMENT PRINTING OFFICE: 1964—O-706-977 817-427-2

ALLIED CHEMICAL

APPLICATION FOR RENEWAL OF SOURCE MATERIALS LICENSE

SUB-526

DOCKET 40-3392

METROPOLIS, ILLINOIS

UF_6 CONVERSION PLANT

JULY, 1982

TABLE OF CONTENTS

Chapter 2 Site Characteristics

Chapter 3 UF_6 Conversion Process and Equipment

Table of Contents (continued) PAGE NO.

Chapter 4 Effluent Control and Waste Management Systems

Chapter 5 Operations

Table of Contents (continued) PAGE NO.

Chapter 6 Accidents and Contingency Response Plans

Table of Contents (continued)

1. Proposed Activities

The purpose of this application and supporting information is renewal of Source Material License SUB-526, Docket No. 40-3392. This license, which is issued to Allied Chemical Company, an operating company of Allied Corporation, was renewed on August 31, 1977 and will expire on August 31, 1982.

The Allied Chemical Company operates a privately owned uranium hexafluoride conversion facility at Metropolis, Illinois. At this facility, natural uranium ore concentrates are chemically converted into high purity uranium hexafluoride (UF_6). The UF_6 product from the facility is shipped to Department of Energy gaseous diffusion plants for enrichment of the U^{235} isotope. Following enrichment, the uranium is converted into fuel for use in nuclear power reactors. The role of the Allied Plant in the Nuclear Fuel Cycle is shown in Figure 1.1, Page 1-2.

The Metropolis Plant was originally built at this location to supply UF_6 conversion for the U.S. Atomic Energy Commission under a five-year contract (1959-1964). Presently, however, the Metropolis facility supplies conversion services for the commercial nuclear power industry.

The present plant is a multi-product chemical manufacturing facility producing sulfur hexafluoride, iodine and antimony pentafluorides, liquid fluorine and uranium hexafluoride. The production of uranium hexafluoride is the only operation requiring licensing by USNRC pursuant to the provision of 10 CFR 40. The licensed facility is designed to produce about 14,000 short tons per year of uranium as UF_6 from uranium concentrates. The plant feed usually assays about 75% uranium and the final UF_6 product contains less than 300 parts per million impurities. In the Allied process, the ore concentrates feed is carried through the successive steps of feed preparation, reduction, hydrofluorination, fluorination and distillation. Chemical reactions are carried out in fluid bed reactors.

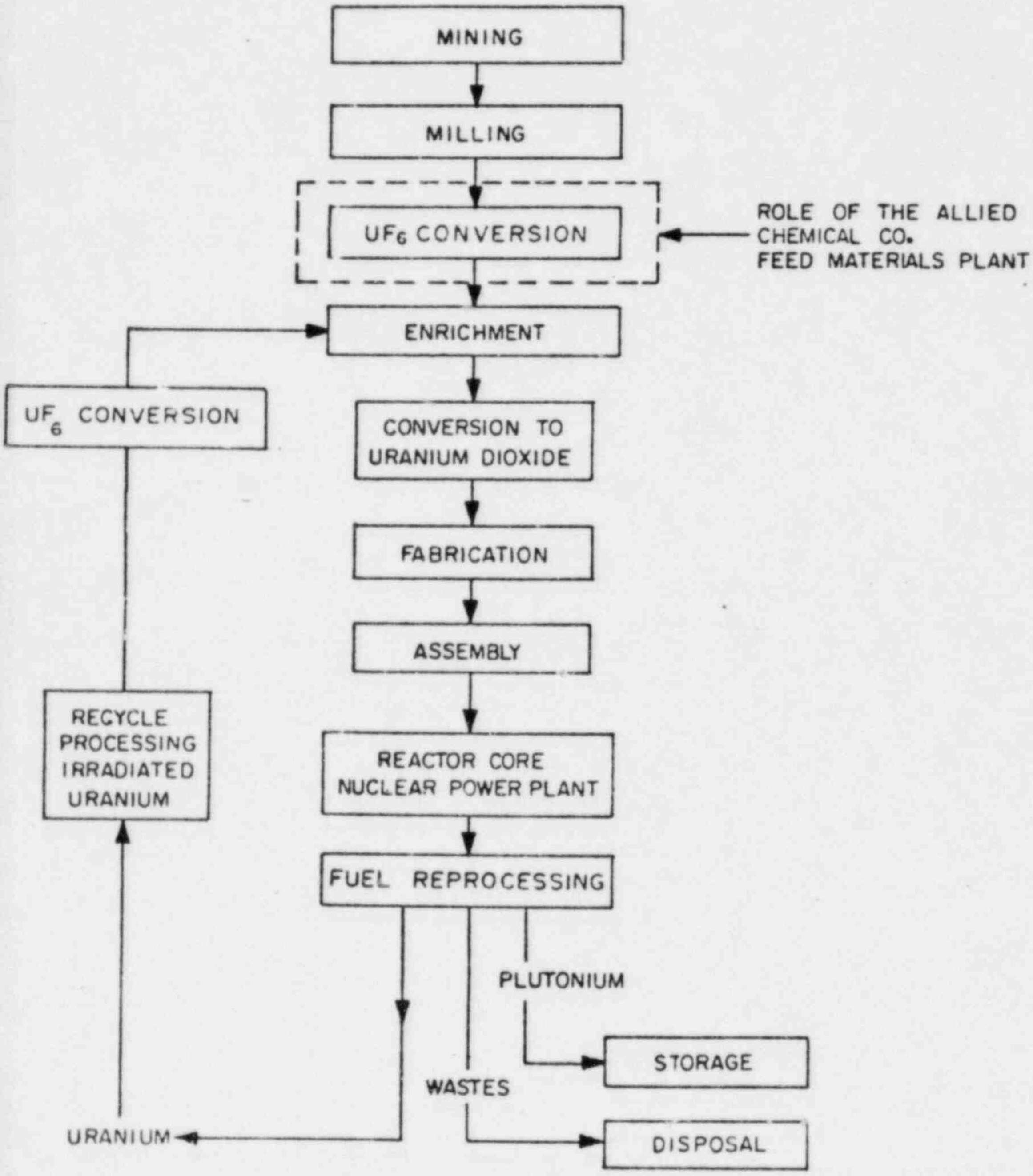


Figure 1.1 UF_6 Conversion Role in The Nuclear Fuel Cycle

2. Site Characteristics

2.1 Site Location and Demography

2.1.1 Site Location

The Allied Chemical Metropolis Plant is located an 862.3 acre tract of land in Massac County at the southern tip of Illinois along the North bank of the Ohio River (Refer to Figure 2.1.1(A), Page 2-2). The site perimeter is formed by U.S. Highway 45 to the North, the Ohio River to the South, an industrial coal blending plant to the West and privately owned, developed land to the East as shown in Figure 2.1.1(B), Page 2-3. Plant operations are conducted in a fenced in, restricted area covering 54 acres in the North central portion of the site, (Refer to Plot Plan, Figure 2.1.1(C), Page 2-4).

The plant site is located in gently rolling hills, typical of Southern Illinois, and bounded on the south by the Ohio River flood plain. The surface water drainage of the site is to the south into the Ohio River.

Approximately one-half of the site consists of idle agricultural fields which are returning to their natural state, and the remaining property is heavily wooded, second-growth timber. The timber is typical second-growth upland hardwood of oak, hickory, hackberry, dogwood, redbud, locust and sassafras.

Wildlife is plentiful within the site boundaries. Many species of mammals are present including deer, rabbit, fox, squirrel, racoon, opossum, and muskrat. Innumerable species of birds, reptiles and amphibians are found on the site.

Figure 2.1.1(A)

Location of Allied Chemical Site

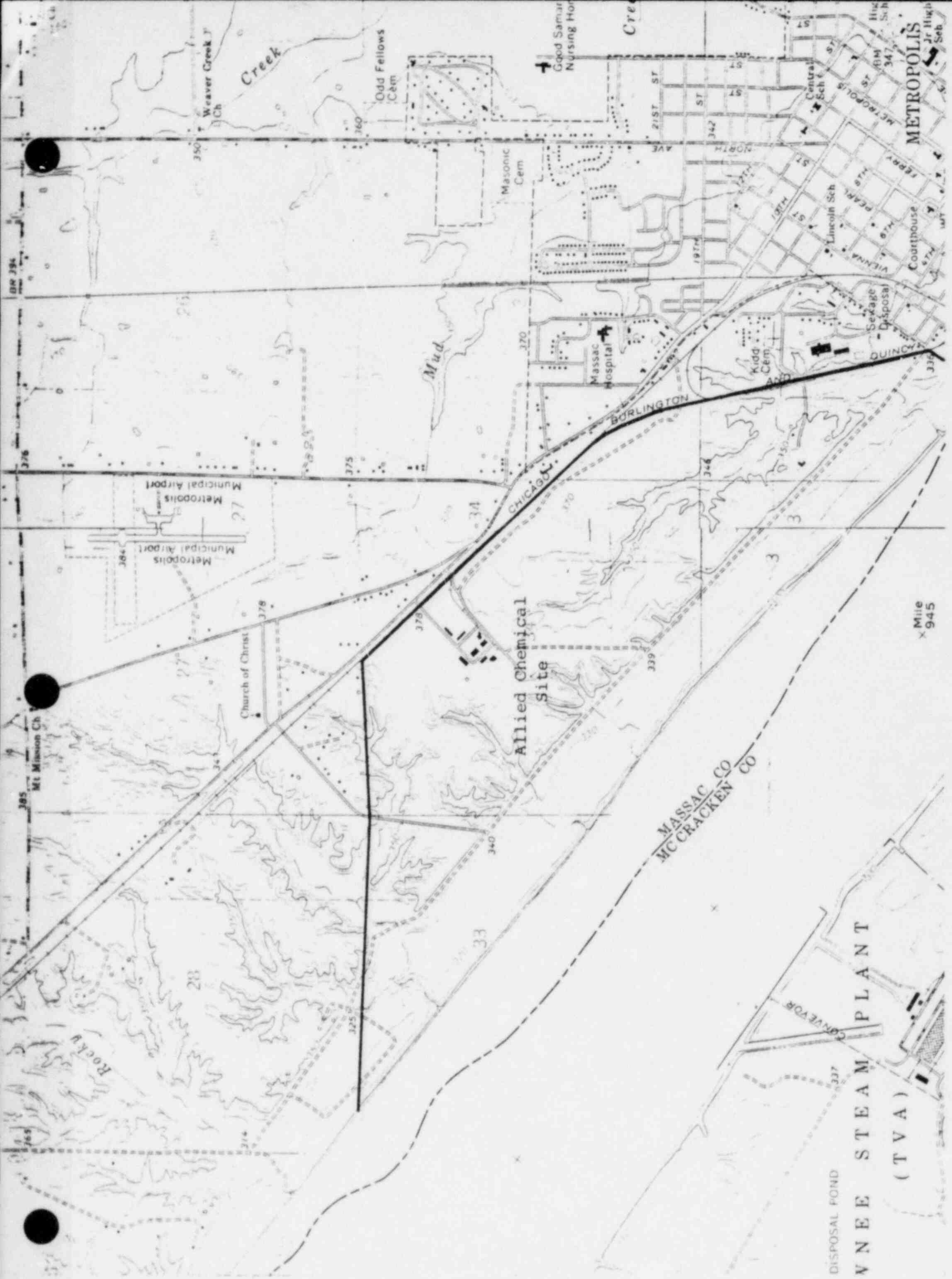
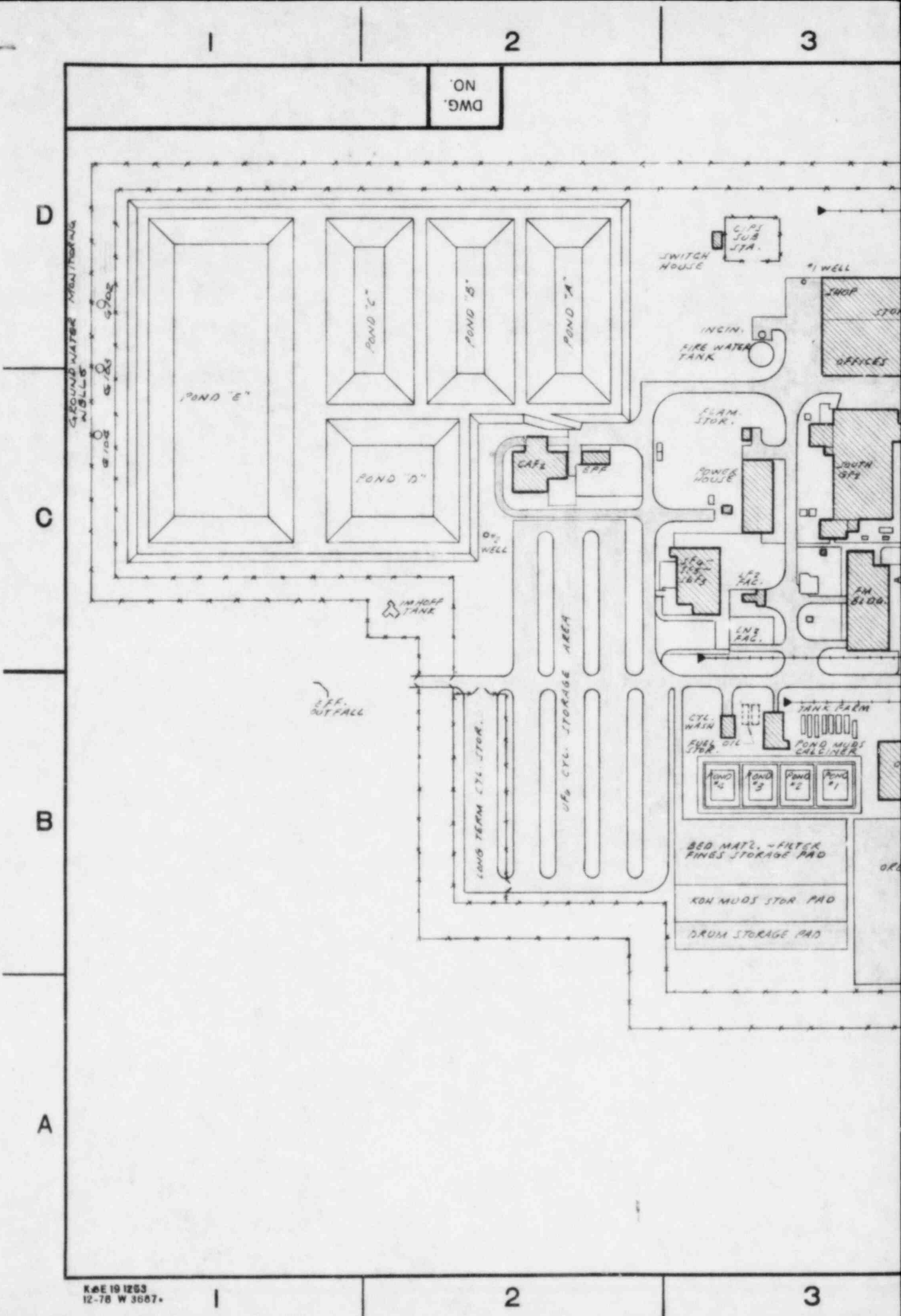
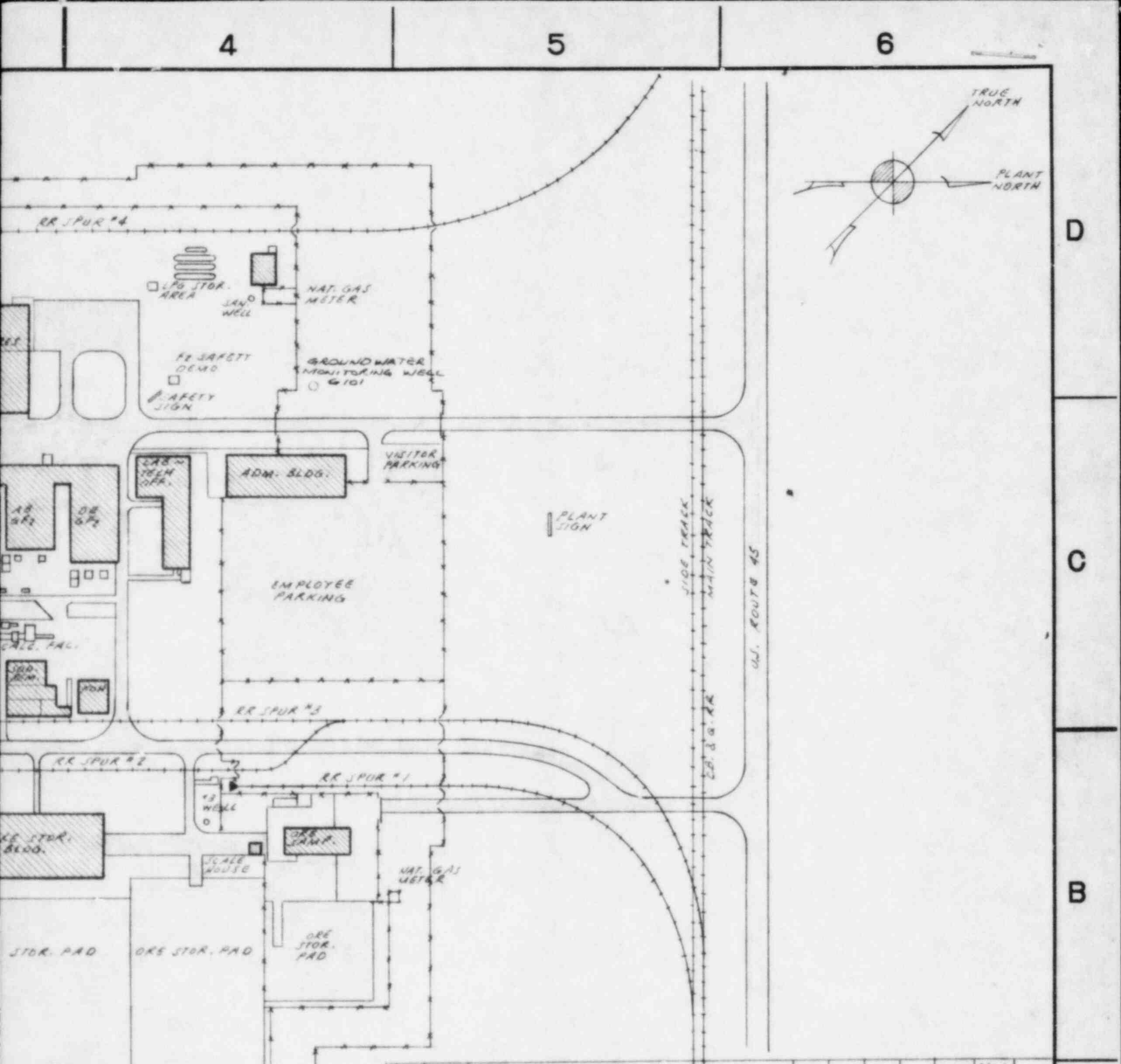


Figure 2.1.1(B)

Allied Chemical Site Boundary



K&E 19 1263
12-78 W 3687



REV	DESCRIPTION	BY	CHK	CH. DRAFT	PROJ. ENG.	PROJ. MGR.	DATE	MICRO FILM
B	ADD MONITORING WELLS	BR					3/10/82	
A	UPDATED	JH					9/28/81	

REFERENCE	DRAWING NO.

Allied Chemical

SPECIALTY CHEMICALS
DIVISION ENGINEERING

PLANT
PROJ. NO.
GO NO.
PROJECT TITLE
DRAWN J. HUNT
DATE 6-26-80
APPD. ENGINEER
DATE
CHECKED
APPD. PROJ. ENGR.
APPD. CHIEF DRAFT.
APPD. PROJ. MGR.
DRAWING TITLE PLOT PLAN ~ METROPOLIS WORKS
SCALE NONE
DWG NO. MTW-2800
REV. B
MICRO FILM

4

5

6

MTW-2800-B

2.1.2 Demography

The plant site is located in a predominately agricultural area. In Massac County about 70 percent of the land area is used for farming and 30 percent is woodlands, idle farms, or urban areas. Approximately 70 percent of farm income is derived from sale of livestock and livestock products while slightly over 30 percent is received from the sale of crops; principally corn, soybeans and wheat.

The population of the area has remained fairly stable since 1900 but in recent years has followed the national trend in farming areas of increasing urban concentration and declining farm population. Cities and towns within a twenty-five mile radius of the site and having a population of more than one thousand are shown in Table 2.1.2(A), Page 2-6.

The population distribution within a 50-mile radius of the Metropolis Plant is presented in Table 2.1.2(B), Page 2-7. Within a one-mile radius of the facility, the population is concentrated in the east sector. The 212 persons in the sector are the only residents within a mile of the plant. The nearest residence is located on the east side of U.S. Highway 45, approximately 1380 feet from the Feed Materials Building. There are 13 other permanent residences in this near-site area ranging out to a distance of approximately 2500 feet from the Feed Materials Building. There are no facilities which would present significant evacuation problems within the immediate vicinity.

Table 2.1.2(A)

Population and distance to towns with population over one thousand within twenty-five miles of plant site (1980 Census)

Illinois

Town	Distance (Miles)	Population
Brookport	7.5	1064
Metropolis	2.5	7124
Mound City	23	1224
Vienna	19	1420

Kentucky

Town	Distance (Miles)	Population
Calvert City	24.5	2388
LaCenter	13	1044
Paducah	8.5	29315
Wickliffe	23	1034

Table 2.1.2(B) Population distribution surrounding Allied Chemical Corporation Metropolis Works, Metropolis, Illinois (1970 census)*

Sector	Distance (miles)									
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	0	6	0	0	0	317	1,033	908	5,875	6,009
NNE	0	0	0	429	0	0	578	861	5,983	16,430
NE	0	0	0	0	124	173	131	4,133	1,794	3,763
ENE	0	0	158	113	0	427	656	1,801	5,898	5,051
E	212	120	0	0	0	577	924	1,626	4,741	10,129
ESE	0	1784	397	452	0	1,168	1,675	5,015	2,643	1,603
SE	0	848	2605	974	0	12,970	28,949	6,833	10,795	5,782
SSE	0	0	0	0	0	2,982	7,868	4,936	11,973	20,031
S	0	0	0	0	1293	1,267	1,533	4,724	5,560	9,860
SSW	0	0	0	0	0	1,049	1,684	2,288	4,989	5,139
SW	0	0	0	0	0	274	1,135	4,800	2,148	6,565
WSW	0	0	0	0	0	709	3,302	8,271	7,230	12,609
W	0	0	0	0	0	279	1,630	5,236	2,946	17,632
WNW	0	0	0	0	0	657	600	3,191	2,726	30,452
NW	0	0	0	320	0	450	1,667	942	10,920	25,750
NNW	0	0	397	0	46	0	1,829	3,045	10,226	39,818
Total	212	2752	3557	2288	1463	23,299	55,194	58,610	96,447	216,629

* Detailed population distribution not available for 1980 census.

2.2 Meteorology

The Metropolis site is located at the Southern end of Illinois and on the North bank of the Ohio River. Due to the location of the site, the climate is more characteristic of Kentucky than of Illinois. Because of a slight modifying influence of the river, the absolute temperature range is smaller than in nearby areas of Illinois. Temperatures of 100°F or higher and zero or lower each occur with a frequency of about once in five years.

The normal precipitation for the site area is 45-46 inches per year and most of this falls during the winter and spring months. July through October is the driest period. The wettest single month is March, while the driest is October.

The average winter has only occasional light snows. The ground remains bare most of the time, and only about fifteen days per season have a snow cover of one inch or more. The seasonal average snowfall is ten inches, but half of the winters have less than 7.3 inches and one-third of the winters have less than five inches of snow. The average annual depth of freeze penetration in the soil is about five inches. During much of the average winter the ground remains unfrozen.

The area has a long period average of fifty-three thunderstorm days per year, but the number of damaging winds and hail storms is not large. The entire Southern Illinois, Western Kentucky area has a forty-five year tornado frequency rate of 2.5 tornadoes per year. The maximum five-minute wind velocity recorded for the site area is sixty-three miles per hour.

A five-year annual summary of wind speed, direction, and stability categories for the years 1976 through 1980 is shown in Table 2.2(A) on Pages 2-9 through 2-14. These data, from the Evansville, Indiana station, 70 miles northeast of the site have been used to prepare a wind rose. Refer to Figure 2.2(A), Page 2-15. The typical average wind in the site area is from the S-SW or N-NW about 22% of the time from each sector. The average speed from these directions is about 7 miles per hour. Wind speed and direction from the other sectors are reasonably uniformly distributed. A weather station at Paducah, Kentucky discontinued providing meteorological information in 1964. Evansville and Metropolis are in reasonable proximity to each other and the geography of the two sites is similar. It is therefore concluded to be appropriate to use Evansville data for the Metropolis Site.

JOB NO.: 51427

Page 1 of 3

ANNUAL (DAY/NIGHT)
WIND DIRECTION BY PASQUILL STABILITY CLASSES (STAR PROGRAM)
7 CLASSES

Station: **#93817 EVANSVILLE, IN**

Period of Record: **1/76 - 12/80 (8 OBS/DAY)**

Data are presented by stability classes and also combined for the period indicated; first, as a bivariate frequency distribution of wind direction vs. wind speed, and second, as normalized values (i.e., relative frequency). Stability classes are based on Pasquill's class structure (see Journal of Applied Meteorology, February 1964), as follows:

Stability Class (Regular STAR)	Identified in lower left corner in this tabulation as:	Definition
1	A	Extremely Unstable
2	B	Unstable
3	C	Slightly Unstable
4	D	Neutral
5	E	Slightly Stable
6	F	Stable
7	G	Extremely Stable

Tabulations can also be prepared for the Regular STAR in 5 classes (E, F, G combined), 6 classes (F, G combined), or 7 classes

Stability Class (Day/Night STAR	Identified in lower left corner in this tabulation as:	Definition
1	A	Extremely Unstable
2	B	Unstable
3	C	Slightly Unstable
4	D	Neutral/Day
5	E	Neutral/Night
6	F	Slightly Stable
7	G	Stable
8	H	Extremely Stable

The Day/Night STAR can be prepared for 6 classes (F, G, H combined), 7 classes (G, H combined), or 8 classes. The Day/Night STAR is normally used in the climatological display model (CDM)

Average wind speed in knots, to tenths, for each direction and each speed class. Overall average wind speed is computed by: $\frac{\text{Sum of Wind Speed}}{\text{Number of Occurrences}}$

NUMBER OF OCCURRENCES: Number of DIR/SPD observations, plus number of calms (winds are tabulated to 16 points; speeds are in knots.)

RELATIVE FREQUENCY OF OCCURRENCES: $\frac{\text{Number of occurrences/stability class}}{\text{Total number of observations}}$

TOTAL NUMBER OF OBSERVATIONS: Number of observations in each month, season, annual or period.

TOTAL RELATIVE FREQUENCY OF OBSERVATIONS: $\frac{\text{Total number of observations}}{\text{Total number of observations}} = 1.00000$

This normalized (relative frequency) table is self explanatory, except that calm values have been distributed in the 0-3 speed category based on the number of observations in speed categories 1-3 and 4-6 as shown below.

Because of the importance of calm winds in air pollution studies, their occurrences are distributed into 0-3 speed category of the percentage frequency (normalized) tables using a ratio based on the number of observations of speeds of 1-6 knots in each direction category.

Example:

	Season:	MAM
R	Total Obs for Season (all Stabilities):	3680
S	Stability Class:	"C"
T	Total Obs. Class "C" - Speeds 1-3	21
U	Total Obs. Class "C" - Speeds 4-6	142
V	Total Calms - Class "C" (Season: MAM)	8

Table 2.2.(A)
Annual Wind Frequency Distribution

To find the distribution of calms into a direction category we must also know the number of observations in that direction that had speeds of 1-3 and 4-6 knots. In our example let us assume we want to find how the calms were distributed into the south direction.

W	Total Obs. S Direction (Season: MAM) "C" Stability Speeds 1-3	3
X	Total Obs. S Direction (Season: MAM) "C" Stability Speeds 4-6	6

Symbolically the Distribution Factor =

$$\left(\frac{V}{R}\right) \quad \left(\frac{W + X}{T + U}\right) + \left(\frac{W}{R}\right)$$

In our example then: % Frequency South Spd 0-3 "C" $= \left(\frac{8}{3680}\right) \quad \left(\frac{3 + 6}{21 + 142}\right) + \left(\frac{3}{3680}\right) = (.002174)\ (.55215) + (.000815) = .000935$

Percentages for Monthly or Annual tables may be determined in a like manner by substituting the proper values.

TABLE A-1. STABILITY CLASS AS A FUNCTION OF NET RADIATION AND WIND SPEED

WIND SPEED (KNOTS)	NET RADIATION INDEX 4	3	2	1	0	-1	-2
0, 1	1	1	2	3	4	6	7
2, 3	1	2	2	3	4	6	7
4, 5	1	2	3	4	4	5	6
6	2	2	3	4	4	5	6
7	2	2	3	4	4	4	5
8, 9	2	3	3	4	4	4	5
10	3	3	4	4	4	4	5
11	3	3	4	4	4	4	4
≥ 12	3	4	4	4	4	4	4

TABLE A-2. INSOLATION AS A FUNCTION OF SOLAR ALTITUDE

SOLAR ALTITUDE (a)	INSOLATION	INSOLATION CLASS NUMBER
$60° < a$	Strong	4
$35° < a \leq 60°$	Moderate	3
$15° < a \leq 35°$	Slight	2
$a \leq 15°$	Weak	1

JOB NO.

A STABILITY CLASSIFICATION BASED ON HOURLY AIRPORT OBSERVATIONS

The following explanation of the Pasquill Stability classification has been extracted from an article by D. Bruce Turner in the February 1964 Journal of Applied Meteorology.

This system of classifying stability on an hourly basis for research in air pollution is based upon work accomplished by Dr. F. Pasquill of the British Meteorological Office (1961). Stability near the ground is dependent primarily upon net radiation and wind speed. Without the influence of clouds, insolation (incoming radiation) during the day is dependent upon solar altitude, which is a function of time of day and time of year. When clouds exist their cover and thickness decrease incoming and outgoing radiation. In this system insolation is estimated by solar altitude and modified for existing conditions of total cloud cover and cloud ceiling height. At night estimates of outgoing radiation are made by considering cloud cover. This stability classification system has been made completely objective so that an electronic computer can be used to compute stability classes. The stability classes are as follows: 1) Extremely unstable, 2) Unstable, 3) Slightly unstable, 4) Neutral, 5) Slightly stable, 6) Stable, 7) Extremely stable. Table A-1 gives the stability class as a function of wind speed and net radiation. The net radiation index ranges from 4, highest positive net radiation (directed toward the ground), to -2, highest negative net radiation (directed away from the earth). Instability occurs with high positive net radiation and low wind speed, stability with high negative net radiation and light winds, and neutral conditions with cloudy skies or high wind speeds.

The net radiation index used with wind speed to obtain stability class is determined by the following procedure:

1) If the total cloud cover is 10/10 and the ceiling is less than 7000 feet, use net radiation index equal to 0 (whether day or night).

2) For night-time (night is defined as the period from one hour before sunset to one hour after sunrise):
   a) If total cloud cover ≤ 4/10, use net radiation index equal to -2.
   b) If total cloud cover > 4/10, use net radiation index equal to -1.

3) For daytime:
   a) Determine the insolation class number as a function of solar altitude from Table A-2.
   b) If total cloud cover ≤ 5/10, use the net radiation index in Table A-1 corresponding to the insolation class number.
   c) If cloud cover > 5/10, modify the insolation class number by following these six steps:
      1) Ceiling < 7000 ft, subtract 2.
      2) Ceiling ≥ 7000 ft but < 16,000 ft, subtract 1.
      3) Total cloud cover equal 10/10, subtract 1. (This will only apply to ceilings ≥ 7000 ft since cases with 10/10 coverage below 7000 ft are considered in item 1 above.)
      4) If insolation class number has not been modified by steps (1), (2), or (3) above, assume modified class number equal to insolation class number.
      5) If modified insolation class number is less than 1, let it equal 1.
      6) Use the net radiation index in Table A-1 corresponding to the modified insolation class number.

Since urban areas do not become as stable in the lower layers as non-urban areas, stability classes 5, 6 and 7 computed using the STAR program may be combined into a single class (5), or classes 6 and 7 may be combined and identified as class 6.

```
THIS TABULATION WAS PREPARED USING THE FOLLOWING HEADER CARD INFORMATION

STATION NUMBER = 9  3817

STATION NAME =  EVANSVILLE,IN 80ES 76-80

LATITUDE =   38.050

LONGITUDE =   87.531

TIME ZONE =      90.0

THIS RUN HAS STAB D BROKEN INTO DAY/NIGHT

HEMISPHERE = WESTERN

NUMBER OF STABILITY CLASSES = 6

INPUT = MAGNETIC TAPE DECK FAMILY 14 TAPE =4

OUTPUT = ANNUAL

PERIOD OF RECORD = 7601  8012

NUMBER OF OBSERVATIONS USED = 8 OBSERVATIONS PER DAY BEGINNING WITH HOUR 00

A TAPE CONTAINING INDIVIDUAL STABILITY OBSERVATIONS  WAS NOT REQUESTED
```

ANNUAL FREQUENCY DISTRIBUTION STATION =93817 EVANSVILLE,IN 8OBS 76-80

	SPEED(KTS)							
DIRECTION	1 - 3	4 - 6	7 - 10	11-16	17-21	GREATER THAN 21	AVG SP	TOTAL
N	60	359	419	181	9	1	7.8	1029
NNE	25	138	179	53	3	0	7.5	398
NE	49	223	208	46	3	0	6.8	529
ENE	95	401	176	47	6	0	6.0	725
E	122	351	202	56	7	0	6.2	738
ESE	50	200	156	32	0	0	6.4	438
SE	45	252	202	44	3	1	6.8	547
SSE	52	244	192	78	4	1	7.2	571
S	61	432	506	324	46	7	8.6	1376
SSW	28	194	368	303	37	5	9.6	935
SW	41	209	365	213	20	1	8.8	849
WSW	32	228	294	170	23	9	8.7	756
W	61	248	294	180	30	4	9.4	817
WNW	79	185	245	190	22	6	8.6	727
NW	219	350	308	248	36	4	7.6	1165
NNW	145	341	304	176	15	1	7.4	982
AVE	3.0	5.0	8.4	12.8	18.2	24.1	6.7	
TOTAL	1164	4355	4418	2341	264	40		

TOTAL NUMBER OF OBSERVATIONS 14600

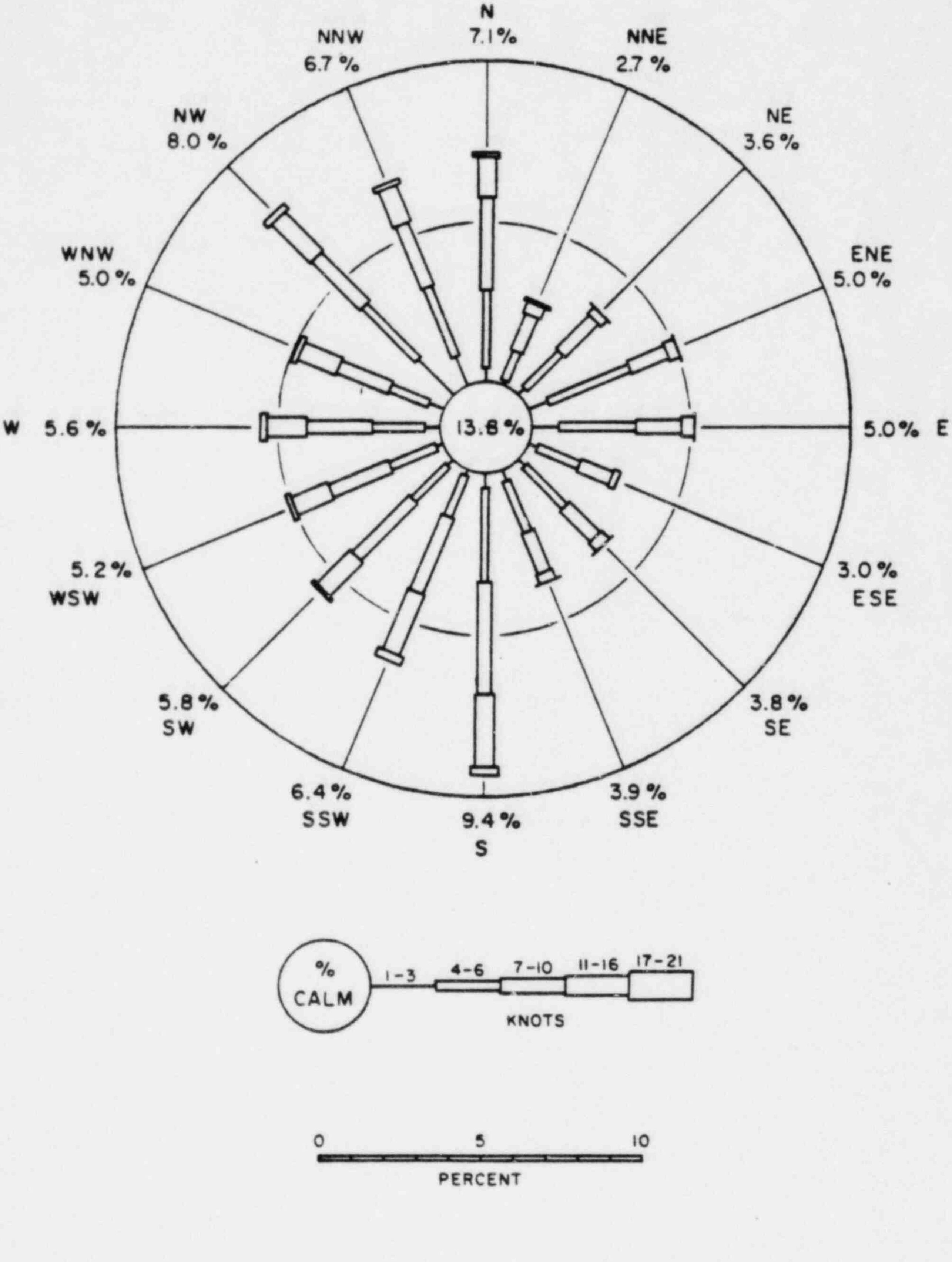
TOTAL NUMBER OF CALMS 2018

ANNUAL RELATIVE FREQUENCY DISTRIBUTION STATION = 93817 EVANSVILLE,IN 80BS 76-80

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	.014603	.024589	.028699	.012397	.000616	.000068	.080973
NNE	.005795	.009452	.012260	.003630	.000205	.000000	.031342
NE	.010168	.015274	.014247	.003151	.000205	.000000	.043045
ENE	.018929	.027466	.012055	.003219	.000411	.000000	.062079
E	.020202	.024041	.013836	.003836	.000479	.000000	.062394
ESE	.009686	.013699	.010685	.002192	.000000	.000000	.036261
SE	.010520	.017260	.013836	.003014	.000205	.000068	.044904
SSE	.010975	.016712	.013151	.005342	.000274	.000068	.046523
S	.016525	.029589	.034658	.022192	.003151	.000479	.106593
SSW	.007478	.013288	.025205	.020753	.002534	.000342	.069601
SW	.009069	.014315	.025000	.014589	.001370	.000068	.064412
WSW	.006703	.015616	.020137	.011644	.001575	.000616	.058292
W	.011917	.016986	.020137	.012329	.002055	.000274	.063698
WNW	.012023	.012671	.016781	.013014	.001507	.000411	.056406
NW	.029250	.023973	.021096	.016986	.002466	.000274	.094045
NNW	.022103	.023356	.020822	.012055	.001027	.000068	.079432
TOTAL	.217945	.298288	.302603	.160342	.018082	.002740	

TOTAL RELATIVE FREQUENCY OF OBSERVATIONS = 1.000000

TOTAL RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE = .138219



Annual wind rose from Evansville, Indiana, site for January 1976 through December 1980.

Figure 2.2(A)

2.3 Hydrology

2.3.1 Groundwater

Within the site area, deposits of Alluvium and Loess do not yield enough water for domestic use. When saturated by precipitation, these formations transmit water to the underlying aquifers of the Pleistocene and Pliocene series. The mixed gravel, sand and clay of the Pleistocene and Pliocene series is the principal aquifer for domestic use. Domestic wells may be bored to a depth of 120 feet before encountering the Porter's Creek Clay formation. The Porter's Creek Clay is not an aquifer but does retard groundwater movement between the Pliocene gravel and the sand in the McNairy formation. The McNairy and Tuscaloosa formations may yield enough water for domestic use but the high iron content and fine grained matrix make these formations generally unattractive. The shallowest aquifer adequate for most industrial needs is the Mississippian limestone which occurs at a depth of 300 to 500 feet. The yield of an industrial well penetrating the Mississippian limestone exceeds one thousand gallons per minute, but usually the water is hard.

The Metropolis Plant water supply is pumped from wells bored into the Mississippian limestone. Process wells No's. 1, 2, and 3 are drilled to depths of 455 feet, 520 feet and 500 feet respectively. The plant sanitary well is 412 feet deep. Refer to Figure 2.3.1(A), Page 2-17 for location of wells on plant site. The total capacity of these four wells is in excess of 4500 gpm and significantly greater than normal operating requirements. Wells 1, 3 and the sanitary well have been in use since 1958. The No. 2 well was drilled in 1971. After placing automatic recorders on the other three wells, a seventy-two hour pumping test was performed on the No. 2 well in October 1971. The drawdown was measured in all four wells during the test. During he pumping test of Well 2, a drawdown of 1.5 feet was observed in the sanitary well and two feet in Well 1 with no apparent drawdown experienced in Well 3. It was concluded that significant hydrologic connection exists between the sanitary well and Wells 1 and 2, but this system has no apparent interconnection with Well 3.

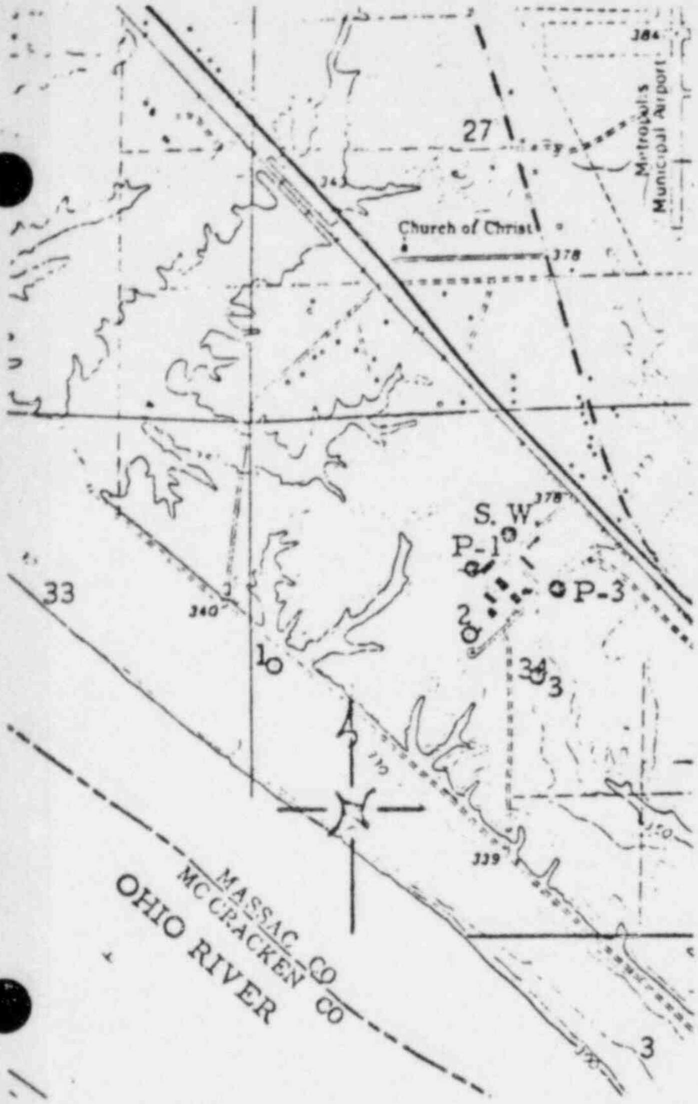


Figure 2.3.1(A)

LOCATION MAP OF
ALLIED CHEMICAL CORPORATION WELLS
METROPOLIS WORKS

For:
ALLIED CHEMICAL CORPORATION
Metropolis, Illinois

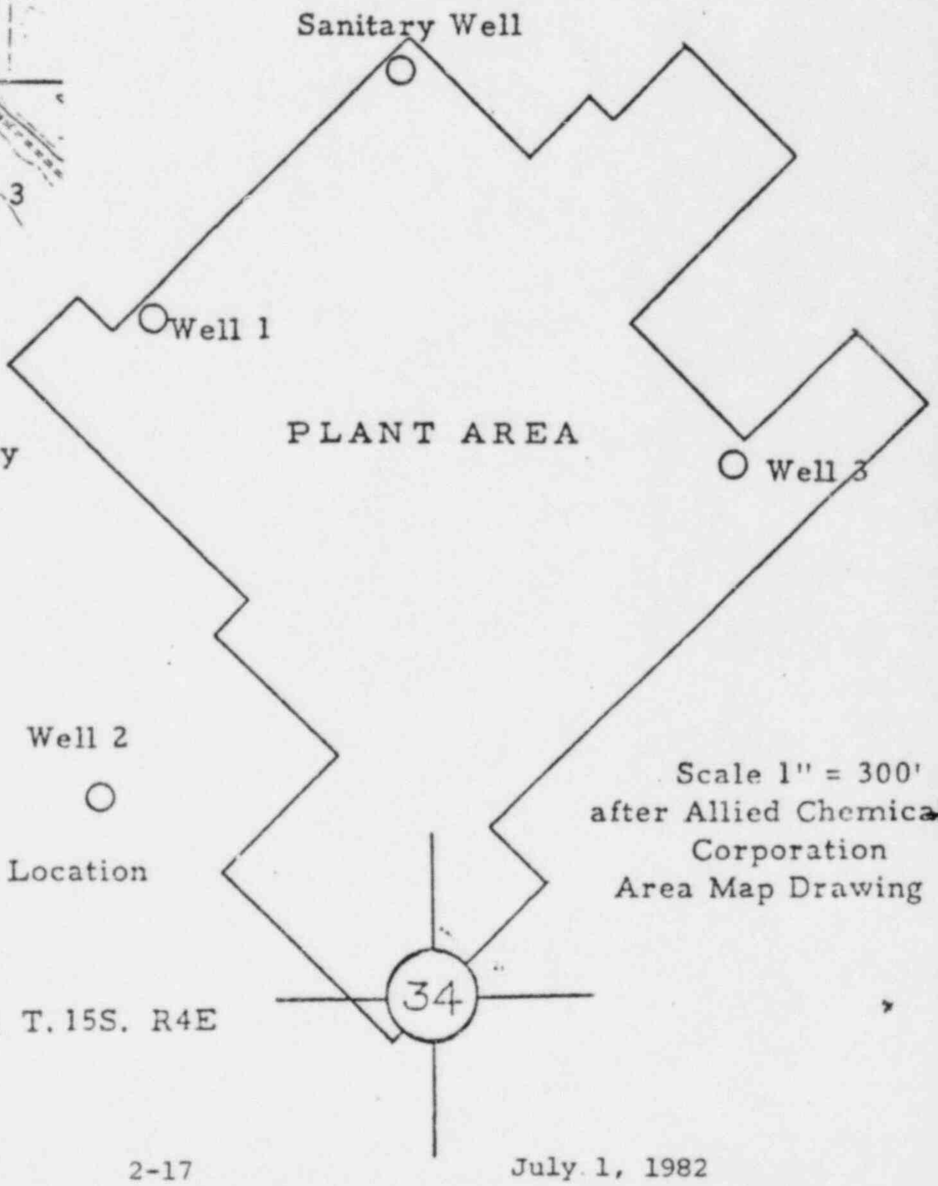
By:
MOODY AND ASSOCIATES, INC.
Meadville * Harrisburg, Pennsylvania
November 1971 REW

Scale
1" = 2000'

After U.S.G.S. 7½" Topographic Quadrangle, Joppa, Illinois-Kentucky

EXPLANATION

- ○ P-1 Process Well 1
- ○ P-3 Process Well 3
- ○ S. W. Sanitary Well
- ○² Proposed Test Well Location



Scale 1" = 300'
after Allied Chemical
Corporation
Area Map Drawing

Cen. Sec. 34, T.15S. R4E

2.3.1 Groundwater (continued)

A comprehensive set of chemical analyses was performed on the sanitary well water in March, 1979. The results from the analyses are shown in Table 2.3.1(A), Page 2-19. Additionally, the State of Illinois, Department of Public Health has established a quarterly sampling program of the plant potable water supply to assure continued compliance with State drinking water standards.

There are no other private water users within the boundaries of the site. Public water use is obtained from the Massac County Water District (county residents) and the City of Metropolis. Both of these sources withdraw their water from wells in the Mississippian limestone aquifer.

TABLE 2.3.1(A)

ANALYSIS OF SANITARY WELL WATER

ANALYSIS		RESULT
pH		7.8
Temperature		64 F°
BOD	Mg/L	14.9
COD	Mg/L	0.054
Suspended Solids	Mg/L	0.4
Specific Conductance	Micrombs/cm	285
Settable Matter	Ml/L/hr.	< 0.1
Color		< 5
Ammonia	Mg/L	< 1.0
Organic Nitrogen	Mg/L	0.11
Nitrate	Mg/L	0.055
Nitrite	Mg/L	< .01
Phosphorus	Mg/L	< .01
Sulfate	Mg/L	15.7
Sulfide	Mg/L	< 0.15
Sulfite	Mg/L	< 2.0
Bromide	Mg/L	< 0.1
Chloride	Mg/L	7.2
Cyanide	Mg/L	< .02
Fluoride	Mg/L	0.5
Aluminum	Mg/L	0.016
Antimony	Mg/L	0.04
Arsenic	Mg/L	< 0.03
Beryllium	Mg/L	< 0.002
Borium	Mg/L	0.02
Boron	Mg/L	< 0.8
Cadmium	Mg/L	< 0.006
Calcium	Mg/L	56
Cobalt	Mg/L	< 0.003
Chromium	Mg/L	< 0.002
Fecal Coliform/	100 Ml.	0
Copper	Mg/L	0.01

ANALYSIS		RESULT
Iron	(Mg/L)	0.29
Lead	(Mg/L)	< 0.01
Magnesium	(Mg/L)	12
Manganese	(Mg/L)	0.002
Mercury	(ug/L)	< 0.2
Molybdenum	(Mg/L)	< .012
Nickel	(Mg/L)	0.004
Selenium	(Mg/L)	< 0.04
Silver	(Mg/L)	0.002
Potassium	(Mg/L)	3.0
Sodium	(Mg/L)	8.0
Thallium	(Mg/L)	< 0.01
Titanium	(Mg/L)	< 0.04
Tin	(Mg/L)	0.10
Zinc	(Mg/L)	0.018
Oil & grease	(Mg/L)	0.3
Phenols	(Mg/L)	< 0.005
Surfactants	(Mg/L)	< 0.025
Chlorine	(Mg/L)	< 0.1
Uranium		0.01
* Alpha Radioactivity	(Pci/L)	0.56 ± 0.15
* Beta Radioactivity	(Pci/L)	2.25 ± 0.37
* Radium - 226	(pCi/L	0.30 ± 0.18

* Ground water monitoring well sample of March 10, 1982.

2.3.2 Surface Water

There are no surface streams within the boundaries of the site; however, there are several natural water drainage concourses which carry rainwater run-off toward the Ohio River.

Most surface streams in the vicinity of the site are used for recreation and for watering livestock. Numerous farm ponds and lakes are found throughout the area. The Ohio River which bounds the site on the south is used for barge transportation, commercial and sport fishing and as a source of water supply for Paducah, Kentucky, eleven miles upstream of the site. The river is approximately 3000 feet wide with a normal pool elevation of 290 feet above mean sea level. River flow is regulated by flood control structures, the nearest being lock and dam No. 52 at Brookport, Illinois, about seven miles upstream from the site.

Stage-discharge records have been maintained at Metropolis, Illinois (Illinois Central Railroad Bridge), since 1928. The maximum discharge was 1,780,000 cfs on February 1, 1937, and the minimum discharge of 15,000 cfs occurred on July 30, 1930. Average discharge is 265,000 cfs. The 7 day, 10 year low flow recorded is 43,600 cfs.

Although flooding is an annual event, the plant site has never been reached by flood waters. While the 1937 flood reached an elevation of 342 feet, the probable elevation of a 100-year flood (1 in 100 chance of occurring in a given year) in the area is 340 feet. The plant site elevation is 375 feet and should be considerably above the most extreme flood.

2.4 Geology and Seismology

2.4.1 Geology

The Metropolis Plant site is located in the northern part of the Mississippian Embayment. This geologic area of Southern Illinois and Western Kentucky is characterized by Quaternary surface materials and subsurface layers of Tertiary and Cretaceous which lie on Mississippian undifferentiated carbonate rocks. The chief geologic resources within the area are sand, gravel, and groundwater.

2.4.1 Geology (continued)

Gently rolling hills are the predominant surface feature of the site area. Drainage is directly; or indirectly through secondary watersheds, into the Ohio River. Bottom land and light colored terrace soils are found along the Ohio River which forms the south boundary of the site. These soils were developed primarily from outwash or alluvium under forest vegetation. Soils in the remainder of the area are light colored silt loams, with moderately slow to slowly permeable subsoils developed primarily under forest vegetation from loess.

The Quaternary surficial materials consisting of clayey silt, silty clay, and sand silt and loess are found throughout the area at depths of from 0-60 feet. The Continental and Porter's Creek clay deposits are principally brown sand, gravel, and clay. The McNairy and Clayton formations consist primarily of sand, clay and silt and extend from approximately 135 feet to greater than 225 feet beneath the surface. The McNairy and Clayton formations rest upon Palezoic rock.

2.4.2 Seismology

The site area is in the northern part of the Mississippi Embayment which has had a long history of seismic activity. The only major earthquakes in historic times were the New Madrid earthquakes of 1811-1812, centered about 60 miles southwest of the site. This earthquake was one of the strongest on record in this country. Major faults, trending toward New Madrid, are found approximately twenty-five to thirty miles east and west of the site. These faults, which occurred millions of years ago have not been active in geologically recent time.

Seismologists are currently unable to predict the recurrence rates for destructive earthquakes such as those of 1811-1812 because of their infrequent occurrences. Nevertheless, experience indicates that major earthquakes originating along the New Madrid fault zone are capable of causing extensive damage in the Metropolis area. One such estimate concluded that a recurrence of an earthquake of the New Madrid intensity had a maximum likelihood of occurring once in 100-300 years in the entire seismic region.

2.4.2 Seismology (continued)

The soil structure in the plant area may have a viscous or visco-elastic response to earthquake loading and may be susceptible to ground wave motion from distant earthquakes; however, severe ground motion tends to be reduced.

3. UF_6 Conversion Process and Equipment

3.1 The UF_6 Conversion Process

Most of the uranium processing equipment is housed in a six story structure termed the Feed Materials Building where essentially all of the steps in the UF_6 conversion process are conducted. A flow chart of the process used for the sampling and conversion of uranium ore concentrates to uranium hexafluoride (UF_6) is depicted in Figure 3.1, Page 3-2 where the source of effluents and emissions from the various process steps are also shown. All major plant equipment is of standard chemical plant design and construction. Details of the effluent control and waste management program utilized in the conversion facility is discussed in Chapter 4. A description of each major processing area is as follows:

3.1.1 Sampling and Storage

The Works receives uranium ore concentrates (in 55-gallon drums) from the uranium mills via rail car or common carrier (truck). The contents of all drums in each lot are emptied and sampled by the falling stream method in the Sampling Plant to obtain representative analytical samples. Each lot of concentrates is then re-drummed, weighed, and stored on storage pads until accountability procedures and the uranium and impurity analyses are completed.

3.1.2 Pre-treatment Facility

Some ore concentrates and all uranium compounds from the uranium recovery facility contain undesirable amounts of contaminants, principally sodium, that must be removed. The pretreatment consists of a four-stage counter-current decantation treatment with ammonium sulfate solution. The uranium solids from this facility discharge into the ore calciner in the ore preparation section.

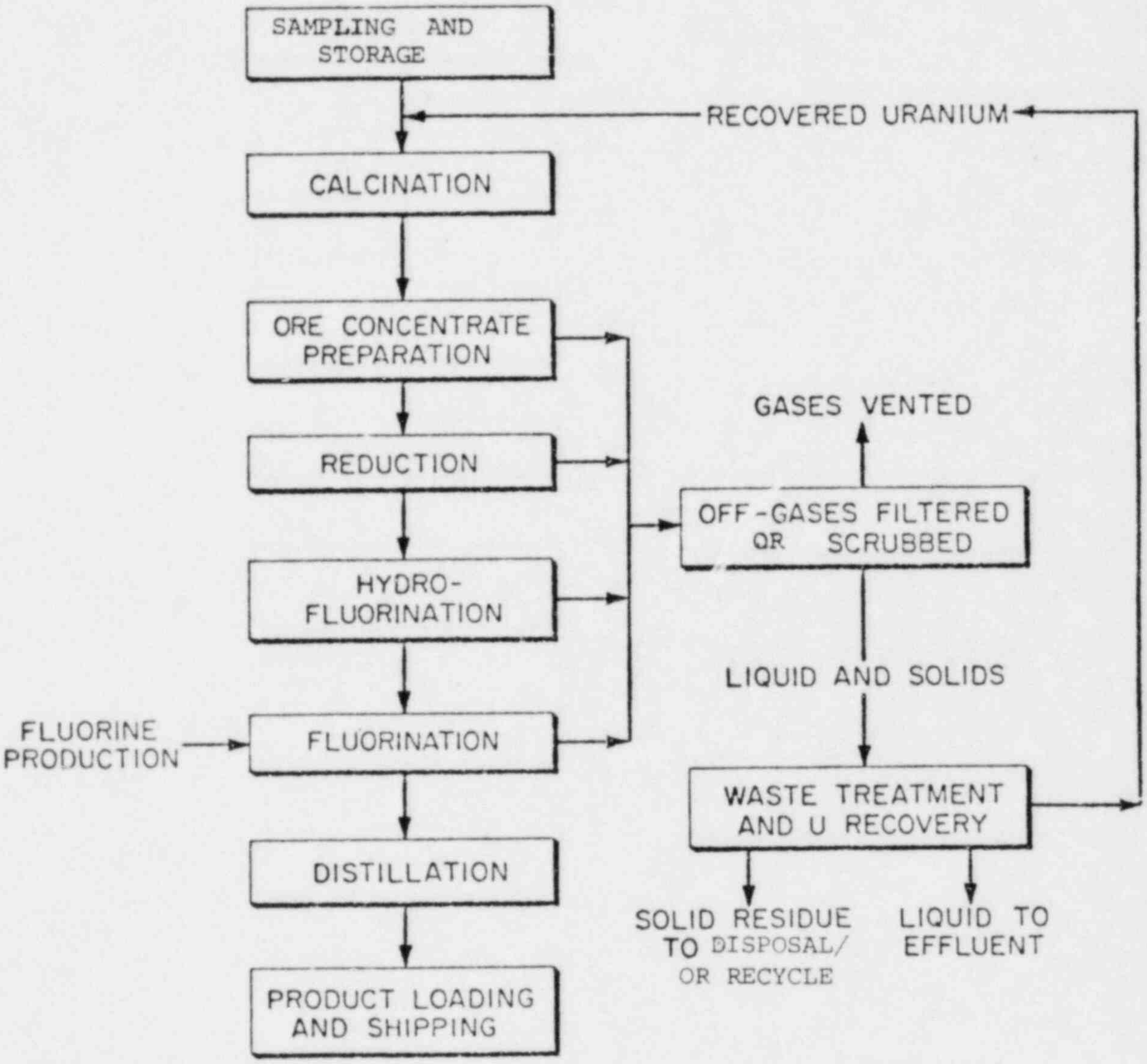


Figure 3.1 UF_6 Conversion Flow Chart

3.1.3 Ore Concentrate Preparation

Incoming ore concentrates are charged into the system through a drum dumping station. The concentrates either go directly to the ore preparation section via the calciner or through the pretreatment facility and then to the calciner. Following the calciner, the ore concentrates are blended, agglomerated, dried, crushed, and sized to a uniform particle. Dusts and fumes from this process are controlled by use of dust collectors as described in Chapter 4.

3.1.4 Reduction

The sized uranium concentrates enter one of two available fluid-bed reactors termed the reductor. In the reductor, the uranium is reduced to the dioxide form utilizing hydrogen from dissociated ammonia; the nitrogen serves as a fluidizing gas. The reductor off-gas (principally hydrogen, nitrogen, water vapor, and some hydrogen sulfide) is passed through filters to remove particulate uranium, and the residual gas is incinerated to convert the hydrogen sulfide into sulfur dioxide and water.

3.1.5 Hydrofluorination

The uranium dioxide from the reductor is fed into two fluid-bed hydrofluorinators operated in series, two reaction trains are available for operation. A counter-current flow of anhydrous HF fluidizing gas converts the uranium dioxide into uranium tetrafluoride (UF_4). The off-gas is filtered to remove particulate uranium and scrubbed with water and potassium hydroxide solution to remove HF before being vented to the atmosphere. The HF scrubber liquors are neutralized, and treated to remove fluoride in the Environmental Protection Facility before being discharged with the main plant effluent.

3.1.6 Fluorination

The UF_4 is fed into one of three available fluid-bed fluorinators that also contain inert bed material. Elemental fluorine is used as the fluidizing gas to convert solid UF_4 to gaseous UF_6 which is volatilized from the fluorinator. Some residual uranium, and non-volatile uranium daughter products remain in the bed material, which is recycled and reused until the buildup of contaminants prohibit further use. The bed material is then retired for radioactive decay and recovery of the uranium content. The volatilized gas containing UF_6, excess fluorine, and HF is passed through a series of filters for particulate removal and through a series of cold traps for UF_6 collection.

3.1.7 Cold Traps and Off-gas Cleanup

The bulk of the UF_6 is condensed in a series of primary cold traps which are operated at approximately -20°F. The secondary and tertiary traps operate at lower temperatures and remove the residual UF_6. Crude UF_6 is removed from the cold traps intermittently following liquifaciton by heating, and then transferred to still feed tanks to await purification by fractional distillation.

Uncondensed gas from the cold traps consisting of F_2, HF, air and traces of UF_6 is routed into scrubbers where contact with aqueous potassium hydroxide solution removes fluorides and traces of uranium prior to release to the atmosphere. The scrubbing solutions are routed to the Environmental Protection Facility for regeneration of KOH which is subsequently reused in the process scrubbers.

The potassium diuranate precipitated in the off-gas scrubbers is settled from the KOH solution, washed to remove soluble fluorides, and recycled to the pre-treatment facility for potassium removal prior to re-entry into the main uranium process flow.

3.1.8 Distillation and Product Packaging

Crude UF_6 from the still feed tanks is fed into a low boiler distillation column. The UF_6 that has been stripped of low-boiling impurities is then fed into a high boiler distillation column where high boiling impurities are eliminated. The product, which exceeds DOE purity requirements, is condensed and packaged into U.S. NRC approved cylinders. There are no gaseous effluents from this process.

3.1.9 Uranium Recovery

Fluorinator filter fines, contaminated fluorinator bed material, miscellaneous recovered dust, and scrap materials are finely ground and leached with a sodium carbonate solution to solubilize the uranium as the tricarbonate complex. The leached material is filtered to separate the uranium from the insoluble waste material (principally inorganic fluorides) which is dried and packaged for recycle or disposal at an NRC licensed radioactive waste disposal facility. The uranium in the filtrate is precipitated, and the recovered uranium is then charged to the head end of the process via the pretreatment facility.

The uranium recovery leach liquors which are withdrawn from the system are treated in the Environmental Protection Facility. The treated liquors are then discharged into the plant effluent.

3.1.10 Cylinder Wash Facility

Periodically, UF_6 product cylinders must be washed and pressure-tested to assure that there has been no significant degradation of design integrity. The cylinders are washed with sodium carbonate solution to recover uranium. The leach liquors are then filtered and the uranium bearing liquid transferred to the uranium recovery facility. The filter residue which contains daughter products of uranium, principally ^{234}Th and ^{234}Pa, is stored on site and eventually disposed of at a licensed waste disposal facility.

3.1.11 Other Operations

Other operations involving the handling of significant quantities of source material include: outdoor pads for storage of drums of ore concentrates and UF_6 product cylinders; the waste drier where residues from the uranium recovery step are de-watered prior to packaging for off-site recycle or disposal, and the Laboratory Building which houses facilities for conducting process control, product, and radiological control analyses.

Additional plant facilities which are involved directly in the UF_6 manufacturing process but do not involve the handling of any significant quantities of source material include a fluorine manufacturing building; a fluoride waste treatment facility with five large settling ponds and a calcium fluoride recovery plant to recycle synthetic CaF_2; a powerhouse; incinerator; two small fluoride spill control ponds, and two small settling ponds to collect any uranium spills.

3.2 Major Conversion Process Equipment

The major UF_6 conversion vessels are fabricated in accordance with A.S.M.E. Codes. The entire process is constructed using standard chemical plant design; however, special metals and alloys are used extensively in the UF_6 and fluorine systems. Process flow and instrumentation drawings are provided in Appendix "A", Page A-1 through A-10. These drawings also show the effluent control systems more fully discussed in Chapter 4, "Effluent Control and Waste Management Systems."

3.3 Instrumentation

The UF_6 conversion process is controlled primarily through use of process instrumentation located in the central control room. The instrumental control system utilizes alarm panels to indicate abnormal conditions in the process such as excessive pressure or vacuum, overloading of equipment, or equipment failure. In addition, the major process systems are electrically interlocked to assure the proper sequence of startup and shutdown of the process. Process equipment which fails to perform properly will trigger an alarm. The malfunctioning equipment is shut down and repaired or replaced. Process control instrumentation relevant to safety and radiation sampling points are shown in the process flow drawings contained in Appendix "A", Page A-1 through A-10.

4. Effluent Control and Waste Management Systems

4.1 Gaseous and Airborne Particulates

All areas in the UF_6 process that produce dusts, mists, or fumes containing uranium or other toxic materials are provided with dust collectors, scrubbers, or ventilation equipment to reduce employee or environmental exposure to as low as reasonably achievable levels. Refer to Table 4.1(A), Pages 4-3 and 4-4 for identification and rated efficiency of each gaseous cleanup system.

The ventilation system used in the UF_6 process area consists of a series of Dravo fresh-air intake units and a series of window and roof exhaust fans. The total air flow through the process building is sufficient to ensure a complete air changeout approximately once every five minutes.

Additionally, the main control room and a process laboratory have separate air conditioning systems. Each is maintained under a slight positive pressure, and each shares a common fresh air intake located outside the UF_6 process building. Figure 4.1, Pages 4-5, shows the location of general ventilation equipment used in the UF_6 conversion facility.

Hoods which are routinely used to handle unencapsulated uranium are periodically checked and adjusted to assure adequate face velocity. Workroom air concentrations of uranium are continuously monitored in process areas to assure the ventilation systems are adequately controlling employee exposures.

There currently are fifty-one (51) individual stacks and exhaust fans associated with the operation of the UF_6 facility which could contain significant concentrations of uranium. These exits are sampled continuously at isokinetic flow conditions using 0.6 to 0.8 micron membrane filters for particulate uranium. If moisture or chemical attack precludes the use of membrane filters, a combination water scrubber-mist impinger is normally used. Stack samples which could have a high loss potential are collected twice per twenty-four hours and counted for alpha radioactivity. If the loss potential is small, the samples are collected once each twenty-four hours. Each twenty-four hours the individual membranes for each sample point are composited and analyzed for uranium content. Uranium emission data is computerized to give losses on a daily, monthly, quarterly, or yearly basis. Table 4.1(B), Pages 4-6 thru 4-8, indicates the quantities of uranium emitted from the process stacks during the most recent three years (1979, 1980, and 1981) of operation.

Essentially all of the stack emissions of uranium are of mixed solubility (Class D and W) due to the variety of milling processes used to produce ore concentrates. In the fluorination and distillation sections the emissions are primarily highly soluble UO_2F2 from UF_6 decomposition. The uranium released in the off-gas from the ash dust collector and vacuum cleaner (Stack No. 1-12) is due primarily to decomposition of residual UF_6 in the bed material and filter fines collected by this system.

In addition to collecting the stack samples taken, operating personnel observe and record pressure drop and temperatures of the dust collectors each two hours. Samples are also analyzed from the off-gas scrubbers as required to minimize emissions. Additional samples, visual observation, and precautions are taken as necessary to ensure optimum performance of the pollution abatement equipment.

Stack discharge alarms have not been found to be feasible for use in the large number of plant stacks continuously sampled for natural uranium. Operational and administrative controls are utilized to shut down equipment when the concentration of uranium in the exit stack exceeds the established administrative limit for the stack.

Stacks which contain non-radiological emissions are shown in Table 4.1(C), Page 4-9. These emission sources are operated in accordance with their individual air permits which are obtained from the Illinois Environmental Protection Agency.

TABLE 4.1(A) GASEOUS CLEANUP SYSTEMS

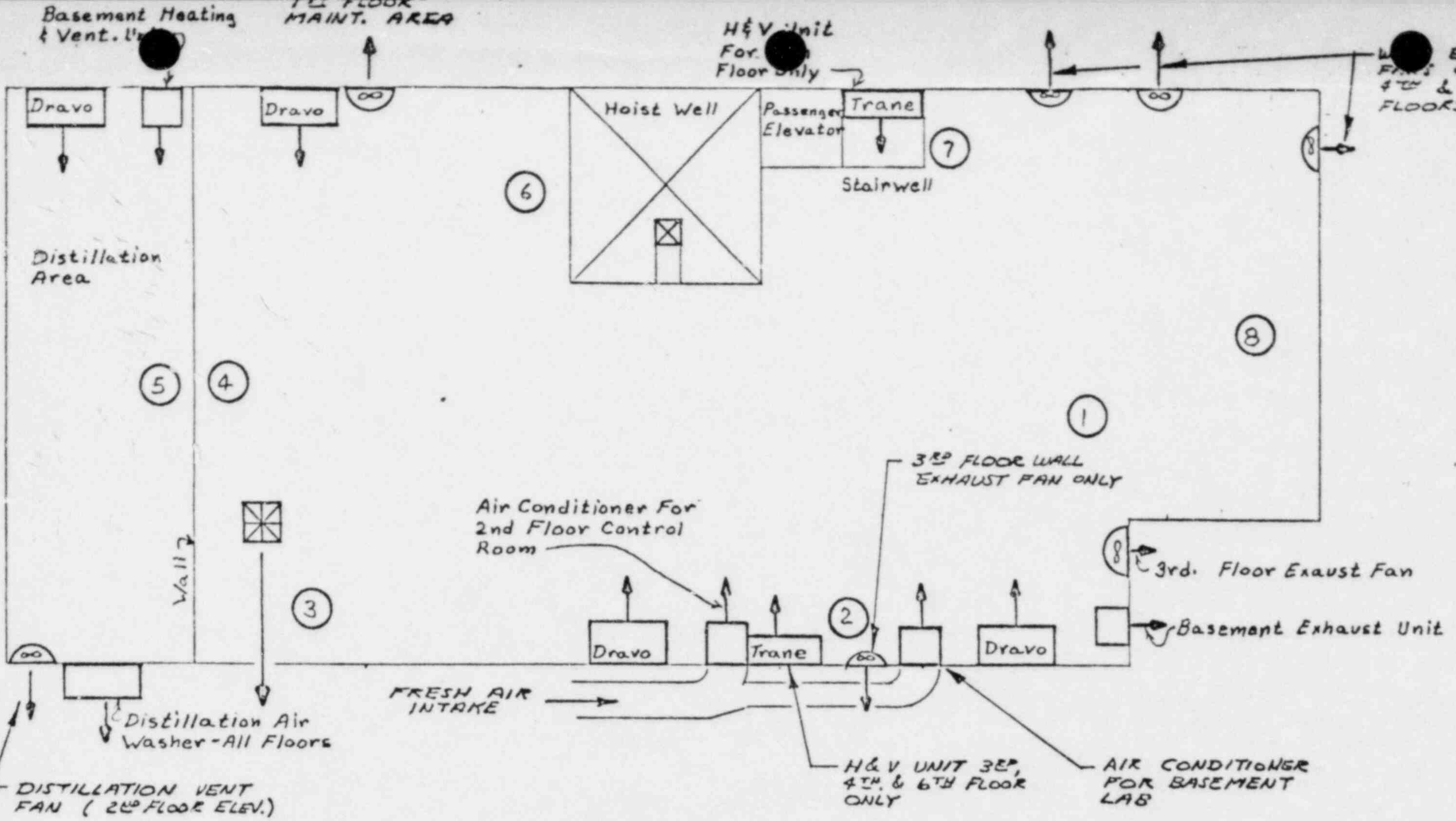
(Rated efficiency in parenthesis)

Description	Stack No.	Contaminate Removed	Primary Control	Secondary Control	Tertiary Control
Wet Oxide Dust Collector	1-1	Particulates	Baghouse (99.9)	Baghouse (99.9)	
Dry Oxide Dust Collector	1-2	Particulates	Baghouse (99.9)	Baghouse (99.9)	
Drum Cleaner Dust Collector	1-3	Particulates	Baghouse (99.9)	Baghouse (99.9)	
Oxide Vacuum Cleaner	1-4	Particulates	Cyclone (95.0)	Baghouse (95.0)	Baghouse (99.0)
UF$_4$ Vacuum Cleaner	1-7	Particulates	Cyclone (80.0)	Baghouse (99.9)	Baghouse (99.9)
"B" UF$_4$ Dust Collector	1-10	Particulates	Baghouse (99.9)	Baghouse (99.9)	
Dry Oxide Dust Collector	1-11	Particulates	Baghouse (99.9)	Baghouse (99.9)	
Ash Vacuum Cleaner	1-12	Particulates	Cyclone (80.0)	Baghouse (99.9)	
Ash Dust Collector	1-12	Particulates	Baghouse (99.9)	Baghouse (99.9)	
"A" Fluorinator Filters	1-13	Particulates	Metal Filters (>99.9)	Metal Filters (>99.9)	
"A" Fluorinator Scrubbers	1-13	F$_2$, HF, & UF$_6$	Spray Tower (80.0)	Packed Tower (99.0)	Coke Box (99.0)
"B" Fluorinator Filters	1-14	System Identical to 1-13			
"B" Fluorinator Scrubbers	1-14	System Identical to 1-13			
"C" Fluorinator Filters	System identical to 1-13 (May use either "A" or "B" fluorinator scrubber system)				
"A" Top Hydrofluorinator Filter	1-23	Particulates	Carbon Filters (>99.9)	Carbon Filters (> 99.9)	
"B" Top Hydrofluorinator Scrubber	1-23	HF	H$_2$O Venturi Jets (83.0)	KOH Venturi Jets (85.0	KOH Packed Tower (99.0)

TABLE 4.1(A) GASEOUS CLEANUP SYSTEMS (continued)

(Rated efficiency in parenthesis)

Description	Stack No.	Contaminate Removed	Primary Control	Secondary Control	Tertiary Control
"B" Top Hydrofluoriantor Filter	1-24	System Identical to 1-23			
"B" Top Hydrofluorinator Scrubber	1-24	System Identical to 1-23			
"A" UF_4 Dust Collector	1-46	Particulates	Baghouse (99.9)	Baghouse (99.9)	
H_2S Incinerator Stack	1-48	H_2S, and S	Sulfur Condenser	Incinerator (99.0)	
Drum Inverter Dust Collector	1-54	Particulates	Baghouse (99.9)	Baghouse (99.9)	
Uranium Recovery Dust Collector	3-2	Particulates	Baghouse (99.9)		
Pond Mud Calciner	4-2	Particulates, HF, SO_2	Baghouse (99.9)	Spray Tower (95.0)	
Sampling Plant Dust Collector	17-1	Particulates	Baghouse (99.9)	Baghouse (99.9)	
Sampling Plant Vacuum Cleaner	17-2	Particulates	Baghouse (99.9)	Baghouse (99.9)	



☒ Roof Vent For 6th Floor

▨ Roof Vent For 5th Floor

Dravo - Heating & Ventilation Unit
Supplies Air to 1st Thru
6th Floors

(1-8) Typical Air Sample Points
On All Floors

ATMOSPHERE AIR SAMPLE POINTS & VENTILATING SYSTEM IN FEED MATERIALS BUILDING

Figure 4.1

REV. A D.C. 2-2-82

MTW-A1150A

TABLE 4.1(B) URANIUM STACK EMISSIONS

Description	Stack No.	S.P. No.	(1)	Height Ft.	ACFM	Kg Uranium 1979	Kg Uranium 1980	Kg Uranium 1981
Wet Oxide Dust Collector	1-1	15	V	98	5,040	29.7	54.4	15.9
Dry Oxide Dust Collector	1-2	27	H	105	2,650	3.8	5.5	15.8
Drum Cleaner Dust Collector	1-3	32	V	40	4,320	2.3	2.1	3.3
Oxide Vacuum Cleaner	1-4	2	H	98	428	3.0	2.0	1.0
UF_4 Vacuum Cleaner	1-7	1	H	12	1,078	9.8	5.8	5.5
"B" UF_4 Dust Collector	1-10	19	V	98	2,889	54.7	50.0	14.8
Dry Oxide Dust Collector	1-11	50	V	40	5,880	4.9	2.6	2.9
Ash Vacuum Cleaner	1-12	26	H			9.5	13.5	2.8
	(one combined discharge)			86	2,561			
Ash Dust Collector	1-12	29	H			0.9	7.6	6.6
"A" Fluorination Coke Box	1-13	30	V	105	193	51.4	25.8	45.7
"B" Fluorination Coke Box	1-14	31	V	105	193	41.0	30.2	22.7
"A" Reductor Blower	1-15	12	H	75	987	1.1	0.6	0.8
"B" Reductor Blower	1-16	43	H	75	987	41.3	23.1	5.8
"A" Top Hydrofluorinator Blower	1-17	7	H	45	6,630	1.5	1.4	64.2
"A" Bottom Hydrofluorinator Blower	1-18	3	H	12	6,630	0.9	0.3	0.1
"B" Top Hydrofluorinator Blower	1-19	42	H	38	87	14.0	31.0	24.5
"B" Bottom Hydrofluorinator Blower	1-20	41	H	45	987	0.5	0.5	0.5
"A" Fluorinator Blower	1-21	6	H	30	4,239	0.9	0.6	2.9

TABLE 4.1(B) URANIUM STACK EMISSIONS

Description	Stack No.	S.P. No.	(1)	Height Ft.	ACFM	Kg Uranium		
						1979	1980	1981
"B" Fluorinator Blower	1-22	5	H	30	4,239	1.7	1.9	1.7
Ore Prep Multifloor Exhaust	1-26	16	V	60	14,145	2.8	1.8	-0-
Exhaust Fan 1st Floor South	1-27	8	H	15	23,000	5.9	5.3	9.6
Exhaust Fan 1st Floor West	1-28	9	H	15	23,000	5.1	5.7	7.7
Exhaust Fan 2nd Floor South	1-29	33	H	30	23,000	0.0	1.1	5.1
Exhaust Fan 3rd Floor South	1-30	10	H	45	23,000	10.4	9.8	4.9
Exhaust Fan 3rd Floor West	1-31	11	H	45	23,000	9.8	10.9	7.7
Exhaust Fan 3rd Floor South	1-32	37	H	45	23,000	3.2	4.9	2.5
Exhaust Fan 3rd Floor North	1-33	38	H	45	23,000	8.6	12.2	8.1
Exhaust Fan 4th Floor South	1-34	13	H	60	23,000	6.9	5.8	9.1
Exhaust Fan 4th Floor West	1-35	14	H	60	23,000	9.6	11.2	11.5
Exhaust Fan 4th Floor South	1-36	39	H	60	23,000	6.0	10.1	4.1
Exhaust Fan 5th Floor South	1-37	17	H	75	23,000	8.6	8.4	11.5
Exhaust Fan 5th Floor West	1-38	18	H	75	23,000	9.1	7.2	10.4
Exhaust Fan 5th Floor South	1-39	40	H	75	23,000	8.4	10 2	7.9
Exhaust Fan Overhead No. 1	1-40	22	V	90	25,000	<0.1	*	*
Exhaust Fan Overhead No. 2	1-41	23	V	90	25,000	9.9	10.3	*

TABLE 4.1(B) URANIUM STACK EMISSIONS

Description	Stack No.	S.P. No.	(1)	Height Ft.	ACFM	Kg Uranium 1979	Kg Uranium 1980	Kg Uranium 1981
Exhaust Fan Overhead No. 3	1-42	24	V	90	25,000	4.3	4.6	9.0
Exhaust Fan Overhead No. 4	1-43	25	V	90	25,000	9.5	15.3	3.7
NH_3 Dissociator Vent	1-45	4	V	60	12,580	3.6	6.3	5.0
"A" UF_4 Dust Collector	1-46	54	V	98	1,338	2.7	3.4	0.2
"C" Fluorinator Blower	1-47	44	H	30	4,239	1.5	0.7	0.4
H_2S Incinerator Stack	1-48	28	V	155	6,500	0.4	0.4	0.5
Distillation Multifloor Exhaust	1-49	45	V	19	27,775	0.3	0.2	< 0.1
"A" Reductor Off-Gas	1-50	55	H	67	733	10.1	0.3	0.7
"B" Reductor Off-Gas	1-51	56	H	67	1,215	1.6	0.5	3.4
Drum Invertor Dust Collector	1-54	59	V	19	15,394	**	**	0.1
Exhaust Fan 3rd Floor North	1-55	57	H	45	8,535	**	1.5	0.2
Exhaust Fan Distillation 1st Floor North	1-56	60	H	22	26,390	**	**	3.4
Exhaust Fan Maint. Area 1st Floor South	1-57	62	H	11	5,268	**	**	**
U-Recovery Dust Collector	3-2	46	V	40	462	< 0.1	< 0.1	< 0.1
Pond Mud Calciner	4-2	53	V	29	3,296	1.1	0.5	0.4
Sampling Plant Dust Collector	17-1	64*	V	23	7,565	0.2	0.5	0.1
Sampling Plant Vacuum Cleaner	17-2	61	H	13	490	**	**	0.2
TOTAL EMISSIONS						412.7	408.1	365.1

* Removed from service

** Not installed to date

(1) Direction of Discharge: H = horizontal, V = Vertical

TABLE [illegible]1(C)

PLANT STACK EMISSIONS

NON-RADIOLOGICAL CONTAMINANTS

(Lbs./hr.-Maximum Rate)

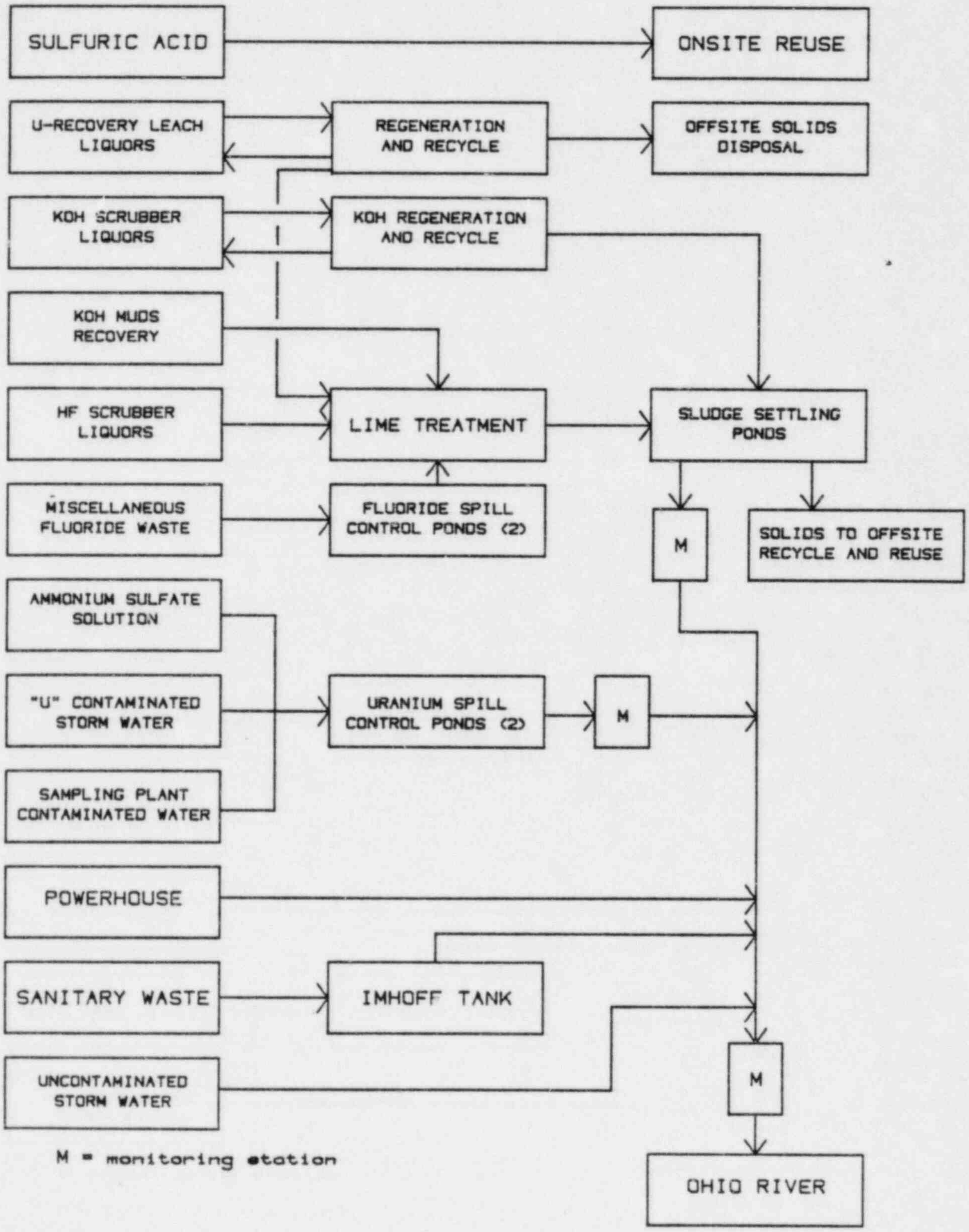
Stack No.	Description	Fluoride	Fluoride as HF	H_2S	Hydracarbons	SO_2
1-1	Wet Oxide Dust Collector			1.3 ± 20%	1.8 ± 15%	
1-13	"A" Fluorination Scrubbers		0.0014			
1-14	"B" Fluorination Scrubbers		0.0014			
1-23	"A" Top Hydrofluorinator Scrubber			0.001		
1-24	"B" Top Hydrofluorinator Scrubber			0.001		
1-48	Incinerator Stack					< 2000 PPM
4-1	Calciner Combustion Gas Flue	1.9± 25%				
4-2	Calciner Exhaust Scrubber Vent	1.8± 25%				
5-1	KOH Scrubber Vent	0.5± 25%				
5-1B	#2P KOH Scrubber - 5KA Expansion	0.25				
5-2	H_2 Scrubber Vent	0.58 ± 25%				
5-2B	#1P H_2 Scrubber	0.09				
6-1	KOH Scrubber Vent	0.5± 25%				
8-3	IF_5 Scrubber Vent		0.015			
8-4	SbF_5 Scrubber Vent		0.61± 25%			
8-5	IF_5 Fume Vent Scrubber	0.002				
14-1	KOH Scrubber	0.5				
14-2	H_2 Scrubber	0.05				
14-3	Melt Tank Scrubber	0.01				

4.2 Liquids and Solids

All liquid wastes from the facility are discharged through the main effluent via natural drainage into the Ohio River. Figure 4.2, Page 4-11, depicts the current wastewater disposition scheme. The main plant effluent is continuously sampled, and the composite sample is analyzed daily for uranium. Administrative controls are utilized in conjunction with daily sampling to limit liquid effluent concentrations of uranium. The administrative investigation limit is established at 5% of the NRC unrestricted release limit; however, experience indicates routine concentrations rarely exceed 2% of the release limit. In the event of a major spill which could significantly increase effluent water concentrations of uranium, additional controls, e.g. diking, neutralization, etc. are utilized to minimize the environmental impact. Suspended and dissolved solids, pH, and fluoride, are monitored in accordance with the NPDES permit. The daily samples of the main effluent are composited into a monthly sample that is analyzed for numerous impurities. Typical analyses of pollutant concentrations are shown in Chapter 5, "Environmental Monitoring Program."

An environmental protection facility (EPF) is utilized to remove chemical pollutants (primarily fluoride) from the main plant effluent stream. The facility process uses calcium hydroxide to precipitate fluorides as insoluble calcium fluoride. Precipitated solids are separated in settling basins prior to recovery of the synthetic CaF_2 which is subsequently transported to an Allied Chemical hydrofluoric acid (HF) production plant. The synthetic CaF_2 is blended with natural CaF_2 for routine HF production. The effluent from the EPF plant has a pH of approximately 12 and is automatically adjusted to a pH of approximately 8 using H_2SO_4. This stream is combined with treated sanitary waste. This combined stream is mixed with the uncontaminated cooling water and the effluent from the uranium settling ponds and again monitored before being discharged into the Ohio River.

Wastewater that may contain uranium, except the HF water scrubber liquors and the uranium recovery leach liquors, is routed through two of four settling ponds, depending on the chemical composition of the waste. Ponds No. 1 and No. 2 provide particulate uranium recovery and fluoride spill control for wastewater containing excessive concentrations of fluoride. The effluent from these two ponds is pumped directly to the environmental protection facility. Settling Ponds No. 3 and No. 4 are used as uranium spill control ponds. These ponds receive spent $(NH_4)_2SO_4$ solutions from the pretreatment facility and all other uranium-contaminated water including that from the Sampling Plant, that does not contain significant fluoride.



CURRENT WASTEWATER DISPOSITION

Figure 4.2

July 1, 1982

The HF water scrubber liquors are routed directly to the environmental protection facility for HF neutralization. The uranium content of this stream averages less than 5 ppm uranium. Uranium recovery leach liquors are recycled for additional leaching. When contaminant concentrations in these liquors exceed operating specifications they are withdrawn and pumped to the environmental protection facility for fluoride removal.

The pH of the uranium settling ponds is maintained slightly basic to minimize dissolved uranium loss. Experience indicates that approximately 90% of the uranium loss from these ponds is soluble uranium. As the effluent leaves the second uranium pond, the level is measured to determine flow rate and a proportional sample is taken for a 24-hour composite sample. The pH and uranium content of the composite sample is analyzed daily. The average flow from these two ponds is approximately 40 gpm. The effluent from the uranium settling ponds is then mixed with the remainder of the facility effluent before discharging into the Ohio River.

The solids level in each of the four ponds is measured periodically; an individual pond is removed from service when the available "freeboard" is reduced to approximately 2 feet. The solids removed from No. 3 and 4 ponds during a cleanout are pumped into the pond muds calciner for drying and are packaged into drums. The dried solids are processed in the uranium recovery unit for recovery of the contained uranium values. The uranium bearing solids from No. 1 and 2 (fluoride ponds) are processed in the KOH muds unit.

These settling ponds are predominately an above grade system. Only about two feet of each pond is below grade. Each time a pond is emptied and cleaned, a thorough examination is made of the lining. The lining is 62 mil EPDM (ethylene-Propylene Diene Monomer) rubber installed over previously used asphalt and burlap liners. The material in the ponds is alkaline and the EPDM rubber liner has excellent resistance to alkaline solutions. In the event a pond liner should develop a leak, seepage drains are installed under each pond to provide means for rapid leak detection.

4.2.1 Effluent Certification

The Plant NPDES Permit was issued by U.S. Environmental Protection Agency, Region V, on May 16, 1975. It became effective on June 15, 1975 and expired on May 31, 1980. An application for renewal was submitted to the Illinois Environmental Protection Agency on November 29, 1979. The Agency has extended the existing permit in accordance with the timely application provisions of Section 122.12(b)(4) of NPDES regulations. Please refer to Appendix "B".

4.2.2 Solid Wastes

Radioactive solid wastes are generated from routine operation of the UF_6 facility. The routine wastes generated consists primarily of contaminated filters, papers, floor sweeping compounds cleaning rags, etc. Approximately one thousand 55-gallon drums of contaminated trash are generated annually. These drums are compacted for a volume reduction of more than 50% before being shipped to a licensed waste disposal site.

The solid radioactive wastes generated in the uranium recovery process consists primarily of inorganic insoluble material (principally CaF_2) which contain small quantities of natural uranium. The average concentration of uranium (nat.) is approximately 2,000 PPM. This material also contains other long-lived isotopes which have not been removed in the uranium milling process and are subsequently separated during the UF_6 conversion process. The average concentration of significant isotopes is about 0.003 uCi/gm. Please refer to Table 4.2.2, Page 4-14 for concentrations of long-lived isotopes. These wastes are dried, appropriately packaged, stored in especially designated areas, and then shipped to a licensed off-site facility for disposal. Approximately 220 pounds of these wastes are generated for each short ton of UF_6 produced in the plant.

Contaminated pieces of process equipment and piping being discarded are decontaminated where feasible to recover uranium values; they are then compacted for volume reduction, before disposal at a licensed site. Non-contaminated scrap metal is sold to various scrap metal dealers. Thorough radiation monitoring is done to assure that the residual radioactivity level is below applicable NRC guidelines.

TABLE 4.2.2

Isotopic Content of Uranium Recovery Solid Wastes

Isotope	Source	Radioactivity Micro curies/gram (uCi/gm)
Uranium (Natural)	Un-recoverable	1.4 E^{-3}
Radium 226	Long-lived daughter not removed in milling process	1.3 E^{-3}
Thorium 230	Long-lived daughter not removed in milling process	2.4 E^{-2}
Thorium (Natural)	Natural Thorium not removed in milling process	2.0 E^{-3}
TOTAL		2.9 E^{-2} uCi/gm

5. Operations

5.1 Corporate Organization and Administrative Procedures

5.1.1 Description of Organization:

The Metropolis UF_6 conversion plant is owned and operated by Allied Chemical Company, which is one of several operating companies of Allied Corporation. Company and Corporate headquarters are located in Morristown, New Jersey. The top ranking member of management at the plant site is the Plant Manager, who reports directly to the company General Manager for UF_6 in Morristown. The General Manager reports to the Executive Vice President who reports directly to the company President/Corporate Group Vice President in Morristown.

Operations of the plant are administered by a plant staff which is organized as shown in Figure 5.1.1, Page 5-2. The Plant Manager's line staff includes: the Manager of Operations; to which the Managers of Production and Process Technology report; the Manager of Maintenance, Employee Relations Manager, Plant Controller, and Safety Supervisor report directly to the Plant Manager.

The Manager of Process Technology has five supervisors reporting to him, three of whom are involved with the technical aspects of the manufacturing process while the remaining two are the Analytical Supervisor and the Health Physicist. The Health Physicist, his assistant, and five (5) other personnel constitute the plant Radiation Protection staff. The company and corporate headquarters staff also provides engineering, safety, and environmental support services as required by the plant. Thus, the organizational structure provides for separate lines of reporting for the production, maintenance, safety and health physics functions.

5.1.2 Management Supervisory Program

Plant operations are conducted in accordance with written operating procedures contained in operating manuals or Job Safety Analyses. Examples of manuals currently in use include: Production Operating

ORGANIZATIONAL CHART FOR METROPOLIS WORKS

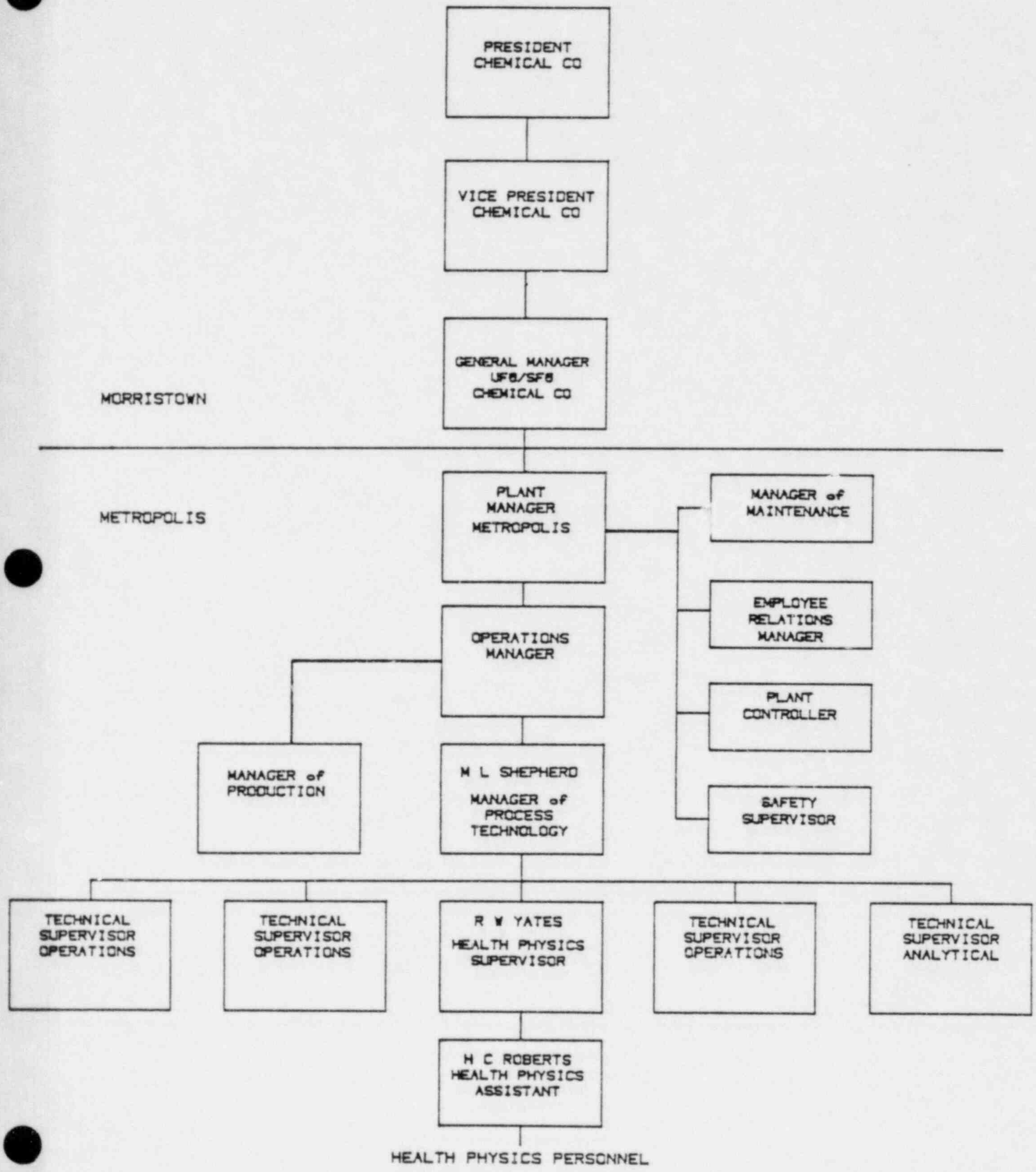


Figure 5.1.1

Manuals, Maintenance Procedure Manuals, Supervisory Safety Manual, Chemical Safety Data Sheet Manual, Spill Control Manual, and Health Physics Policy and Procedure Manual. Written Job Safety Analysis procedures are utilized which provide step-by-step instructions for performing selected jobs which are considered to involve significant hazards. Changes in the Job Safety Analyses or Manuals are required to pass through standardized chains of review and approvals before becoming effective. In most cases, final approval must be granted by the Plant Manager; however, operating manuals and JSA's require approval only by the cognizant Technical Supervisors and Department Manager.

The plant also utilizes a strict work permit system to ensure safe job performance during non-routine maintenance operations. In such cases a Special Work Permit or a Tank Entry Permit is issued as appropriate for the type of repair work to be done. The primary purpose of the system is to ensure that the employees performing the work are properly instructed and to provide Management with an opportunity to review the adequacy of the special precautions to be taken before the work is started. Before any facility tank may be entered, a Tank Entry Permit must be signed by either the Production Manager, the Maintenance Manager, or the Technical Manager; the Health Physicist, the Safety Supervisor, the first line supervisor, and the employees performing the actual work also sign the permit. Both types of permit forms require a detailed check-off list of safety precautions which are reviewed by both supervisory and maintenance personnel before being approved and signed. Upon completion of the job, the permit cards which required Health Physics approval are retained for documentation of procedure effectiveness.

5.1.3 Management Audit and Inspection Program

Inspection of plant operation involves essentially continuous observation by cognizant supervisory personnel on multiple daily visits through the plant facility to ascertain that operations are being conducted in accordance with standard procedures.

A primary responsibility of the plant Health Physicist is to review and audit plant operations for compliance with the license and 10CFR20 regulations. The Health Physicist has been delegated the authority to shut down operations or require additional safety precautions when he deems such measures are needed. In addition, he must approve in writing, entry of personnel into vessels which have been used in processing radioactive materials, and also approves procedural or equipment changes which involve health physics matters.

Plant Staff Meetings are normally held weekly. The Health Physicist and Safety Supervisor attend the meetings to provide interface with Plant Management concerning plant Health and Safety programs and procedures.

In addition to the plant audit and inspection program, the company headquarters environmental staff also conducts plant audits to assure compliance with company, federal, and state standards for Occupational Health, Safety, and Pollution Control.

5.1.4 ALARA Program

A plant ALARA "As Low as Reasonably Achievable", committee is utilized by management to ensure that exposures and effluent releases are effectively controlled. This committee, consisting of the Plant Manager, Operations Manager, the Department Managers, the Health Physicist and the President, and Vice President of the local union, meets quarterly to review the radiological safety program performance for the previous quarter and to formulate plans for reducing the radiation exposure of Metropolis Works employees. Regulatory Guide 8.10 is utilized by the committee for formulating plant operating philosophy in reducing exposures.

Business transacted at the meetings includes a detailed evaluation of personnel exposures to identify any possible undesirable trends developing in these exposures or in effluent releases and, if needed, to initiate a plan of action directed toward determining the reasons for any increase and reversing any upward trend. A report is written covering the findings of the ALARA committee which is distributed to all members and Department Managers. This committee activity,combined with the job safety analysis process, the ongoing inspection and audit of plant operations, employee training, and administrative procedures for review by the Health Physics Department of operating procedures involving radiological safety matters, demonstrates the commitment of Plant management to comply with the "ALARA" philosophy.

5.2 Qualifications

A description of the qualifications and experience of the incumbent Health Physicist and Assistant Health Physicist is shown in Appendix "C". These personnel are responsible for conducting the plant radiation safety program. Additional responsibilities include occupational health in the non-uranium manufacturing areas, transportation of hazardous materials, and supervision of the health physics staff.

The minimum qualifications required for the staff positions which relate directly to administration and supervision of the radiation safety program are as follows:

Manager of Process Technology:

Requires a Bachelor's degree in Physical Science, Engineering or Biological Science and a minimum of five years experience which includes direct supervision of Professional personnel, and a working knowledge of radiation protection requirements.

Health Physics Supervisor:

Position requirements must include a Bachelor's degree in physical or biological science and a minimum of three years of Health Physics experience or equivalent advanced academic training.

Assistant Health Physicist:

The minimum requirements for this position include a Bachelor's degree in physical or biological science and at least one year of experience in the Nuclear industry.

5.3 Training

New employees receive a four hour indoctrination in plant safety and procedures which includes the issuance of personal safety equipment, a tour of the plant facilities, demonstrations of proper use of safety equipment and lectures covering the importance of and proper procedures for radiation protection. Additionally, each employee is issued and requested to study a copy of the "Metropolis Works Health Physics Guide". A copy is reproduced as Appendix "D". A safety indoctrination form which outlines the initial training, the assignment of lockers, the issuance of TLD badges and safety equipment, and the fitting of respirators is signed and dated by the Safety Supervisor, the Health Physicist and the new employee.

During the employee's first week, at least 15 minutes per day is spent with his immediate supervisor reviewing safety and radiation protection procedures. Adequacy of his training is verified by his performance and informal examination by his foreman. All employees are reinstructed in safety hazards and proper radiation protection procedures at monthly safety meetings.

The monthly safety meetings consist of three (3) councils as follows:

"A" Council Committee consisting of the Plant Manager, Operations Manager, the five departmental managers, the Health Physicist, the Safety Supervisor and three hourly employees, one each from the production, maintenance and service/stores departments. The Committee meets monthly to review and set plant health and safety policy.

"B" Council Committee consisting of all first line supervisors and foremen meets monthly for training and motivation in health and safety practices.

"C" Council monthly meetings are attended by all hourly employees for instruction and review of plant safety and radiological safety procedures.

Examples of training information provided to employees during the Radiation Protection segment of each monthly "C" Council include the following:

- Radiological Emergency Planning
- ALARA
- Air Activity Measurement of Contamination
- Surface Contamination Monitoring & Control
- Decontamination Procedures
- Waste Disposal
- External Exposure Control
- Radiation Dose and Dose Limits
- Uranium Deposition & Toxicity
- Respiratory Protection
- Employee Rights and Responsibilities (Part 19 & 20)
- Slide or Movie Presentation and Annual Quiz

5.4 Security

Access to the 54-acre plant operating area is restricted by using two, separate six foot cyclone fences with three strands of barbed wire at the top of each. Entrance gates are protected by guards employed by an outside contractor who specializes in such service. Employees and visitors enter the plant area through the main gate which is secured by a guard on a twenty-four hour per day basis. Construction personnel and ore concentrate deliveries enter through the Sampling Plant gate which is also secured by a guard on a twenty-four hour basis.

The plant property outside the restricted area fence (808 acres total) is posted "No Trespassing" at the boundary. Occupancy, or unauthorized entry, by members of the public is not normally permitted inside the boundaries of the entire 862 acre site.

Vendor and service vehicles are allowed to enter the plant area through the main or construction gates after being issued a vendor pass and signing the visitor log provided by the guard. Privately owned employee vehicles are not normally allowed inside the restricted area.

During nighttime hours a guard makes surveillance tours on an hourly basis. The tour route includes check points around the perimeter fence at designated plant service facilities.

A gate pass system is used for removal of equipment and scrap materials. The guard will not allow the removal of plant materials unless a gate pass is provided which has been signed by a department supervisor, a department manager, and the health physics department. The health physics department signs the pass only after an appropriate radiation survey is made to ascertain that no radioactive material is involved.

5.5 Radiation Safety

5.5.1 External Radiation Surveys:

Each employee of the facility is issued an individually assigned TLD whole body badge. The TLD badge service is currently supplied by Eberline Instrument Corporation. The vendor supplies new badges on a monthly basis for all hourly employees. Salaried employee badges are exchanged quarterly due to their significantly lower exposure potential.

External gamma surveys of process equipment had been conducted periodically for many years prior to April 1, 1977. Based upon years of survey data, it was concluded that significant variations in equipment radiation levels did not occur during routine operations. Based upon past survey data, process areas which have or could possibly have radiation fields in excess of 5 millirem per hour are marked off utilizing yellow and magenta paint stripes on the floor around the equipment. The boundary of the radiation area is determined by the points which measure a maximum of 2.5 mr/hr. The floor stripes are utilized in conjunction with training to warn employees to minimize stay-times in these areas.

Investigative beta-gamma instrument surveys are conducted when a process or procedural change is made which could result in increased employee exposure. Exposure rate and occupancy factors are appropriately utilized to determine if additional precautions are needed. Additionally, each time a radioactive material vessel is entered for inspection or repairs, a radiation survey is conducted by the Health Physics department and appropriate employee protection is specified utilizing time, distance and shielding considerations.

Plant entrances are posted with signs bearing the radiation symbol and the words:

RADIATION

RADIATION AREA

RADIOACTIVE MATERIALS

Any area or container in this plant
may contain radioactive materials.

Instrumentation used in performing surveys and calibration methods are presented in "Appendix "E"

Utilization of these external radiation exposure controls has resulted in approximately 90% or more of plant employees receiving an annual whole body dose of less than 500 mrem during the most recent three (3) years of operation. Table 5.5.1,Page 5-9 also indicates the number of employees receiving more than 500 mrem annual whole body dose has steadily decreased from 10.3% in 1979 to 2.1% in 1981. The maximum employee dose measured during the most recent three-year period was 1.6 Rem (whole body), and 2.4 Rem (skin) which represents 32% and 8% of the 10CFR20 limit respectively. No employee of the plant as ever exceeded the 5 Rem annual limit for whole body exposure.

TABLE 5.5.1

PERSONNEL MONITORING REPORT

1979 - 1981

ANNUAL WHOLE BODY DOSE RANGES * (REMS)	1979	1980	1981
No measurable exposure	122	132	175
Measurable Exposure Less Than 0.100	131	152	158
0.100 - 0.250	68	127	108
0.250 - 0.500	113	71	69
0.500 - 0.750	29	32	10
0.750 - 1.000	11	5	1
1.000 - 2.000	10	0	0
TOTALS	484	519	521

* Individual values exactly equal to the values separating exposure ranges shall be reported in the higher range.

Historical data and plant operating experience indicate employees are most likely to receive whole body doses greater than 500 mrem as a result of working in the ore concentrate sampling plant or other jobs where close contact with uranium or its daughter products is likely to occur. In accordance with ALARA principles exposure times are minimized to the extent practicable, and in the Sampling Plant jobs are rotated on a two hour basis.

5.5.2 Airborne Radiation Surveys

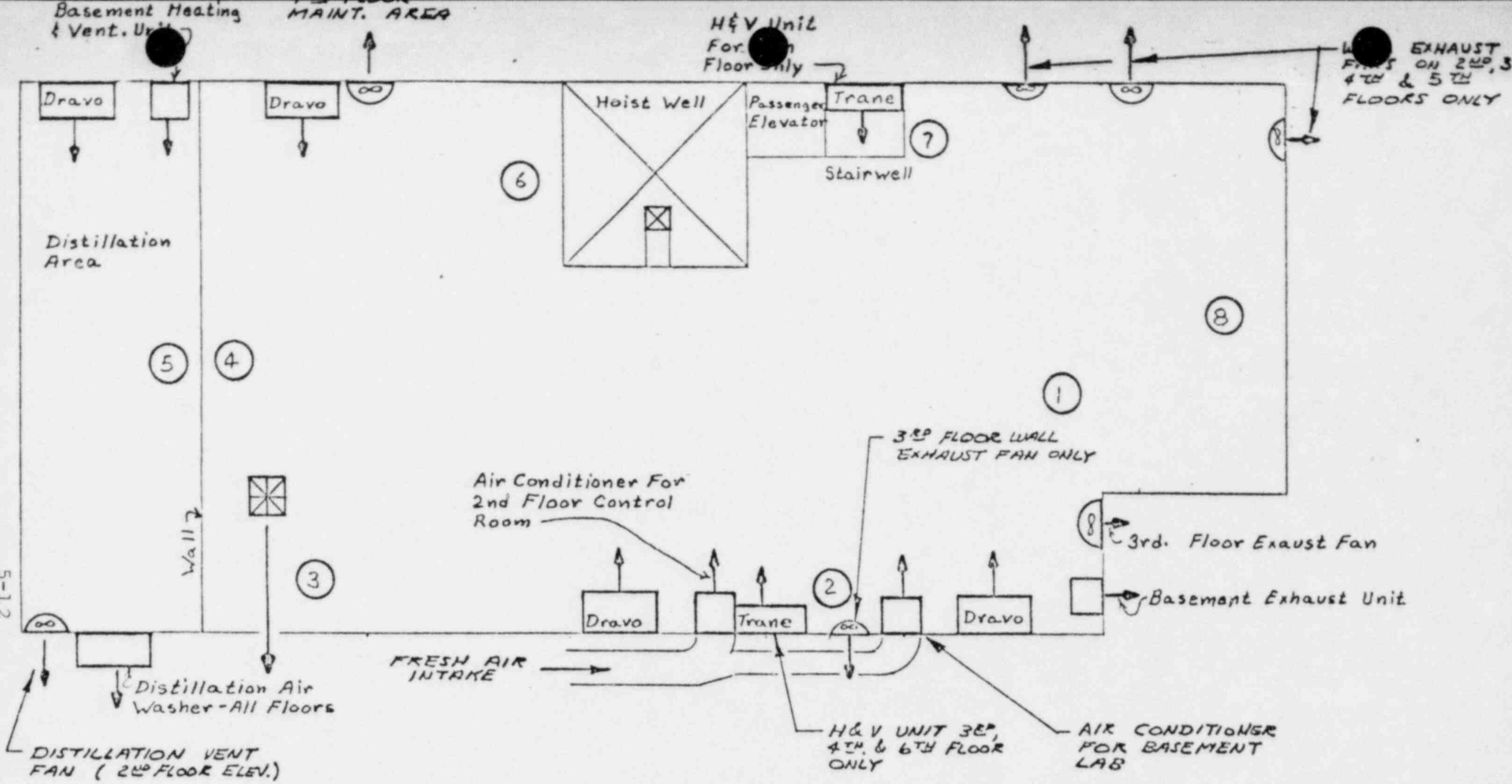
There are fifty-six (fixed) breathing zone area air sampling points in the UF_6 operating area, one in the UF_6 plant laboratory, four in the sodium removal facility, three in the drum dumping area, and nine in the Sampling Plant to determine airborne radioactivity levels. The membrane filters from all air sampling points are changed and counted daily for Alpha radioactivity. The air activity is calculated (uCi/cc) and reported daily during periods of normal operation. However, during periods of abnormal operating conditions (visible spills or leaks), the sample points are changed after the upset is corrected and the area decontaminated of visible contamination. Precautionary use of respiratory protection is required from the time of the spill until air activity is reduced to less than 40% of MPC. The air samples are then changed at two hour intervals until analytical results indicate the air activity is below the administrative limit.

Each fixed breathing zone sampler is located approximately five feet above the floor and consists of: a 25 mm open-face filter holder, membrane filter, flowmeter, and associated fittings for connection to a central sample vacuum system. Eight samplers are located on each floor of the UF_6 facility. The location of each sample station in the Feed Materials building and Sampling Plant is shown in Figures 5.2.2(A) and 5.2.2(B), Pages 5-12 and 5-13. The sampling rate used is 40 SCFH which is approximately equal to "standard man" respiration rate.

All air activity filters are counted for alpha radioactivity in the Health Physics laboratory using an automatic planchet counting system. This instrument is calibrated monthly using a certified U308 alpha source. Additionally, the flowmeters utilized for regulating the sampler air flows are checked quarterly by comparing flow rates with a test flowmeter which has been calibrated using a dry test meter. Refer to Appendix "E" for test and calibration procedures.

Air activity trends during the most recent three years of operation are shown in Table 5.2.2(A), Page 5-14. The data indicates the Feed Material building averaged about 23% of the limit during the three year period. Abnormal spills, or UF_6 release activity is included in the monthly average values. This inclusion of data results in some monthly data appearing high relative to other months. Historically, we have found the highest air activity occurs during a UF_6 release, and although the activity is of very short duration, it is a significant contribution to the average. Incidents (airborne radioactivity areas) occurred 13, 12, and 15 times respectively during the years 1979, 1980, and 1981. An "airborne radioactivity area" is defined in accordance with guidance provided in Regulatory Guide OH 710-4 as being a floor in which the activity exceeds MPC averaged for the eight sampling stations, or the activity exceeds 25% of MPC including appropriate occupancy. Occupancy in the Feed Materials operating areas is less than 20 hours per week; however, in the drum dumping area occupancy in conjunction with activity levels constitute an "Airborne Radioactivity Area". The area is appropriately posted and respirators are required when performing the job.

The air activity in the drum dumping area is higher than in other areas due to the necessity of handling unencapsulated ore concentrates. After the drum is dumped into the ventilated drum inverter hopper, residual uranium is vacuumed by hand from the inside walls of the drum before final drum cleaning which is accomplished in a shot blaster. A new dust collection system was installed in the drum dumping area in November, 1980. Subsequent equipment and procedural modifications have significantly reduced airborne radioactivity in the area. In addition, a timer controlled sampling device was installed in the area in April, 1981 to measure concentrations when work was actually being performed. During the first six (6) months, using the timer controlled sampling, the average employee exposure was shown to be less than 2 MPC-hrs/shift, refer to Table 5.2.2(B), Page 5-15. The maximum individual exposure measured during either calendar quarter was a total of 98 MPC-hrs or approximately 19% of the quarterly 520 MPC-hr. limit.



☒ Roof Vent For 6th Floor

✳ Roof Vent For 5th Floor

Dravo - Heating & Ventilation Unit Supplies Air to 1st Thru 6th Floors

(1-8) Typical Air Sample Points On All Floors

ATMOSPHERE AIR SAMPLE POINTS & VENTILATING SYSTEM IN FEED MATERIALS BUILDING

Figure 5.2.2(A)

REV. A D.C. 2-2-82

MTW-A1150A

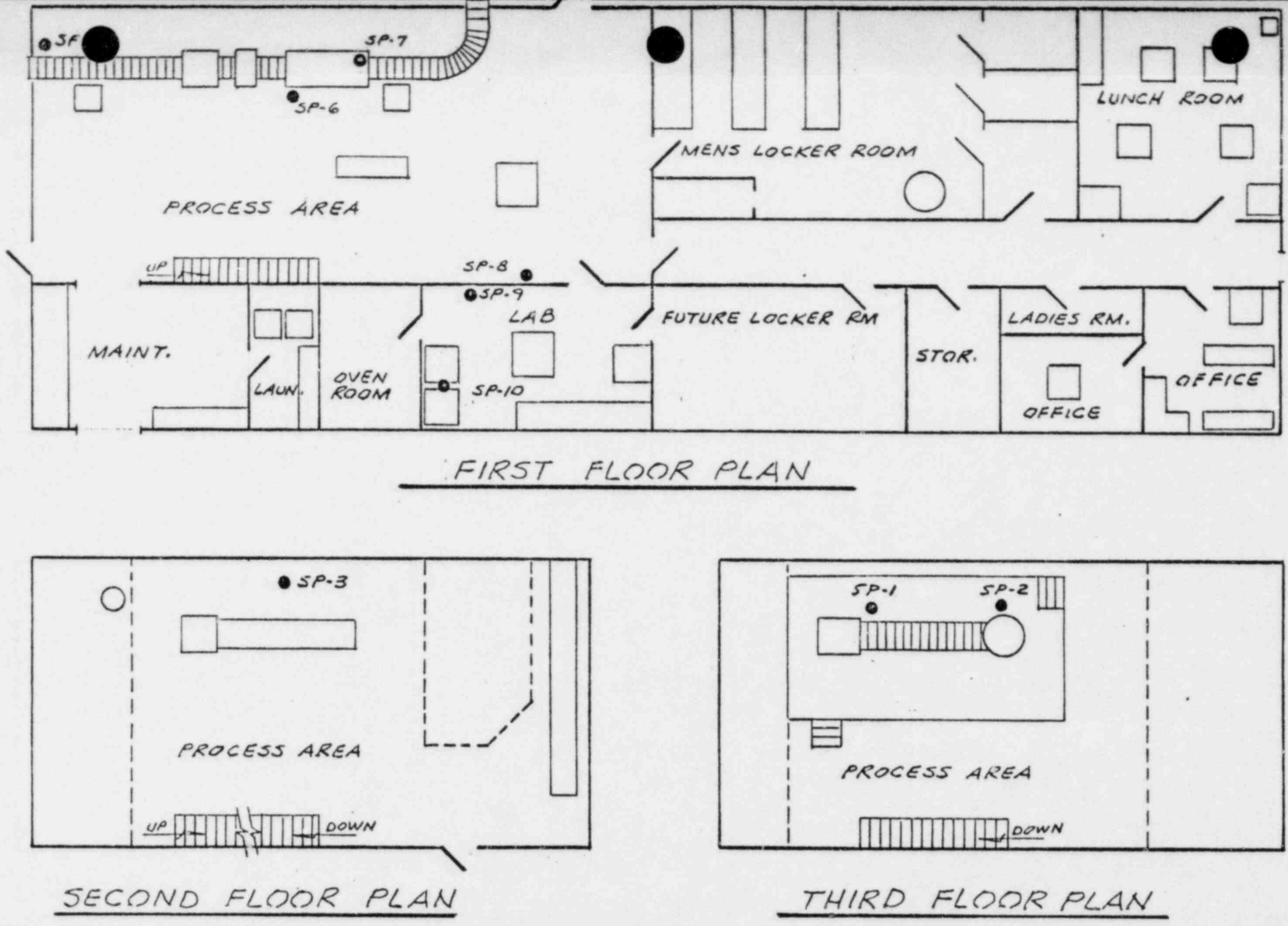


Figure 5.2.2(B)

A REVISED SP-1 & SP-2 DC 2-2-8
ORE SAMPLING PLANT
HEALTH PHYSICS
SAMPLE POINTS
1-23-78 SCALE ~ NONE
MTW-1729 A

TABLE 5.2.2(A)

MONTHLY AIRBORNE URANIUM CONCENTRATIONS*

MONTH	1979			1980			1981		
	FM "All Floors"	Drum Dumper	Sampling Plant	FM "All Floors"	Drum Dumper	Sampling Plant	FM "All Floors"	Drum Dumper	Sampling Plant
Jan.	20.2	121.0	16.0	33.0	156.0	21.0	19.7	75.0	17.0
Feb.	35.3	153.0	19.0	35.0	125.0	23.0	23.1	84.0	19.0
March	31.0	108.0	15.0	16.0	170.0	22.0	17.9	103.0	17.0
April	15.7	88.0	20.0	24.0	135.0	17.0	21.4	79.0	19.0
May	21.9	82.0	16.0	21.0	96.0	19.0	20.4	23.0	13.0
June	16.7	92.0	17.0	31.0	96.0	21.0	22.1	54.9	12.0
July	16.6	113.0	20.0	22.0	82.0	23.0	43.7	56.0	20.0
August	20.6	101.0	18.0	21.0	97.0	22.0	17.7	37.0	15.0
Sept.	23.6	95.0	21.0	27.0	88.0	23.0	17.0	31.6	14.0
Oct.	21.9	106.0	22.0	26.0	82.0	16.0	20.3	77.0	15.0
Nov.	20.0	96.0	20.0	18.0	66.0	16.0	24.9	41.0	16.0
Dec.	30.7	148.0	25.0	17.0	66.0	16.0	10.3	39.0	11.0
Annual Average	22.9	108.6	19.1	24.3	104.9	19.9	21.5	58.4	15.7

* Expressed as percent of 10CFR20 Limit - $1E^{-10}$ uCi/cc

TAB .2.2(B)

DRUM DUMPER AIR ACTIVITY TIMER CONTROLLED-VERSUS AREA SAMPLING

Sampling Period	Timer Controlled Sample		Area Sample DD-1	
	Occupancy Hrs./Shift	MPC - Hrs./Shift	% Of MPC	MPC - Hrs./Shift*
April 1981	2.5	3.26	79.0	2.30
May 1981	2.5	0.99	24.0	0.79
June 1981	3.1	1.98	55.0	1.57
July 1981	2.4	2.13	56.0	1.98
August 1981	2.1	1.40	37.0	1.24
September 1981	2.0	1.14	32.0	1.34
6 Months Average	2.4	1.82	47.2	1.54

NRC Limits: $1\ E^{-10}$ uCi/cc for airborne uranium (MPC)

40 MPC-hrs. (soluble uranium) in any seven consecutive days

520 MPC-hrs. (insoluble uranium) in any quarter

* Assumes 3.2 hrs/shift occupancy factor from previous studies and includes only the shifts when actual work was performed, e.g., in September, 1981. The total MPC-hrs of exposure at 3.2 hrs/shift was 77.65 ÷ 58 shifts actually worked = 1.34 MPC-hrs/shift.

5.5.3 Internal Exposure Control

The primary control utilized in the plant for maintaining internal exposures as low as reasonably achievable is confinement of source material within process vessels. Extensive air sampling determines when confinement is breached and during these occasions respiratory protection is utilized by employees working in the contaminated area. In addition, a comprehensive bioassay program is conducted (refer to Section 5.5.4) to determine if significant uptake of uranium has occurred.

Plant regulations require that each individual have a respirator on his person before entering the UF_6 facility or the Sampling Plant. Failure to wear a respirator in a designated area may subject an employee to disciplinary action. No extended periods of time are anticipated for the wearing of respirators by individuals, and indeed, experience has shown that this is true. Respirators are normally worn following process equipment breakdowns which result in area contamination. Flashing red lights, posting, radiation ribbon, and written instructions are used to insure that employees wear respirators in airborne contamination areas until such time that air sampling indicates the air activity in the area has been reduced to an acceptable level. An in-plant administrative limit of 40% of MPC is used as the air activity level at which respirators are worn.

Contamination of the UF_6 process building is minimized through the efforts of full-time decontamination employees whose sole function is the cleaning of floors, equipment and process lines. In addition, janitors routinely clean all control rooms, the lunchroom and office spaces.

Each potentially exposed employee is given an annual qualitative and quantitative respirator fit test. The basic fitting procedure consists of selecting by elimination, the best of several types of half-mask respirators available. A qualitative test is used which exposes the individual to an irritant smoke while he is wearing the respirator. The wearer is then subjected to a quantitative test using a Dynatech Frontier Model FE 259 Polydisperse aersol generator, and Model FE-222 test booth. The respirator model which affords the wearer the greatest respiratory protection is assigned to the individual. The individual protection factors obtained using this testing program favorably exceed those allowed by Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection." The respiratory equipment used in the plant is shown in Table 5.5.3, Page 5-17. Each new employee is

TABLE 5.5.3

RESPIRATORY PROTECTIVE EQUIPMENT

Manufacturer and Type		Model Number	Approval Number
Mine Safety Appliance, ½ mask respirator	(small)	Comfo II	TC-21C-135
Mine Safety Appliance, ½ mask respirator	(med.)	Comfo II	TC-21C-135
Mine Safety Appliance, ½ mask respirator	(Large)	Comfo II	TC-21C-135
American Optical ½ mask respirator	(small)	R-5057	TC-21C-160
American Optical ½ mask respirator	(large)	R-6057	TC-21C-160
Scott ½ mask respirator	(small)	6411-3050	TC-21C-178
Scott ½ mask respirator	(large)	6413-3050	TC-21C-178
Norton ½ mask respirator	(small)	7500-30M	TC-21C-152
Norton ½ mask respirator	(large)	7500-30	TC-21C-152
Willson ½ mask respirator	(large)	1212	TC-21C-142
MSA, full-face chin type gas mask with GMR cannister		Ultravue	TC-14G-105
MSA, full-face, continuous flow air-line respirator			TC-19C-93
MSA, full-face ultra twin respirator			TC-21C-155
MSA, self-contained air mask		401	TC-13F-30
Scott, self-contained air pak II			TC-13F-39

fitted and instructed in the proper fitting of respirators, and in-field tests for respirator function immediately prior to use. These instructions and fitting procedures are repeated annually for all potentially exposed employees.

When conditions indicate that the protection provided by a half-face respirator may be inadequate, respiratory equipment is used which will provide the individual greater protection factors, such as a full-face gas or airline mask, or self-contained breathing apparatus, as appropriate. This respiratory protective equipment is available at strategic locations throughout the plant for immediate use. For purposes of computing individual exposures to airborne radioactivity, the respiratory protection factors used are in accordance with the recommendations contained in NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials", and Regulatory Guide 8.15.

At the end of each shift, used respirators are deposited in one of the receptacles provided for this purpose throughout the plant. Respirators thus collected are completely disassembled and cleaned. Each cartridge is checked for radioactivity using a beta-gamma probe to detect low levels of activity. Any cartridge showing radioactivity above 300 CPM is discarded. All parts of the used respirator except the cartridges are washed, disinfected, rinsed, dried, and packaged prior to re-issue.

Additional employee exposure control is obtained by requiring employees actively engaged in operations to wear plant issued and maintained clothing and shoes. Personnel are assigned two lockers each, a "hot" and a "cold" locker. Each employee is issued three sets of coveralls which are numbered for return to the individual. When an employee reports for work, he is required to change into coveralls, safety shoes, a hard hat and safety glasses. At the end of the shift, the coveralls are placed in containers provided for that purpose. Company-provided equipment is kept in the "hot" locker assigned to the employee and does not leave the plant. Used coveralls are taken to the plant laundry where they are washed, dried and returned to the respective employee.

Experience indicates that contamination picked up on coveralls during the normal working day is negligible. There are, however, instances when an employee may be required to work under conditions such that contamination is significant. At such times, additional coveralls, shoe covers, respiratory protection, and gloves are required to insure that adequate protection is afforded. Upon completion of the job, the outer

5.5.3 Internal Exposure Control (continued)

clothing is removed and placed in plastic bags at the job site. The employee then proceeds to a shower provided in the UF_6 facility for decontamination and changes into clean coveralls. The employee then proceeds to the regular shower and locker room to change in the normal manner at the end of his shift. The contaminated clothing removed in the UF_6 facility is stored and washed separately from the routine clothing. In this way, the spread of and possible re-suspension of contamination is minimized.

5.5.4 Bioassay Program

The current plant bioassay program consists of urinary uranium sampling for evaluation of exposure to the more soluble uranium component of plant materials, and whole body counting to determine the lung deposition of insoluble natural uranium. The program utilizes guidance provided in Regulatory Guide 8.22, and WASH-1251.

Hourly employees are required to leave a urine sample twice monthly following a 24-96 hour absence from work. The sampling schedule is appropriately adjusted to allow for vacations, illnesses, etc. Potentially exposed salaried employees submit one sample monthly. Employees are encouraged to leave urine samples at the end of a shift following a known or suspected exposure to airborne uranium to determine if an exposure has actually occurred. This is in addition to the routine specimens collected.

The fluorimetric method currently used for urinary uranium has a minimum sensitivity of approximately 2 ug "U"/liter. The action level used is 30 ug/L. Employees whose urinary excretion rate exceeds 30 ug/L are required to submit a confirmatory sample. In the event the confirmatory sample is found to be above the action level, and it is known that the exposure was to plant materials other than "highly transportable" UF_6, the employee is restricted, and scheduled for a whole body count. For UF_6 exposures, appropriate samples and calculations are performed to determine if the recommended daily intake limit of 2.5 mg of soluble uranium was exceeded.

Whole body counting is performed at least annually on each potentially exposed employee. Additional counts are performed, when required, as investigative support for the urinary uranium bioassay program. The minimum sensitivity of the presently owned whole body counter is 63 micrograms U^{235}, or about 32% of the maximum permissible lung burden (MPLB) for natural uranium. The action point for a confirming re-count is 50% of MPLB. An investigation is conducted when confirmed results exceed 50% of MPLB. Employees with a confirmed lung burden are placed on work

5.5.4 Bioassay Program (continued)

restriction. If the maximum permissible lung burden is exceeded by a factor of 2 or more, the employee is referred to a physician.

Bioassay results from the most recent 3-years of plant operations indicate a decreasing trend in the number of urinary uranium values exceeding the 30 μg/L action level. Refer to Table 5.5.4(A), Page 5-21. During 1981, approximately 0.4% of all urinary uranium values were above the plant action level. A significant number of these incidents were due to the immediate high values obtained following employee exposure to highly soluble UF_6. No cases have been confirmed where the chemical toxicity limit for the kidney was exceeded.

The whole-body counting data presented in Table 5.5.4(B), Page 5-22, indicates approximately 4.6% of the counts performed exceeded the action point. Experience indicates chest surface contamination is frequently the cause of counts above the action point. Current counting procedure requires the employee to re-shower with particular emphasis on thorough cleaning of the chest and hair, before a confirming recount is performed. A confirmed maximum permissible lung burden of natural uranium has not been measured in a plant employee since the counting system has been in operation.

5.5.5 Contamination Survey Program

Uranium processing areas, e.g. Feed Material building, Sodium Removal, and Uranium Recovery, are surveyed monthly for removable alpha contamination using smear tests. The administrative action level used for these areas is 2500 DPM/100 CM^2. Eating areas such as the lunchroom, or offices and control rooms used for eating purposes, and plant locker rooms are surveyed weekly. All other non-uranium processing areas in the plant are surveyed quarterly. The administrative limit for these "clean" areas is 250 DPM/100 CM^2. These contamination limits are equal to, or more restrictive than those considered as low as reasonably achievable for "yellowcake" in Regulatory Guide OH 710-4. An area which is found to exceed the plant administrative limit is scheduled for immediate decontamination by the full-time decontamination personnel utilized in the plant. Daily visual surveys are also made in uranium processing areas to detect contamination caused by leaks of highly visible LSA uranium compounds. Contamination detected in this manner is also scheduled for clean-up.

Protective clothing and shoes are furnished by the plant to each employee who might be exposed to contamination. These articles do not leave the plant site. Employees are encouraged to shower daily before changing into their personal

TABLE 5.5.4(A)

URINARY URANIUM DATA

CONCENTRATION	YEAR 1979	 1980	 1981
	NUMBER OF SAMPLES		
< 5 ugU/L	5267	5827	6398
5 to 15 ugU/L	2115	1466	1246
15 to 30 ugU/L	496	176	48
> 30 ugU/L	123	38	28
TOTAL SAMPLES	8001	7507	7720

TABLE 5.5.4(B)

WHOLE BODY COUNTING DATA

	YEAR		
	1979	1980	1981
Total Counts performed	284	384	398
Counts $< \text{MDL}^{(1)}$	243	302	330
Counts MDL to 100 μgU^{235}	30	64	50
Counts (2) 100 μgU^{235} to 200 μgU^{235}	10	18	18
Counts (2) $> 200\ \mu gU^{235}$	1	0	0

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(1) MDL = 63 μgU^{235}

(2) Recounts were $< 100\ \mu gU^{235}$

clothing. In addition, locker and change rooms are surveyed weekly to assure contamination is limited to operating areas.

Articles for release to unrestricted areas are surveyed to assure the removable alpha contamination is less than the 1000 DPM/100 CM^2 specified in Regulatory Guide OH 710-4.

Empty transport vehicles used to deliver ore concentrates into the plant are surveyed prior to release. Outgoing shipments of product, wastes, and analytical samples are also surveyed to assure compliance with applicable DOT contamination limits. Test and calibration procedures are presented in Appendix "E".

5.5.6 Environmental and Effluent Monitoring Program

5.5.6.1 Airborne Effluent Survey Program

A comprehensive environmental monitoring program is conducted by the plant to demonstrate compliance with applicable environmental quality standards, and to provide operational "site specific" data which precludes conservative assumptions sometimes used in environmental modeling where "site specific" data is absent.

The environmental air survey program consists of taking continuous air samples (low volume) at four points along the restricted area fence line (Stations No. 9, 10, 12, and 13). Two samplers are located near the site boundary in the prevailing wind direction (Stations No. 8 and 11). One sampler is located off-site approximately one mile downwind of the Feed Material building (Station No. 6). An additional continuous air sampler was installed at the location of the nearest downwind residence in July 1980 (Station No. NR-7). Refer to Drawing No. MTW-4781, Appendix "F" for location of each environmental air sampling station.

Each low volume (No. 6, 8, 9, 10, 11, 12, and 13) sampler is changed weekly and analyzed for uranium and fluoride content. Results are reported as uCi/cc uranium and ug/m^3 fluoride. Additionally, a quarterly composite of the 13 weekly samples is sent to a vendor analytical laboratory for Ra^{226} and Th^{230} analysis. Weekly samples obtained at the nearest resident (NR-7) sample station are analyzed for uranium (uCi/cc), and the activity median aerodynamic diameter (AMAD) of the aerosol distribution. In addition, quarterly composites of the weekly samples are analyzed by a vendor laboratory for Ra^{226} and Th^{230}.

Quarterly simulated lung fluid solubility tests are also run to determine the simulated biological half-life of uranium collected during the quarter. Simulated lung fluid solubility tests have been attempted to determine the solubility of Th^{230} collected in the quarterly composites. This procedure was not feasible because the concentration of the Th^{230} in the test solutions was below the minimum detection level of the vendor laboratory; thus, a solubility curve could not be constructed to determine the biological half-life of Th^{230}. The "site specific" data collected from Station NR-7 is used to calculate compliance with 40CFR190 requirements.

The concentrations of uranium found in environmental air samples during the three most recent operating years are shown in Tables 5.5.6.1(A), 5.5.6.1(B), and 5.5.6.1(C) on Page 5-28, through Page 5-30. The maximum annual concentration at the restricted area fence line during the three-year period was $3.4E^{-14}$ uCi/cc of uranium during 1980. This represents less than 1% of the 10CFR20, Table II limit of $5E^{-12}$ uCi/ml for natural uranium. The maximum concentration measured near the site boundary (No. 8 and No. 11), but within the site, and under Allied Chemical control, was only 0.6% of the unrestricted or public concentration limit. The average annual concentration of uranium at the nearest residence during 1981, the only full year of operation of this sample station (NR-7), was 1.6 E^{-14} uCi/cc of uranium or about 0.3% of the public concentration limit.

The quarterly composite concentrations of Ra^{226} and Th^{230} are shown in Table 5.5.6.1(D), Page 5-31. It should be noted that fence line samples were not analyzed for Ra^{226} and Th^{230} prior to the second quarter of 1980; however, analyses are available during the three year period near the boundary line (Stations No. 8 and 11). The maximum annual average concentration at the restricted area fence line was $2.2E^{-16}$ uCi/cc for Ra^{226}, and 3.9 E^{-15} uCi/cc for Th^{230} during 1981. These values represent 0.01% and 1.3% of the 10CFR20 release limits of $2E^{-12}$ uCi/ml and $3E^{-13}$ uCi/ml respectively. The maximum annual value for Ra^{226} near the site boundary was 0.006% of the public limit during 1980, and 1.0% of the Th^{230} limit during 1979. Actual measurements taken at the nearest residence during 1981 indicate significantly lower concentrations of Ra^{226} and Th^{230} than those measured near the site boundary. This is attributed to improved analytical sensitivity gained by sampling at 40 CFM at Station NR-7 versus 2 CFM with the low volume samplers. Actual measurements at the nearest residence during 1981 indicates 0.002% of the public concentration limit for Ra^{226}, and 0.2% of the limit for Th^{230}.

The analytical data collected at the nearest residence sampling station (NR-7) is shown in Table 5.5.6.1(E), Page 5-33. This "site specific" data is used to calculate the nearest resident radiation dose in conjunction with dose conversion factors provided from The Battelle Pacific Northwest Laboratories DACRIN computer code. The dose factors vary by particle size and solubility, in accordance with the task group on lung dynamics model. Dose factors used in performing quarterly dose calculations are shown in Table 5.5.6.1(F), Page 5-34.

The nearest residents are adults, they do not consume vegetables from a home garden, nor do they pasture beef or dairy cattle. The nearest beef cattle pastureland is approximately 1½ miles NE of the plant and is grazed during the growing season. The nearest dairy cattle are grazed approximately 8 miles east of the plant. For dose calculation purposes, 100% occupancy is assumed for the nearest resident. Radium^{226} is taken to be class "W" solubility in accordance with ICRP-30, Part 1. Thorium^{230} is assumed to be class "Y" due to insufficient analytical sensitivity to demonstrate otherwise, and in accordance with recommendations of ICRP-30, Part 1, for Thorium oxides.

The quarterly dose to the nearest resident is derived by combining air concentration and solubility from Table 5.5.6.1(E) with dose factors (Table 5.5.6.1(F) as follows:

dose (mrem/qtr.) = Air Concentration uCi/cc (Note 1) X Annual Breathing Rate (Note 2) X

Solubility Fraction (Note 3) X Dose Conversion Factor (Note 4) X

1000 (mrem/Rem) X 0.25 (¼ of year)

Note (1) - Natural uranium concentration is factored by isotopic composition:

U^{234} - 0.48877
U^{238} - 0.48877
U^{235} - 0.02245

Note (2) - The annual breathing rate is taken to be 8.32 E^9 cc, based upon 16 hours non-occupational @ 9600 L/8 hrs. and 8 hrs. resting @ 3600 L/8 hrs

Note (3) - The solubility fraction found from simulated lung fluid testing, "D", "W", or "Y".

Note (4) - The dose factor is adjusted by the biological half-life actually found in the solubility test, divided by the half-life used in the task group model for calculating dose. This factor may significantly change the calculated dose for "W" or "Y" class materials, but does not appear significant for "D" class plant materials which are rapidly excreted from the body, the majority with a half-life of less than the 0.5 days used in the model.

An example calculation is performed as follows to determine the lung dose during the first quarter of 1981 for U^{238}, Class "Y":

$$(2.22\ E^{-14}\ \mathrm{uCi/cc} \times 0.48877) \times 8.32\ E^{9}\ \mathrm{cc} \times 0.497 \times \left(187 \times \frac{250}{500}\right) \times 1000 \times 0.25 = 1.05\ \text{mrem to lung from Class "Y"}\ U^{238}.$$

Repetitive calculations are thus performed for each significant isotope according to the particle size and solubility. The resulting quarterly and annual dose is shown in Table 5.5.6.1(G) Page 5-35. The lung and bone are the critical organs of interest for the inhalation pathway. The maximum annual dose calculated for the lung is 6.3 mrem during 1981. Greater than 95% of the lung dose results from insoluble "W" and "Y" class U^{234} and U^{238}, plus insoluble ("Y" Class) Th^{230}. The bone dose for 1981 is calculated to be 6.3 mrem. Approximately 90% of the bone dose results from soluble ("D" Class) U^{234} and U^{238}, plus (Class "Y") Th^{230}. The internal dose was also calculated for total body, kidney and LLI. These doses are significantly less than the lung or bone dose and are not considered significant.

It should be noted that the calculated dose is a 50-year dose commitment, while the dose limits recommended by the Environmental Protection Agency (40 CFR 190) are based on the actual maximum annual doses resulting from emissions during the operating time of the plant. Thus, assuming an additional 30 years of plant operations, the internal dose from inhalation would be approximately 3/5 of the 50-year dose commitment or about 3.8 mrem to the lung and bone.

Environmental air sample results for fluoride (ug/m^3) are presented in Tables 5.5.6.1(H)(I) and (J), Pages 5-36, thru 5-38. During the most recent three years of plant operation the average concentration at the fence line was 0.16 ugF$^-$/m^3. The maximum annual concentration near the site boundary was 0.10 ug/m^3 during 1980 at Station No. 11. The State of Illinois does not have an ambient air quality standard for fluoride; however, the State of Kentucky, which joins the plant property on the south, has established a standard (401 KAR3:020) which limits ambient concentrations of fluoride in air to a maximum monthly average of 1 PPB (part per billion) as HF. This monthly limit of 1 PPB as HF is the equivalent of 0.76 ug F$^-$/m^3. An examination of the monthly air monitoring results indicates the 0.76 ug/m^3 standard was not exceeded during any month, at any of the seven sampling stations. The maximum monthly concentration found near the site boundary (Station No. 8 and 11) during the three year period occurred during March 1980 and was less than 50% of the limit. The maximum off-site (Station No. 6) concentration was 0.036 ug/m^3 or about 5% of the standard during January, 1981. This concentration compares favorably with current literature which indicates background fluoride concentrations in rural areas free of industrial contamination is usually below detectable levels; however, the highest fluoride concentration detected in a non urban area by the National Air Pollution Control Administration was 0.16 ug/m^3, and some urban areas were as high as 1.89 ug F$^-$/m^3.

TABLE 5.5.6.1(A)

ENVIRONMENTAL AIR MONITORING

URANIUM (uCi/cc)

1979

Sampling Station No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Ave.
9	1.5E-14	1.1E-14	2.4E-14	3.0E-14	2.1E-14	5.1E-14	1.1E-14	1.4E-14	4.9E-15	1.6E-14	2.3E-14	1.5E-13	3.1E-1
10	2.6E-14	3.1E-14	2.0E-14	4.4E-14	1.7E-14	2.4E-14	8.6E-14	2.5E-14	7.5E-14	2.3E-14	1.8E-14	1.1E-14	3.3E-1
12	4.4E-14	3.4E-14	1.7E-14	3.1E-15	4.9E-14	1.8E-14	1.1E-14	8.8E-15	2.9E-14	2.9E-14	2.4E-14	4.0E-14	3.5E-1
13	8.1E-15	1.9E-14	1.9E-14	2.3E-14	4.2E-14	4.0E-14	1.9E-14	5.8E-14	1.1E-14	4.6E-14	5.0E-14	3.8E-14	3.1E-1
Average	2.3E-14	2.4E-14	2.0E-14	2.5E-14	3.2E-14	3.3E-14	3.2E-14	2.7E-14	3.0E-14	2.9E-14	2.9E-14	6.0E-14	
6	1.2E-15	1.1E-15	1.1E-15	1.9E-15	8.3E-16	3.6E-15	1.7E-15	2.7E-15	1.3E-15	5.2E-15	2.8E-15	2.8E-15	2.2E-1
8	1.0E-14	9.9E-14	9.5E-15	2.2E-14	3.0E-14	2.1E-14	1.1E-14	3.1E-14	5.9E-15	2.7E-14	2.4E-14	2.1E-14	2.6E-1
11	1.7E-15	7.9E-14	2.8E-14	2.6E-14	1.3E-14	4.2E-14	1.7E-14	2.3E-14	1.4E-14	3.2E-14	2.2E-14	4.4E-14	2.8E-1

Sampling Locations:

No. 6 5300 Ft.NNE (Metropolis Airport)
No. 8 1035 Ft. NE of UF_6 Building
No. 9 775 Ft.NNW of UF_6 Building
No. 10 720 Ft. SW of UF_6 Building
No. 11 1240 Ft. N. of UF_6 Building
No. 12 590 Ft. SSE of UF_6 Building
No. 13 755 Ft. NE of UF_6 Building

Stations No. 9, 10, 12 and 13 are located on restricted area fence line.
No. 8 and 11 are located on-site near nearest property boundary
No. 6 is located off-site

TABLE 5.6.1(B)

ENVIRONMENTAL AIR MONITORING

URANIUM(uCi/cc)

1980

Sampling Station No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Ave.
9	2.2E-414	1.1E-14	2.0E-14	1.2E-14	7.6E-15	1.9E-14	1.5E-14	1.3E-14	1.2E-14	4.3E-14	4.9E-15	5.0E-15	1.5E-14
10	5.9E-14	2.4E-14	2.4E-14	4.1E-14	5.0E-14	5.3E-14	3.4E-14	2.9E-14	6.3E-14	3.4E-14	5.5E-14	1.5E-14	4.0E-14
12	3.4E-14	6.7E-14	5.0E-14	3.3E-14	3.2E-14	3.2E-14	2.2E-14	4.1E-14	3.8E-14	5.7E-14	2.6E-14	3.6E-14	3.7E-14
13	1.2E-14	2.0E-14	2.2E-14	3.7E-14	3.1E-14	7.1E-14	5.0E-14	8.1E-14	5.0E-14	7.1E-14	3.6E-14	5.2E-14	4.4E-14
Average	3.2E-14	3.1E-14	2.9E-14	3.1E-14	3.0E-14	4.4E-14	3.0E-14	4.1E-14	4.1E-14	5.1E-14	3.0E-14	2.7E-14	
6	1.8E-15	1.8E-15	2.0E-15	1.8E-15	2.9E-15	7.0E-15	7.2E-15	4.6E-15	3.4E-15	4.1E-15	1.8E-15	3.0E-15	3.5E-15
8	1.3E-15	4.9E-15	1.0E-14	2.1E-14	1.4E-14	4.1E-14	2.5E-14	3.9E-14	2.6E-14	4.2E-14	1.6E-15	3.2E-14	2.1E-14
11	1.4E-14	1.3E-14	7.0E-14	2.4E-14	2.6E-14	4.5E-14	3.8E-14	2.6E-14	2.5E-14	3.7E-14	1.0E-14	2.8E-14	2.9E-14

Sampling Locations:

No. 6 5300 Ft. NNE (Metropolis Airport)
No. 8 1035 Ft. NE of UF_6 Building
No. 9 775 Ft. NNW of UF_6 Building
No. 10 720 Ft. SW of UF_6 Building
No. 11 1240 Ft. N of UF_6 Building
No. 12 590 Ft. SSE of UF_6 Building
No. 13 755 Ft. NE of UF_6 Building

Stations No. 9, 10, 12 and 13 are located on restricted area fence line
No. 8 and 11 are located on-site near nearest property boundary
No. 6 is located off-site

TABLE 5.5.6.1(C)

ENVIRONMENTAL AIR MONITORING

URANIUM (uCi/cc)

1981

Sampling Station No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Ave.
9	6.0E-15	2.0E-14	4.9E-15	3.7E-15	1.4E-14	9.6E-15	5.1E-15	2.5E-15	8.0E-15	2.1E-14	1.4E-14	1.0E-14	1.0E-14
10	8.1E-15	2.4E-14	1.4E-14	5.8E-14	2.7E-14	1.2E-14	1.2E-14	2.9E-14	3.3E-14	4.9E-14	2.0E-14	1.9E-14	2.5E-14
12	5.2E-14	3.7E-14	5.3E-14	1.9E-14	2.3E-14	1.2E-14	1.9E-14	5.6E-15	1.8E-14	4.1E-14	1.3E-14	2.4E-14	2.6E-14
13	5.1E-14	4.9E-14	5.0E-14	8.9E-14	1.6E-14	4.6E-14	2.2E-14	2.3E-14	9.4E-15	2.4E-14	1.3E-14	1.5E-14	3.4E-14
Average	2.9E-14	3.1E-14	3.0E-14	4.4E-14	2.0E-14	2.0E-14	1.5E-14	1.5E-14	1.7E-14	3.4E-14	1.5E-14	1.7E-14	
6	2.6E-15	1.2E-15	6.6E-15	5.3E-15	1.3E-15	3.8E-15	1.4E-15	9.4E-16	1.5E-15	2.5E-15	1.7E-15	7.7E-16	2.5E-15
8	1.7E-14	1.9E-14	1.8E-14	4.0E-14	7.3E-15	2.2E-14	7.3E-15	3.6E-15	7.4E-15	8.9E-15	5.3E-15	7.1E-15	1.4E-14
11	1.0E-14	2.7E-14	1.0E-14	4.4E-14	1.2E-14	2.2E-14	7.5E-15	6.5E-15	1.1E-14	2.2E-14	1.2E-14	9.8E-15	1.6E-14

Sampling Locations:

No. 6	5300 Ft.	NNE (Metropolis Airport)
No. 8	1035 Ft.	NE of UF_6 Building
No. 9	775 Ft.	NNW of UF_6 Building
No. 10	720 Ft.	SW of UF_6 Building
No. 11	1240 Ft.	N of UF_6 Building
No. 12	590 Ft.	SSE of UF_6 Building
No. 13	755 Ft.	NE of UF_6 Building

Stations No. 9, 10, 12 and 13 are located on restricted area fence line
No. 8 and 11 are located on-site nearest property boundary
No. 6 is located off-site

TABLE .6.1(D)

ENVIRONMENTAL AIR MONITORING

Ra^{226} and Th^{230} (uCi/cc)

YEAR	SAMPLE STATION NO.	1st QUARTER Ra^{226}	1st QUARTER Th^{230}	2nd QUARTER Ra^{226}	2nd QUARTER Th^{230}	3rd QUARTER Ra^{226}	3rd QUARTER Th^{230}	4th QUARTER Ra^{226}	4th QUARTER Th^{230}	ANNUAL AVERAGE Ra^{226}	ANNUAL AVERAGE Th^{230}
1979	6	8.2E-18	4.0E-17	< 4.15E-17	2.88E-16	< 4.2E-17	3.5E-16	9.11E-17	4.4E-16	4.6E-17	2.8E-16
	8	4.7E-17	3.3E-15	4.13E-17	5.02E-15	7.4E-17	1.1E-15	8.12E-17	2.9E-15	6.1E-17	3.1E-15
	11	1.5E-17	2.3E-15	6.2E-17	2.00E-15	< 4.8E-17	6.7E-16	1.36E-16	1.7E-15	6.5E-17	1.7E-15
1980	9			1.9E-16	< 3.4E-16	1.0E-16	9.1E-16	7.9E-17	8.5E-16	9.9E-17	7.0E-16
	10	Note (1)		2.94E-16	3.6E-15	8.2E-17	6.8E-15	2.0E-16	4.2E-15	1.9E-16	4.9E-15
	12			1.86E-16	2.0E-15	2.8E-16	4.8E-15	2.8E-16	4.2E-15	2.5E-16	3.7E-15
	13			2.51E-16	1.6E-15	1.7E-16	4.7E-15	2.0E-16	4.9E-15	2.1E-16	3.7E-15
	6	< 2.49E-17	< 1.46E-16	< 2.6E-17	< 5.6E-16	4.7E-17	2.2E-16	1.0E-16	3.6E-16	4.9E-17	3.2E-16
	8	5.83E-17	8.45E-16	1.24E-16	< 3.5E-16	3.5E-17	5.5E-15	1.7E-16	2.3E-15	9.7E-17	2.2E-15
	11	8.14E-17	1.53E-16	1.81E-16	1.1E-15	6.5E-17	1.3E-15	1.4E-16	1.1E-15	1.2E-16	9.1E-16
1981	9	7.4E-17	< 4.5E-16	1.1E-16	1.2E-15	5.3E-17	< 1.8E-16	5.6E-17	5.2E-16	7.3E-17	5.9E-16
	10	1.1E-16	1.6E-15	4.8E-16	9.7E-15	5.2E-16	1.0E-14	7.7E-16	6.9E-16	4.7E-16	5.5E-15
	12	3.1E-16	4.7E-15	1.8E-16	1.7E-15	4.8E-17	1.2E-15	9.0E-17	1.9E-16	1.6E-16	7.8E-15
	13	2.1E-16	2.2E-15	2.7E-16	4.2E-15	8.1E-17	< 4.3E-16	6.5E-17	< 5.7E-16	1.6E-16	1.9E-15
	6	7.6E-17	8.1E-16	1.2E-16	< 2.8E-16	7.8E-17	< 2.9E-16	Sample Lost		9.1E-17	4.6E-16
	8	1.0E-16	1.8E-15	1.8E-16	6.8E-16	5.7E-17	4.8E-16	9.4E-17	< 3.9E-16	1.0E-16	8.4E-16
	11	3.0E-17	< 3.8E-16	9.4E-17	1.1E-15	< 3.8E-17	4.4E-16	6.6E-17	8.8E-16	5.7E-17	7.0E-16

Table 5.5.6.i(D) (continued)

Sampling Locations:
No. 6 5300 Ft. NNE (Metropolis Airport)
No. 8 1035 Ft. NE of UF_6 Building
No. 9 775 Ft. NNW of UF_6 Building
No. 10 720 Ft. SW of UF_6 Building
No. 11 1240 Ft. N of UF_6 Building
No. 12 590 Ft. SSE of UF_6 Building
No. 13 755 Ft. NE of UF_6 Building

Note (1):

No's. 9, 10, 12 and 13 not analyzed for Ra and Th prior to second quarter 1980.

Station No. 9, 10, 12, and 13 are located on restricted area fence line

No. 8 and 11 are located on-site near nearest property boundary

No. 6 is located off-site

TABL[illegible]5.6.1(E)

NEAREST RESIDENT (NR-7)(1) AIR SAMPLING DATA

SAMPLING PERIOD		CONCENTRATION				SOLUBILITY(2)					
						D		W		Y	
Year	Quarter	Ra^{226} uci/cc	Th^{230} uci/cc	Uranium uci/cc	Particle Size AMAD	T½	%	T½	%	T½	%
1980 (1)	3	2.4E-17	3.3E-16	1.98E-14	2.6	< .06D 0.80D	35.0 20.0	59.5D	45.0		
	4	3.7E-17	4.8E-16	2.15E-14	4.2	< .08D 1.8 D	35.0 21.5	72.0D	43.5		
1981	1	5.6E-17	1.2E-15	2.2E-14	4.6	< .08D 1.9 D	25.0 25.3			250D	49.7
	2	4.1E-17	6.7E-16	2.72E-14	3.3	< .08D 1.4 D	36.4 21.4			165D	42.2
	3	3.0E-17	3.5E-16	8.11E-15	3.9	< .08D 1.9 D	26.6 21.6			120D	51.8
	4	3.4E-17	1.9E-16	8.16E-15	3.2	< .08D 2.4 D	31.7 21.3	80.6D	47.0		

(1) Sampling Station established July 1, 1980, located 1380' NE of Feed Materials Building.

(2) Biological half-life (T½) expressed in days (D) from simulated lung fluid solubility test.

TABLE 5.5.6.1(F)

50-YEAR-DOSE COMMITMENT FACTORS

BATTELLE PACIFIC NORTHWEST LABORATORIES - DACRIN COMPUTER CODE

rem/uci INHALED

Ref. Organ	Quarter	Year	Part.Size AMAD um	Element:	Ra	Th	U			U			U		
				Isotope:	226	230	234	234	234	235	235	235	238	238	238
				Solubil.Class:	W	Y	D	W	Y	D	W	Y	D	W	Y
Lung	3rd	1980	2.6		67.0	289	0.48	29.5	-	0.46	28.0	-	0.43	26.0	-
	4th	1980	4.2		51.7	229	0.38	23.0	-	0.36	21.5	-	0.33	20.5	-
	1st	1981	4.6		49.5	216	0.36	-	218	0.34	-	210	0.31	-	187
	2nd	1981	3.3		58.7	254	0.42	-	260	0.41	-	240	0.38	-	222
	3rd	1981	3.9		53.8	232	0.39	-	230	0.38	-	223	0.34	-	212
	4th	1981	3.2		60.0	260	0.43	27.0	-	0.41	25.0	-	0.38	23.8	-
Bone	3rd	1980	2.6		330	625	44.0	11.5	-	42.0	10.5	-	40.0	10.7	-
	4th	1980	4.2		370	535	46.0	12.0	-	44.9	11.2	-	43.0	11.0	-
	1st	1981	4.6		380	520	47.0	-	3.2	45.0	-	3.1	43.5	-	3.0
	2nd	1981	3.3		355	580	46.0	-	3.4	43.5	-	3.3	42.0	-	3.1
	3rd	1981	3.9		365	550	47.0	-	3.3	44.5	-	3.2	43.0	-	3.0
	4th	1981	3.2		305	580	45.5	12.0	-	43.5	10.9	-	41.5	11.0	-

TABLE 5.6.1(G)

NEAREST RESIDENCE CRITICAL ORGAN INHALATION DOSE

1980 and 1981

Sampling Period	Lung (mrem)	Bone (mrem)
3rd Quarter 1980	0.82	1.6
4th Quarter 1980	0.85	2.0
1980 ½ Year Total	1.7	3.6
1st Quarter 1981	2.9	2.4
2nd Quarter 1981	2.3	2.3
3rd Quarter 1981	0.64	0.80
4th Quarter 1981	0.44	0.79
1981 Total	6.3	6.3

TABLE .5.6.1(H)

ENVIRONMENTAL AIR MONITORING

FLUORIDE (ug/m3)

1979

Sampling Station No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
9	0.093	0.035	0.078	0.121	0.115	0.277	0.048	0.042	0.006	0.073	0.126	0.170	0.099
10	0.566	0.228	0.251	0.485	0.282	0.109	0.329	0.171	0.549	0.169	0.162	0.145	0.287
12	0.462	0.194	0.257	0.113	0.258	0.048	0.028	0.017	0.090	0.213	0.082	0.265	0.169
13	0.117	0.043	0.136	0.427	0.122	0.082	0.088	0.089	0.042	0.210	0.133	0.226	0.146
Average	0.310	0.125	0.181	0.287	0.194	0.129	0.123	0.080	0.172	0.166	0.126	0.202	0.175
6	0.021	0.013	0.010	0.006	0.007	0.007	0.004	-0.001	-0.001	0.016	0.034	0.015	0.008
8	0.060	0.027	0.066	0.075	0.072	0.038	0.024	0.023	0.009	0.092	0.061	0.084	0.053
11	0.061	0.048	0.061	0.066	0.038	0.096	0.026	0.032	0.025	0.094	0.077	0.275	0.075

Sampling Locations:

No. 6	5300 Ft.	NNE (Metropolis Airport)
No. 8	1035 Ft.	NE of UF_6 Building
No. 9	775 Ft.	NNW of UF_6 Building
No. 10	720 Ft.	SW of UF_6 Building
No. 11	1240 Ft.	N of UF_6 Building
No. 12	590 Ft.	SSE of UF_6 Building
No. 13	755 Ft.	NE of UF_6 Building

Stations No. 9, 10, 12 and 13 are located on restricted area fence line

No. 8 and 11 are located on-site near nearest property boundary

No. 6 is located off-site

TABLE 5.5.6.1(I)

ENVIRONMENTAL AIR MONITORING

FLUORIDE (ug/m^3)

1980

Sampling Station No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
9	0.093	0.136	0.139	0.111	0.043	0.086	0.043	0.113	0.022	0.154	0.049	0.048	0.086
10	0.646	0.269	0.269	0.372	0.221	0.167	0.136	0.753	0.749	0.179	0.190	0.265	0.386
12	0.107	0.352	0.265	0.185	0.078	0.125	0.074	0.187	0.069	0.214	0.100	0.196	0.163
13	0.076	0.100	0.148	0.266	0.132	0.168	0.055	0.249	0.067	0.185	0.128	0.169	0.145
Average	0.231	0.214	0.205	0.234	0.119	0.137	0.077	0.331	0.227	0.183	0.117	0.170	0.195
6	0.005	0.012	0.003	0.006	0.010	0.027	0.010	0.027	0.006	0.013	0.016	0.022	0.013
8	0.028	0.045	0.046	0.073	0.052	0.074	0.024	0.104	0.034	0.092	0.084	0.108	0.064
11	0.077	0.099	0.366	0.128	0.101	0.098	0.032	0.107	0.042	0.081	0.037	0.074	0.104

Sampling Locations:

No. 6 5300 Ft. NNE (Metropolis Airport)
No. 8 1035 Ft. NE of UF_6 Building
No. 9 775 Ft. NNW of UF_6 Building
No. 10 720 Ft. SW of UF_6 Building
No. 11 1240 Ft. N of UF_6 Building
No. 12 590 Ft. SSE of UF_6 Building
No. 13 755 Ft. NE of UF_6 Building

Stations No. 9, 10, 12, and 13 are located on restricted area fence line

No. 8, and 11 are located on-site near nearest property boundary

No. 6 is located off-site

TABLE 5.6.1(J)

ENVIRONMENTAL AIR MONITORING

FLUORIDE (ug/m3)

1981

Sampling Station No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
9	0.058	0.098	0.033	0.084	0.030	0.063	0.019	0.017	0.017	0.032	0.115	0.038	0.050
10	0.221	0.203	0.222	0.266	0.170	0.088	0.041	0.193	0.085	0.130	0.081	0.083	0.149
12	0.234	0.114	0.333	0.068	0.070	0.053	0.045	0.017	0.031	0.049	0.051	0.117	0.099
13	0.693	0.343	0.192	0.181	0.079	0.127	0.038	0.043	0.022	0.047	0.089	0.064	0.160
Average	0.302	0.190	0.195	0.150	0.090	0.083	0.143	0.068	0.039	0.065	0.084	0.076	0.115
6	0.036	0.013	0.019	0.015	0.006	0.010	0.006	0.004	0.005	0.008	0.008	0.006	0.011
8	0.159	0.091	0.064	0.067	0.023	0.049	0.016	0.017	0.018	0.021	0.029	0.041	0.050
11	0.074	0.040	0.027	0.101	0.024	0.054	0.014	0.011	0.016	0.036	0.033	0.050	0.040

Sampling Locations:

No. 6	5300 Ft.	NNE (Metropolis Airport
No. 8	1035 Ft.	NE of UF_6 Building
No. 9	775 Ft.	NNW of UF_6 Building
No. 10	720 Ft.	SW of UF_6 Building
No. 11	1240 Ft.	N of UF_6 Building
No. 12	590 Ft.	SSE of UF_6 Building
No. 13	755 Ft.	NE of UF_6 Building

Stations No. 9, 10, 12 and 13 are located on restricted area fence line

No. 8 and 11 are located on-site near nearest property boundary

No. 6 is located off-site

5.5.6.2 Liquid Effluent Survey Program

Wastewater treatment, deposition, and sampling methods are discussed in Chapter 4, "Effluent Control and Waste Management Systems", additional water information is provided in Chapter 2 under "Hydrology". Compliance with applicable effluent release limits and water quality criteria is determined by sampling the plant effluent discharge and the Ohio River which is the receiving stream for plant effluents.

As indicated in Paragraph 4.2, Page 4-10, the main plant effluent is continuously sampled and a daily composite is analyzed for uranium content. The daily samples are composited into a monthly composite sample which is analyzed for uranium, gross alpha, gross beta, and several non-radiological constituents. Quarterly composites of the monthly samples are analyzed by a vendor laboratory for Ra^{226} and Th^{230}. Additionally, NPDES permit compliance is determined by six (6) weekly grab samples for pH, and twice weekly analysis of 24-hour composite samples for fluoride, suspended and dissolved solids.

Environmental water and mud samples are taken semi-annually from four locations on the Ohio River, and at three area lakes and ponds. Refer to Figure 5.5.6.2, Page 5-42 for location of surface water sampling stations. These samples are analyzed for uranium and fluoride content.

Table 5.5.6.2(A),(B), and (C), Pages 5-43, 5-44 , and 5-45 provide the radioactivity concentrations found in plant effluent water during the last three years of plant operation. The maximum annual gross alpha activity occurred in 1979 and was 300 pCi/liter. This represents about 1% of the 30,000 pCi/L limit at the point of discharge from the restricted area. The maximum annual beta concentration was 320 pCi/L in 1979. Experience indicates the majority of the beta activity results from the presence of Th^{234} in the effluent. Assuming all beta activity was from Th^{234}, the maximum concentration found represents only 1.6% of the release limit. The maximum monthly uranium concentration and maximum annual average uranium concentrations were 1.2 PPM and 0.74 PPM. These values represent 2.7% and 1.7% of the limits respectively for natural uranium. This concentration of activity may be considered "absent" in the effluent in accordance with footnote (5) of 10CFR20, Table II. Soluble Radium^{226} has the most restrictive limit ($3E^{-8}$ uCi/ml of the isotopes appearing in the plant effluent. The maximum individual quarterly value found for soluble Ra^{226} was only 3.7% of the release limit during the first quarter of 1979.

The concentrations of non-radiological contaminants discharged in the plant effluent are shown in Tables 5.5.6.2(D) through (F) on Pages 5-46 through 5-48. None of the contaminants measured exceeded recognized waste water quality standards, and fluoride, the principle contaminant of concern in the effluent, is within the State of Illinois recommended discharge limit of 15 mg/L. The maximum monthly fluoride value was 7.6 mg/L in March of 1979; however, the NPDES permit requires compliance based upon twice weekly sampling for F^-, suspended and dissolved solids, and six grab samples for pH. Using NPDES sampling criteria rather than monthly averages; there were no excursions of the permit in 1981; five pH excursions during 1980 with the maximum time being 80 minutes and the minimum excursion time 25 minutes; during 1979 there were five excursions, one for pH alone, one involving pH and suspended solids, and one for suspended solids alone. There were two fluoride excursions of 24-hours each of 15.5 ppm F^- and 18.9 ppm F^- respectively. These brief excursions of the permit limits, at the point of discharge, would not be expected to produce any environmental impact on the Ohio River.

The average discharge rate for the plant effluent during the three-year period was 4.1 million gallons per day (MGD) or about 6.3 cubic feet per second (CFS). The effluent discharges into a natural drainage course, which also carries run-off during periods of heavy precipitation. The effluent travels about 2000 feet across Allied property before it enters the Ohio River. The quantity of effluent discharged into the river (6.3 CFS) is insignificant compared to the average flow of the Ohio River of 265,000 CFS. Moreover, this discharge would comprise only 0.03% of the river's lowest flow on record (15,000 CFS). Under these conditions, the contaminants discharged would not be detectable after mixing with the river and should have no significant environmental impact.

Environmental water samples collected from the Ohio River confirm that the plant is not contributing significant fluoride or uranium to the ambient river concentration Refer to the Tables 5.5.6.2(G) and (H), Page 5-49 and 5-50. During the last three years of plant operation the ambient river concentration of uranium and fluoride upstream of the plant discharge averaged 0.22 PPM F^- and 0.036 PPM uranium. Downstream concentrations at Joppa, Illinois averaged 0.23 PPM F^- and 0.024 PPM uranium. Joppa is the nearest downstream municipality which could, but does not, use river water for drinking purposes. The State of Kentucky, which owns the Ohio River, limits fluoride in drinking water (401 KAR 5:025), at the point of withdrawal, to 1 PPM F^-. The EPA drinking water standard excludes natural uranium from the prescribed limits; however, the established limit for Ra^{226} is 5 pCi/L. The three-year average concentration of soluble Ra^{226} in the plant effluent, before dilution by the large Ohio River Volume, is 0.7 pCi/L. Thus the calculated dose to any downstream consumer would be significantly below established standards.

Analysis of mud samples (bottom sediment) for uranium and fluoride indicate there is some deposition of both uranium and fluoride in river sediment at the point of effluent discharge into the river. With the exception of a likely contaminated sample in the spring of 1979, the uranium concentrations upstream (Dam 52) and downstream (Joppa, IL) of the plant discharge do not differ significantly. Fluoride concentrations in sediment are generally higher downstream compared to upstream. There are no established standards for uranium or fluoride in stream sediments; however, the offsite concentrations fall within the concentration range of many naturally occurring materials e.g.: Florida phosphate rock contains up to 200 PPM U, and some United States soils contain up to 300 PPM F^- to plow depth (6").

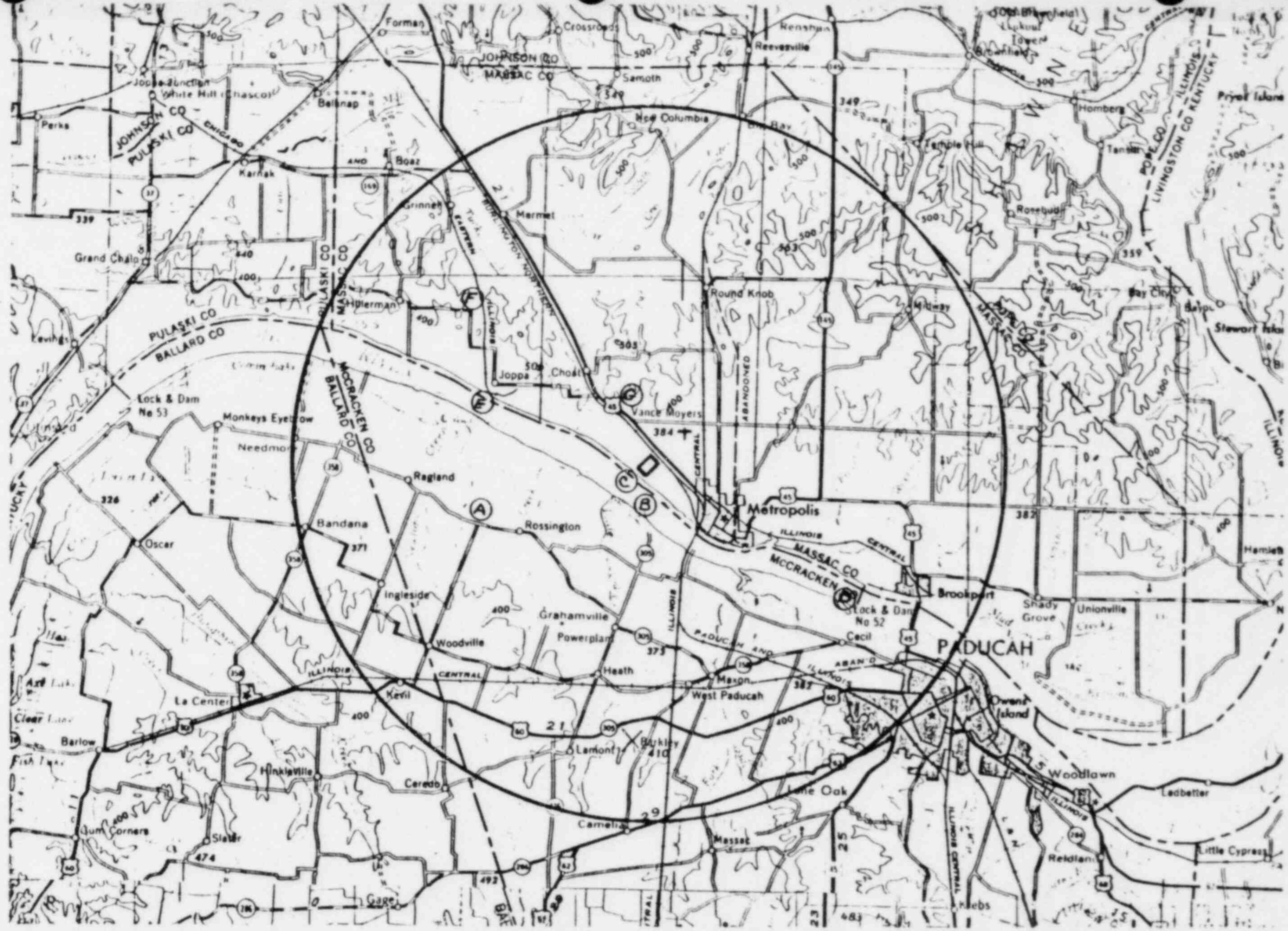

Figure 5.5.6.2 A-G Off-site surface water and mud samples.

SURFACE WATER SAMPLING STATIONS

TABLE 5.5.6.2(A)

RADIOACTIVITY IN PLANT LIQUID EFFLUENT

1979

Month	Gross Alpha (pCi/ml)	Gross Beta (pCi/ml)	Total U-Nat.		Ra^{226} (uCi/ml)		Th^{230} (uCi/ml)	
			PPM	uCi/ml	Sol.	Insol.	Sol.	Insol.
January	.33	.37	.50	$3.4E^{-7}$				
February	.44	.44	.80	$5.4E^{-7}$				
March	.27	.28	1.1	$7.4E^{-7}$	$1.1E^{-9}$	$<7.2E^{-11}$	$1.0E^{-8}$	$7.7E^{-10}$
April	.45	.25	1.2	$8.1E^{-7}$				
May	.37	.42	1.0	$6.8E^{-7}$				
June	.21	.41	.60	$4.1E^{-7}$	$1.4E^{-10}$	$5.0E^{-10}$	$<1.7E^{-9}$	$1.9E^{-8}$
July	.33	.34	.60	$4.1E^{-7}$				
August	.46	.46	.80	$5.4E^{-7}$				
September	.23	.38	.60	$4.1E^{-7}$	$9.1E^{-10}$	$3.2E^{-10}$	$<4.1E^{-9}$	$<3.0E^{-9}$
October	.19	.16	.40	$2.7E^{-7}$				
November	.29	.32	.77	$5.2E^{-7}$				
December	.01	.03	.56	$3.8E^{-7}$	$7.3E^{-10}$	$3.4E^{-10}$	$8.5E^{-10}$	$1.2E^{-8}$
Annual Average	0.30	.32	0.74	$5.0E^{-7}$	$7.2E^{-10}$	$3.1E^{-10}$	$4.2E^{-9}$	$8.7E^{-9}$

TABLE 5.5.6.2(B)

RADIOACTIVITY IN PLANT LIQUID EFFLUENT

1980

Month	Gross Alpha (pCi/ml)	Gross Beta (pCi/ml)	Total U-Nat.		Ra^{226} (uCi/ml)		Th^{230} (uCi/ml)	
			PPM	uCi/ml	Sol.	Insol.	Sol.	Insol.
January	.15	.18	.46	$3.1E^{-7}$				
February	.18	.24	.65	$4.4E^{-7}$				
March	.20	.24	.61	$4.1E^{-7}$	$7.8E^{-10}$	$2.5E^{-10}$	$< 1.2E^{-9}$	$4.5E^{-9}$
April	.16	.21	.38	$2.6E^{-7}$				
May	.25	.19	.60	$4.1E^{-7}$				
June	.09	.22	.21	$1.4E^{-7}$	$6.1E^{-10}$	$2.2E^{-10}$	$< 2.7E^{-9}$	$1.4E^{-8}$
July	.11	.15	.38	$2.6E^{-7}$				
August	.48	.11	.40	$2.7E^{-7}$				
September	.23	.24	.48	$3.2E^{-7}$	$8.4E^{-10}$	$1.6E^{-10}$	$< 1.3E^{-9}$	$1.3E^{-8}$
October	.23	.25	.60	$4.1E^{-7}$				
November	.18	.17	.50	$3.4E^{-7}$				
December	.57	.08	.30	$2.0E^{-7}$	$6.0E^{-10}$	$2.7E^{-10}$	$< 1.4E^{-9}$	$1.6E^{-8}$
Annual Average	0.24	0.17	0.46	$3.1E^{-7}$	$7.1E^{-10}$	$2.2E^{-10}$	$< 1.7E^{-9}$	$1.2E^{-8}$

TABLE 5.5.6.2(C)

RADIOACTIVITY IN PLANT LIQUID EFFLUENT

1981

Month	Gross Alpha (pCi/ml)	Gross Beta (pCi/ml)	Total U-Nat.		Ra^{226} (uCi/ml)		Th^{230} (uCi /ml)	
			PPM	uCi/ml	Sol.	Insol.	Sol.	Insol.
January	.21	.22	.40	$2.7E^{-7}$				
February	.37	.38	.58	$3.9E^{-7}$				
March	.15	.19	.29	$1.9E^{-7}$	$6.8E^{-10}$	$< 1.5E^{-10}$	$< 1.9E^{-9}$	$6.6E^{-9}$
April	.16	.30	.35	$2.4E^{-7}$				
May	.18	.46	.40	$2.7E^{-7}$				
June	.19	.28	.37	$2.5E^{-7}$	$6.9E^{-10}$	$< 8.0E^{-11}$	$< 1.4E^{-9}$	$5.0E^{-9}$
July	.15	.25	.44	$3.0E^{-7}$				
August	.22	.25	.51	$3.5E^{-7}$				
September	.38	.34	1.0	$6.8E^{-7}$	$7.0E^{-10}$	$< 1.2E^{-10}$	$< 1.6E^{-9}$	$2.2E^{-9}$
October	.13	.21	.30	$2.0E^{-7}$				
November	.20	.23	.40	$2.7E^{-7}$				
December	.03	.16	.51	$3.5E^{-7}$	$7.1E^{-10}$	$1.8E^{-10}$	$< 8.2E^{-10}$	$2.3E^{-9}$
Annual Average	.20	0.27	0.46	$3.1E^{-7}$	$7.0E^{-10}$	$1.3E^{-10}$	$< 1.4E^{-9}$	$4.0E^{-9}$

TABLE 5.5.6.2(D)

NON-RADIOLOGICAL CONTAMINANTS IN PLANT LIQUID EFFLUENT

1979

Contaminant	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Chloride	42.1	47.0	48.4	47.8	27.9	32	35.5	29	29	38.8	40	39	38
Chromium (+6)	< 0.003	< 0.003	< 0.003	0.003	< 0.003	0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Chromium (+3)	0.006	< 0.01	< 0.01	0.007	< 0.01	0.01	0.014	0.027	0.027	0.014	0.029	0.017	0.015
Fluoride	4.9	5.0	7.6	5.8	5.8	6.8	5.8	6.8	6.8	4.6	5.0	3.8	5.7
Iron	0.18	0.17	0.08	0.096	0.19	0.44	0.14	0.20	0.28	0.12	0.18	0.1	0.18
Molybdenum	0.08	0.06	0.05	0.038	0.06	0.05	0.07	0.54	0.078	0.074	0.17	0.05	0.11
Nickel	0.01	0.01	0.02	0.016	0.02	0.02	0.013	0.016	0.014	0.14	0.01	0.014	0.015
pH (Average)	7.5	7.3	7.4	7.4	7.4	7.1	7.1	7.6	7.4	7.4	7.5	7.1	7.4
Phosphate	1.32	1.15	0.78	0.76	0.74	0.58	0.64	0.56	0.65	0.74	0.96	0.46	0.78
Solids (Total Dissolved)	986	885	565	832	843	737	839.2	753	755	813	841	643	791
Solids (Suspended)	1.4	8.6	0.9	4.0	6.6	3.1	2.2	1.0	< 0.1	1.0	1.0	< 0.1	2.5
Sulfate	427	73	293	357	282	315	400.6	353	369	325	383	232	317
Vanadium	0.01	0.01	0.02	< 0.02	0.02	< 0.03	0.02	0.20	0.066	0.19	0.77	0.03	0.12
Average Flow (Mgd)	3.49	3.76	3.58	3.88	3.55	3.55	3.59	3.68	3.75	3.50	3.59	3.61	3.63

TABLE 5.6.2(E)

NON-RADIOLOGICAL CONTAMINANTS IN PLANT LIQUID EFFLUENT

1980

Contaminant	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Chloride	38	45.6	46	59.3	54	26.3	31.4	39.2	26	32.8	28.8	34.3	38.5
Chromium (+6)	0.008	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.003	0.003	0.003	<0.003	<0.003
Chromium (+3)	<0.003	0.007	0.009	0.005	0.007	0.010	0.003	0.009	0.014	0.006	0.007	0.014	0.008
Fluoride	3.6	4.1	4.4	3.6	4.2	5.8	5.8	3.8	4.8	5.4	3.4	4.4	4.4
Iron	0.15	0.15	0.27	0.054	0.06	0.17	0.02	0.070	0.22	0.096	0.09	0.14	0.12
Molybdenum	0.024	0.048	0.046	0.042	<0.02	0.08	<0.02	0.026	0.048	0.16	0.11	0.21	0.070
Nickel	0.011	0.009	0.017	0.009	0.015	0.022	0.005	0.007	0.032	0.019	0.01	0.02	0.015
pH (Average)	7.1	7.3	7.1	7.2	7.4	7.6	7.3	7.3	7.3	7.5	7.3	7.2	7.3
Phosphate	0.40	0.052	0.066	0.04	0.21	0.90	0.04	0.35	0.094	0.62	0.38	0.89	0.34
Solids (Total Dissolved)	667	714	756	764	716	774	603	649	659	802	593	768	705
Solids (Suspended)	1.6	0.9	5.5	1.9	2.6	0.90	1.0	1.0	1.0	0.8	0.2	0.9	1.5
Sulfate	282	314	324	322	263	305	230	237	215	317	207	293	276
Vanadium	<0.02	<0.02	0.61	<0.02	0.06	0.048	<0.02	0.016	0.12	<0.02	0.03	0.09	0.09
Average Flow (Mg/d)	3.91	3.73	4.07	3.89	7.39	4.23	4.25	4.37	4.26	4.31	3.89	4.21	4.38

TABLE [illegible].6.2(F)

NON-RADIOLOGICAL CONTAMINANTS IN PLANT LIQUID EFFLUENT

1981

Contaminant	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Chloride	35.4	41.6	36.2	33.2	34	34.9	38.2	26.9	36.5	40.3	38.4	46.7	36.9
Chromium (+6)	0.003	<0.003	<0.003	<0.003	0.001	0.001	0.001	0.004	<0.001	<0.001	0.015	<0.002	0.003
Chromium (+3)	0.017	0.009	0.007	0.01	0.007	0.007	0.003	<0.001	0.004	0.007	0.004	0.025	0.008
Fluoride	3.9	5.3	3.4	6,2	6.0	6.1	5.0	5.0	4.2	3.8	4.8	4.0	4.8
Iron	0.058	0.17	0.21	0.17	0.214	0.14	0.036	0.06	0.06	0.25	0.038	0.13	0.13
Molybdenum	0.282	0.15	0.092	0.11	0.098	0.084	0.042	0.024	0.02	0.14	0.045	<0.13	0.10
Nickel	0.014	0.013	0.01	0.01	0.013	0.021	0.010	0.01	0.007	0.011	0.006	0.025	0.013
pH (Average)	7.3	7.2	7.2	7.2	7.4	7.4	7.5	7.6	7.4	7.5	7.4	7.3	7.4
Phosphate	1.00	1.12	0.74	0.88	0.83	0.87	0.43	0.018	0.152	0.53	0.20	0.65	0.62
Solids (Total Dissolved)	887	938	747	721	756	764	693	742	661	690	727	716	754
Solids (Suspended)	<0.1	<0.1	1.8	1.8	3.1	1.2	1.0	0.60	3.1	3.2	1.8	1.9	1.6
Sulfate	359	396	309	363	382	340	326	295	269	247	299	270	321
Vanadium	0.15	0.58	0.012	0.088	0.212	0.008	0.006	0.05	0.002	0.012	0.004	<0.31	0.11
Average Flow (Mg/d)	4.11	4.30	4.59	4.47	4.33	4.22	4.28	4.14	4.16	3.99	3.96	3.97	4.21

TABLE 5.5.6.2(G)

SEMI-ANNUAL ENVIRONMENTAL SURFACE WATER SAMPLES

URANIUM AND FLUORIDE (PPM)

Sample Station No.	Location	Spring 1979		Fall 1979		Spring 1980		Fall 1980		Spring 1981		Fall 1981	
		U	F^-	U	F^-	U	F^-	U	F^-	U	F^-	U	F^-
A	Lamb Farm	0.020	0.10	0.014	0.25	0.076	0.56	Lake Dry	Lake Dry	0.004	0.26(1)	0.014	<0.1
B	TVA (1)	0.013	0.68	0.008	0.21	0.008	<0.1	0.006	0.56	0.003	0.14	0.016	<0.1
C	Plant Site-outflow (2)	0.040	0.42	0.059	1.05	0.13	3.35	0.10	1.9	0.004	0.19	0.058	0.66
D	Brookport Dam (3)	0.016	<0.1	0.005	0.10	0.16	0.56	0.015	0.28	0.002	0.18	0.016	<0.1
E	Joppa Power Plant (4)	0.017	0.13	0.018	0.17	0.072	0.46	0.009	0.31	0.002	0.19	0.024	0.10
F	Lindsay Lake	0.006	0.11	0.005	0.17	0.064	0.40	0.009	0.28	0.001	0.20	0.020	<0.1
G	Oak Glenn Lake	0.025	0.46	0.016	3.5	0.001	<0.1	0.001	0.10	0.001	0.24	0.014	<0.1

(1) Ohio River opposite plant outflow

(2) Ohio River at plant outflow

(3) Ohio Eiver, 7 miles upstream, at Lock and Dam No. 52

(4) Ohio River, 5 miles downstream, at Joppa, Illinois

TABLE 5.5.6.2(H)

SEMI-ANNUAL MUD SAMPLES

URANIUM AND FLUORIDE (PPM)

Sample Station No.	Location	Spring 1979		Fall 1979		Spring 1980		Fall 1980		Spring 1981		Fall 1981	
		U	F^-	U	F^-	U	F^-	U	F^-	U	F^-	U	F^-
A	Lamb Farm	0.98	2.5	1.62	<2.5*	1.62	10.5	1.29	8.0	4.32	18.7	1.87	< 2.49
B	TVA (1)	0.86	14.5	2.84	< 2.5	0.71	27.5	1.08	16.0	2.50	32.5	1.00	37.3
C	Plant Site Outflow (2)	3.74	35.0	3.49	< 2.5	44.7	2599	24.21	4926	2.00	49.7	3.43	156.6
D	Brookport Dam (3)	0.75	45.0	4.62	2.5	1.37	32.5	1.21	37.3	0.75	21.1	1.15	19.0
E	Joppa Power Plant (4)	28.35	65.0	2.74	< 2.5	1.37	64.8	1.11	87.3	1.62	46.8	1.14	129.8
F	Lindsay Lake	1.49	3.0	1.09	< 2.5	1.50	< 2.5	1.97	14.2	1.36	5.85	1.15	< 2.5
G	Oak Glenn Lake	0.99	< 2.5	3.13	< 2.5	1.50	< 2.5	1.99	13.5	0.86	3.71	0.95	< 2.5

*Exceptionally heavy rainfall - 10" in November, 1979.

(1) Ohio River opposite plant outflow

(2) Ohio River at plant outflow

(3) Ohio River, 7 miles upstream, at Lock and Dam No. 52

(4) Ohio River, 5 miles downstream, at Joppa, Illinois

5.5.6.3 Other Environmental Monitoring

Environmental samples are collected semi-annually of soil and vegetation. Six sample stations are located on-site at the same location of the low volume air samplers. Seven additional stations are located off-site in the surrounding areas of Illinois and Kentucky covering a radius of about eight miles from the plant. Refer to Figure 5.5.6.3(A), Page 5-53 for location of on-site samples and Figure 5.5.6.3(B) Page 5-54 for location of off-site stations. Each sample is analyzed for uranium and fluoride content. Additionally, direct radiation is continuously monitored using environmental TLD's. An environmental TLD badge is located on the restricted area fence on each side of the plant. One badge is located at the nearest property boundary, and one is located at the Metropolis Airport approximately one mile NE of the facility. The badges are exchanged quarterly for analysis by a vendor laboratory. Refer to Drawing No. 4781, Appendix "F" for location of direct radiation measurements.

Table 5.5.6.3(A), Page 5-55 shows the results for uranium and fluoride in soil during the 1979, 80 and 81 operating years. The three-year off-site average concentration of uranium in soil is 1.8 PPM. Most values fall in the range of 1-10 PPM U with the exception of Station No. 6 in the Fall of 1981. The source of this elevated result could not be determined. Limits for uranium contamination of soils have not been developed; however, the EPA has drafted a standard or "action level" for persons exposed to transuranics in surface soils of 30 DPM/gram. Applying this action level to the isotopes of natural uranium would result in a calculated action level of 20 PPM U (Nat.). This approach is very conservative because it is known that transuranics e.g. Pu^{239} is several orders of magnitude more toxic than natural uranium. None of the off-site soil analyses indicated contamination exceeding 20 PPM U. Using the EPA guidelines for transuranics, the maximum individual off-site dose would be significantly less than 1 millirad to the pulmonary lung or 3 millirad to bone from uranium contamination in soil.

On-site uranium in soil concentrations averaged 13.2 PPM during the three-year period. Considerable construction activity in building concrete storage pads disrupted normal sampling and trend analysis for Station No. 12. This resulted in the Sampling Station being physically relocated on two occasions. Fence line Stations No. 9, 10, and 13 are considered more representative of maximum on-site contamination. Only one of these samples exceeded the off-site criteria during the three-year period (No. 10 in the Fall of 1981).

Off-site fluoride in soil concentrations averaged 7.9 ppm F^- during the period. These concentrations are not considered significant because many agricultural soils contain greater concentrations of fluoride due to annual application of super phosphate fertilizer which contains about 1-3% fluoride. About 90% of the applied fluoride may accumulate in the soil. Fluorides in soil often are, or rapidly become, relatively insoluble forms that are not readily available to plants grown on the soil. Fluoride accumulation in forage plants is thus, more indicative of environmental impact than soil concentration.

Table 5.5.6.3(B), Page 5-56 provides concentrations of fluoride and uranium in and on vegetation for 1979, 1980, and 1981. The off-site concentration (Stations No. 1 thru No. 7) averaged 7.5 PPM F^- during the three-year period. The maximum individual off-site concentration was 23.8 PPM in the Fall of 1980. These values are considerably below the Kentucky standard (401KAR 3:020) which allows 40 PPM during the growing season, 60 PPM as a two-month average, or 80 PPM maximum one month average. Although plant species collected for analysis of fluoride could be grazed by cattle, there is in fact, very little pastureland utilization. Most farms are planted in row crops of soybeans or corn.

Although elevated on-site concentrations of uranium and fluoride in vegetation have been found, these areas are inside the property boundary and under licensee control.

Environmental TLD radiation monitoring results are shown in Table 5.5.6.3(C), Page 5-57. The maximum annual average of direct gamma radiation consistently occurs at the east restricted area fence. This is due to a large ore concentrate storage area immediately adjacent to the sample station. The quarterly average at this station during 1981 was 378.1 mrem/91 day quarter. This maximum potential whole-body exposure level is about 28% of that allowed by 10CFR20.105(b)(2). The three-year average near the site boundary is about 154 mrem per year if an individual were continuously present, and about 112 mrem/year at the Metropolis Airport. These latter two values are within the expected range of natural background.

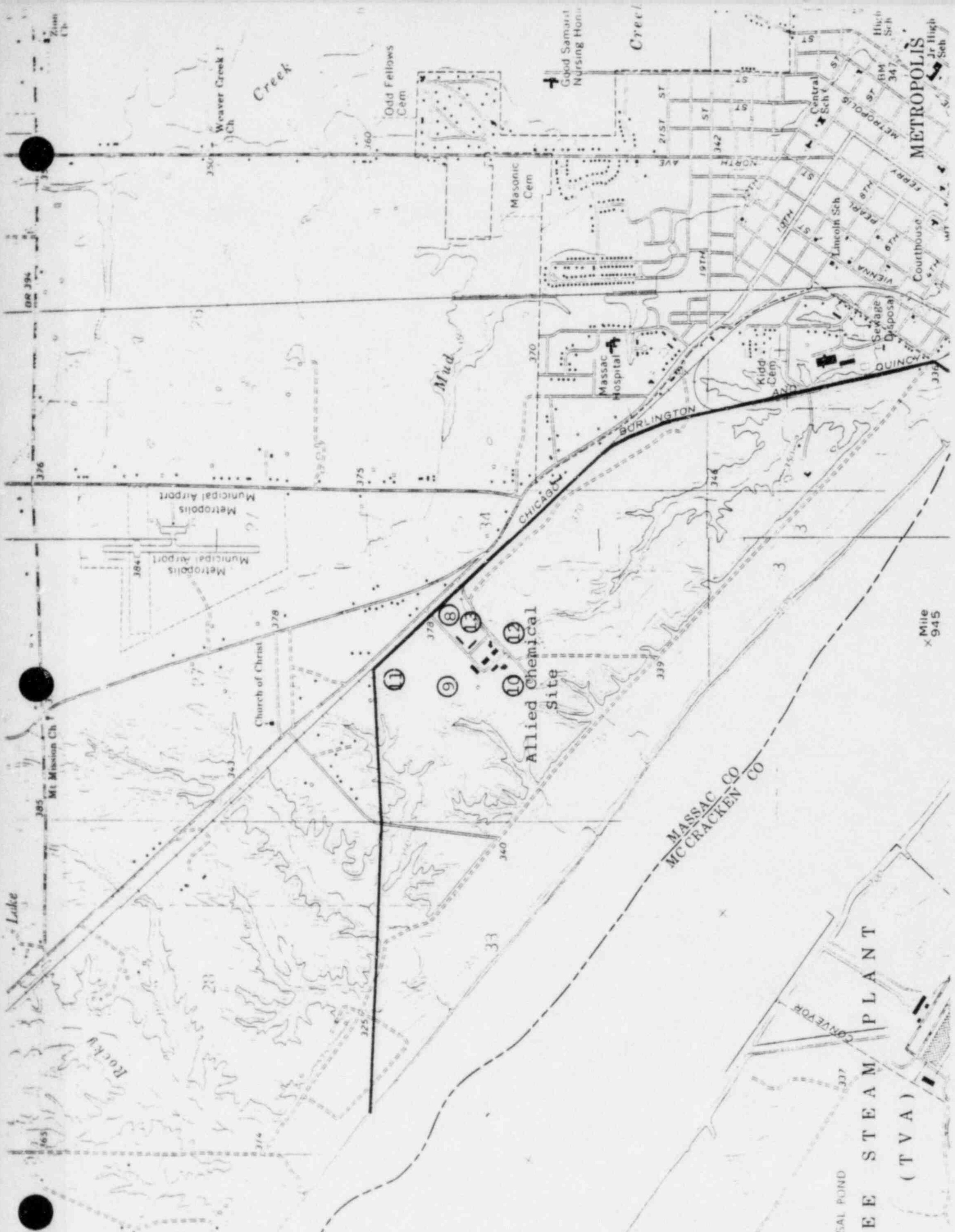

Figure 5.5.6.3(A)

On-site Soil, Vegetation, and Air Samples

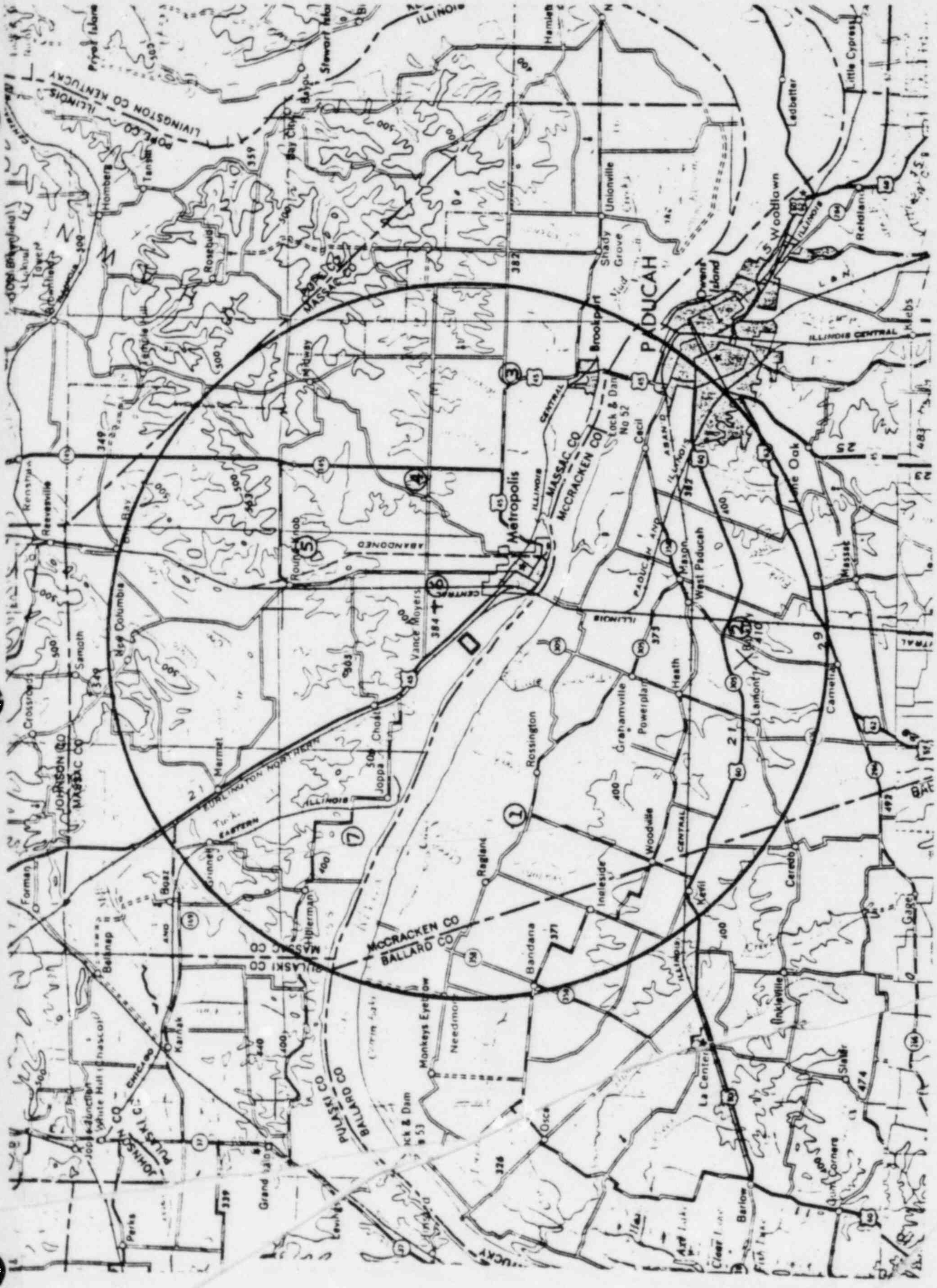

Figure 5.5.6.3(B)

Off-Site Soil and Vegetation Samples

TABL[illegible].5.6.3(A)

SEMI-ANNUAL SOIL SAMPLES

URANIUM AND FLUORIDE

Sample Station No.	Location	Spring 1979 U	Spring 1979 F⁻	Fall 1979 U	Fall 1979 F⁻	Spring 1980 U	Spring 1980 F⁻	Fall 1980 U	Fall 1980 F⁻	Spring 1981 U	Spring 1981 F⁻	Fall 1981 U	Fall 1981 F⁻
1	Lamb Farm	9.18	< 2.5	1.12	< 2.5	0.85	9.5	0.16	12.5	0.72	5.37	1.66	8.43
2	Brubaker Farm	1.87	< 2.5	2.50	<2.5	1.08	8.7	0.15	6.5	0.63	5.23	1.60	3.99
3	Texaco Station	1.25	5.0	4.49	<2.5	1.37	99.9	0.15	9.4	0.56	7.12	1.18	6.74
4	Ill. Power Equip.Station	3.99	<2.5	2.12	4.1	1.02	10.5	0.13	6.4	0.57	5.23	1.56	< 2.49
5	Reineking Properly	2.97	3.3	2.00	2.5	1.06	9.9	0.08	10.7	0.81	9.84	1.37	5.45
6	Metropolis Airport	2.25	<2.5	2.25	<2.5	1.62	6.2	0.21	4.7	1.37	6.72	18.20	6.22
7	Maple Grove School	1.74	< 2.5	0.87	<2.5	0.85	7.2	0.08	7.5	0.32	6.62	1.67	< 2.49
8	Northeast of Feeds Bldg.	3.74	11.0	6.62	2.5	15.46	24.9	1.05	22.5	6.61	22.4	12.83	13.96
9	West of Fees Bldg.	2.24	2.5	7.35	5.5	0.31	16.5	0.66	22.3	9.31	20.7	6.60	15.49
10	South of Feeds Bldg.	9.33	25.0	12.49	<2.5	0.45	114.6	1.05	32.4	18.05	44.8	30.34	104.9
11	North of Feeds Bldg.	4.36	3.0	3.25	<2.5	0.35	16.0	3.29	6.8	0.67	18.1	10.15	9.74
12	East of Feeds Bldg.	28.41	362	19.35	<2.5	167.0	249	0.35	101.4	0.36	22.4	27.73	109.6
13	Northeast of Feeds Bldg.	7.47	37.5	10.61	<2.5	14.10	79.7	1.27	47.5	10.80	57.4	2.25	84.9
	Off-site Average (Points 1-7)	3.32	2.97	1.76	2.73	1.12	21.7	0.137	8.24	0.711	6.59	3.89	5.12
	On-site Average (Points 8-13)	12.54	73.5	9.95	3.00	32.95	83.45	1.28	38.82	7.63	30.97	14.98	56.43

TABL[illegible].5.6.3(B)

SEMI-ANNUAL VEGETATION SAMPLES

URANIUM AND FLUORIDE (PPM)

Sample Station No.	Location	Spring 1979		Fall 1979		Spring 1980		Fall 1980		Spring 1981		Fall 1981	
		U	F⁻	U	F⁻	U	F⁻	U	F⁻	U	F⁻	U	F⁻
1	Lamb Farm	1.38	< 4	2.47	< 4	5.05	6.59	1.61	11.6	16.09	9.61	6.12	4.95
2	Brubaker Farm	2.04	< 4	1.88	< 4	6.59	16.9	1.67	10.4	10.73	7.11	10.24	7.85
3	Texaco Station	4.20	< 4	1.73	< 4	7.46	9.6	1.94	7.6	11.98	7.04	10.12	7.42
4	Ill. Power Equip.Stattion	2.91	< 4	2.80	< 4	6.90	8.7	1.94	23.8	14.65	8.37	4.28	< 3.74
5	Reineking Property	1.81	< 4	1.66	< 4	3.95	3.7	2.15	6.9	5.17	7.55	7.85	< 4.12
6	Metropolis Airport	3.29	< 4	1.11	< 4	4.51	18.0	2.02	8.8	7.06	7.18	4.79	6.55
7	Maple Grove School	5.97	5.9	1.10	< 4	4.38	4.4	1.88	13.4	8.35	10.70	6.35	< 4.12
8	Northeast of Feeds Bldg.	17.11	< 4	9.0	7.52	12.58	48.2	5.50	86.1	6.03	149.5	17.20	87.54
9	West of Feeds Bldg.	17.59	< 4	5.76	5.54	7.43	54.0	2.75	32.3	4.07	15.33	21.64	21.56
10	South of Feeds Bldg.	4.40	< 4	9.85	7.85	15.52	75.5	2.89	31.2	4.44	24.27	53.33	86.02
11	North of Feeds Bldg.	7.99	7.8	7.95	5.13	7.40	147.2	3.97	55.6	10.97	30.31	10.48	69.00
12	East of Feeds Bldg.	16.94	17.7	22.92	< 4	38.23	51.7	8.56	55.7	3.77	27.16	69.36	171.5
13	Northeast of Feeds Bldg.	25.68	31.1	17.98	27.5	26.02	234.0	8.83	438.9	24.32	287	20.89	263.3
	Off-site Average (Points 1-7)	3.09	4.27	1.82	< 4	5.55	9.7	1.89	11.79	9.15	9.60	7.11	5.54
	On-site Average (Points 8-13)	12.82	11.43	12.24	9.59	17.86	101.8	5.42	116.6	8.93	88.92	32.15	116.5

TABLE 5.5.6.3(C)

ENVIRONMENTAL TLD RADIATION MONITORING

(MREM/QUARTER) 1979, 1980, and 1981

Sampling Period		North Fence	East Fence	South Fence	West Fence	North Boundary	Airport
1979	First Quarter	72.6	*	105.4	35.2	38.2	27.0
	Second Quarter	78.6	301.6	125.0	36.8	40.4	29.8
	Third Quarter	76.0	403.2	199.8	31.4	40.6	28.0
	Fourth Quarter	78.6	310.4	113.4	33.4	35.6	25.8
	Average	76.5	338.4	135.9	34.2	38.7	27.7
1980	First Quarter	79.8	377.6	121.2	44.6	49.0	41.2
	Second Quarter	89.2	300.2	119.8	36.4	49.0	33.8
	Third Quarter	78.6	311.4	160.0	32.2	33.8	27.2
	Fourth Quarter	69.8	426.0	166.8	41.8	43.6	29.8
	Average	79.4	353.8	142.0	38.8	43.9	33.0
1981	First Quarter	78.3	485.7	175.8	38.9	38.9	28.0
	Second Quarter	58.9	329.8	149.5	27.8	32.2	22.5
	Third Quarter	53.2	339.2	130.9	26.2	29.4	18.9
	Fourth Quarter	53.7	357.5	160.3	31.2	29.4	22.5
	Average	61.0	378.1	154.1	31.0	32.5	23.0

* TLD Missing

5.5.7 Decommissioning Program and Surety Arrangements

A decommissioning and surety arrangement plan for the UF_6 facility was approved by the Commission on January 31, 1980. Please refer to Appendix "G".

6. Accidents and Contingency Response Plans

6.1 Radiological Accidents

A spectrum of plant accident conditions involving radioactive materials have been analyzed to determine potential impact. These accidents range from real (small powder and UF_6 spills), to large hypothetical releases of UF_6 (rupture of a UF_6 product cylinders). Using computerized dispersion modeling, it was concluded that the only plant accident involving radioactive materials which could produce a significant off-site impact, is a large uncontrolled release of uranium hexafluoride (UF_6). A specific plan has been developed and approved by the commission for minimizing the potential impact of radiological accidents. Refer to "Metropolis Works Radiological Contingency Plan", submitted June 9, 1981; amended January 5, 1982; and approved by the Commission on March 24, 1982.

6.2 Non-radiological Accidents

The UF_6 conversion process consumes relatively large quantities of corrosive raw materials in particular, anhydrous hydrogen fluoride (HF), and anhydrous ammonia. Plant accidents that release substantial amounts of these chemicals could produce off-site environmental effects which may present short term health effects.

The U.S. Environmental Protection Agency's PTDIS computer model has been used to evaluate the potential impact of accidental releases of these chemicals. The model computes short term concentrations downwind from a point source at specified distances. Average meteorology at Evansville, Indiana was used as input to the computer program. Stability Class "D" and an average wind speed of 3.06 meters per second was used to determine downwind concentrations for a given release rate. The meteorological information indicates the probability of a wind from the south (toward the nearest site boundary) is 9.4%, and the relative frequency of "D" stability is 24.2%.

6.2.1 Hydrofluoric Acid (HF) Release

In assessing the impact of an HF release, it is assumed the release persists for one hour, at ground level, in the open, so that there is no attenuation by filtration or scrubbing. Four criteria were selected to evaluate potential downwind effects:

1) Air concentrations not exceeding 0.25 mg/m^3 (0.3 ppm), which is in the range where exposures of the order of one hour can cause damage to vegetation.

2) Concentrations up to 2 mg/m^3 (2.5 ppm), which is the TLV for an 8-hour work day recommended by the American Conference of Governmental Hygienists.

3) Concentrations up to 7 mg/m^3 (8.5 ppm), which is the emergency exposure limit for 60 minutes recommended by the National Academy of Sciences.

4) Concentrations not exceeding 40 mg/m^3 (50 ppm), which is extremely dangerous for even very short exposures.

Experimental data and occupational experience indicate that man is susceptible to irritation from gaseous HF. At 10 mg/m^3, the mucosa are irritated; at 26 mg/m^3 for 3 minutes, he is uncomfortable and able to taste the gas; at 50 mg/m^3, the severity of the irritation increases; at 100 mg/m^3, a stinging sensation of the skin is added and other irritations are so severe as to make exposure for more than one minute intolerable. For this reason, it is unlikely that persons able to escape would remain in the toxic cloud for any length of time.

The calculated release rates required to produce a given downwind concentration at the nearest site boundary (330 meters) are shown in Table 6.2.1(A). Additionally, the downwind distance and area of influence is shown for each concentration criteria in Table 6.2.1(B).

TABLE 6.2.1(A)

Release Rates Producing Given Concentrations at Site Boundary

Ground Level Concentration (mg/m^3)	Release Rate (lbs/hr)
0.25	6.48
2.0	51.8
7.0	181.3
40.0	1007

Table 6.2.1(B)

Area of Influence For Given Release Rates

Release Rate (lbs/hr.)	Concentration (mg/m^3)	Downwind Distance (M)	Downwind Area (acres)
51.8	2.0	330	2
51.8	0.25	1150	25
181.3	7.0	330	2
181.3	2.0	700	10
181.3	0.25	2600	130
1007	40	330	2
1007	7.0	950	18
1007	2.0	2100	82
1007	0.25	8100	990

As shown in the above tables, a release of more than 181 pounds of HF is required to exceed the 60 minute exposure limit (7 mg/m^3) if the wind is toward the nearest site boundary. The 7 mg/m^3 limit would not be exceeded off-site for a release of 1007 lbs of HF if the prevailing wind is from essentially any direction other than south or southwest; however, temporary vegetation damage may occur on-site for any release greater than 6.5 lbs of HF, or off-site for a release of more than 51.8 lbs of HF if the prevailing wind is toward the nearest boundary.

In addition to calculating the size of release which would produce certain concentrations at the nearest boundary line, we have also considered two very serious hypothetical events. The first concerns the rupture of a UF_6 cylinder at a temperature above 65° C where the material would vaporize and hydrolyze to HF and $(UO_2)\ F_2$ in moist air. It has been assumed that 9200 lbs of UF_6 would escape from the cylinder producing 2090 lbs of HF and 6200 lbs of uranium as $(UO_2)\ F_2$.

6.2.1 Hydrofluoric Acid (HF) Release (continued)

The second possible accident is that in which an HF tank car being unloaded is struck by another railroad car. To estimate this value, it was assumed that the HF was being transferred to storage using air pressure at 40 psig and that the 1.5 inch liquid unloading line ruptured allowing anhydrous HF liquid to discharge onto the ground. HF would pour out of the opening at a rate exceeding 5 gps and would form a pool on the ground. If the temperature were near or above the 67°F boiling point, some of the liquid would flash immediately into gas cooling the liquid well below the boiling point. It is assumed that 5000 gallons(one-half of a 10,000 gallon car) would be discharged forming a circular pool of liquid about 100 ft. in diameter and one inch deep. HF would evaporate from this approximately 8,000 sq. ft. surface at a rate of 2.7 lbs. per hour per sq. ft. for a total of 21,600 lbs/hr. For the dispersion calculation, we used 25,000 lbs. per hour for the emission rate.

The HF concentration at the nearest boundary line was calculated to be 157 mg/m^3 and 1060 mg/m^3 for each incident respectively. The downwind area of influence is shown in Table 6.2.1(C).

Table 6.2.1(C)

Area of Influence For Hypothetical HF Accidents

Release Rate (lbs/hr.)	Concentration (mg/m^3)	Downwind Distance (M)	Downwind Area (Acres)
2090	157	330	
	40	510	2
	7.0	1450	40
	2.0	3300	190
	0.25	13300	2500

Table 6.2.1(C) (continued)

Area of Influence for Hypothetical HF Accidents

Release Rate (lbs/Hr.)	Concentration (mg/m^3)	Downwind Distance (M)	Downwind Area (acres)
25000	1060	330	
	40	2300	100
	7.0	7300	775
	2.0	17500	
	0.25	75000	

Although these hypothetical accidents are not considered credible due to the preventative procedures used in the plant, the plant "Radiological Contingency Plan" and Emergency Disaster Plan" are designed to minimize any off-site impact which could be produced by a large release of HF. The use of fire hose spray, for example, is known to be very effective in reducing HF emissions from ground level point sources.

There have been two significant releases of HF since the plant began operation in 1958. The first involved the leakage of 95 lb of UF_6 which, fully hydrolyzed, is equivalent to about 22 lb. of HF. The leak occurred in a building as a result of a valve failure in the distillation section. Elevated fluoride concentrations were not detected offsite because of the effectiveness of the emergency control procedures.

In a second incident, a leak was detected in an HF tank car awaiting delivery to the plant. It was estimated that a total of about 250 lb of HF was lost over a period of more than 1 hour; emergency procedures were instituted to prevent the spread of the material, and no offsite impact was measured.

Although accidental releases of HF could result in concentrations at the boundary and beyond which might cause environmental damage and short term exposure of nearby populations, their probability is considered extremely low due to plant control procedures and wind frequency distribution.

6.2.2 Ammonia Release

Dispersion modeling was performed to determine the ammonia release rate which would produce a given concentration criteria at the nearest site boundary. The exposure criteria utilized are:

20 PPM (13.8 mg/m^3) - First perceptible odor (TLV for NH_3 = 25 PPM)

40 PPM (27.6 mg/m^3) - A few individuals may suffer slight eye irritation

100 PPM (69 mg/m^3) - Noticeable irritation of eyes and nasal passages after a few minutes exposure.

400 PPM (276 mg/m^3) - Severe irritation of the throat, nasal passages and upper respiratory tract.

700 PPM (1,173 mg/m^3) - Severe eye irritation, no permanent effect if the exposure is limited to less than one-half hour.

The results of the dispersion calculations for the nearest site boundary are shown in Table 6.2.2(A).

Table 6.2.2(A)

Release Rates Producing a Given Concentration at Site Boundary

Ground Level Concentration (PPM)	Release Rate (lbs/hr)
20	357
40	714
100	1785
400	7140
700	12495

The modeling indicates approximately 400 pounds of ammonia released in a one-hour period would provide an exposure near the TLV value; however, this concentration of ammonia has a perceptible odor which would provide ample warning for potentially exposed individuals. Severe irritation of the throat, nasal passages and upper respiratory tract (400 PPM) would require a release of more than 7000 pounds with the wind toward the nearest boundary. The plant has never experienced an accidental spill of ammonia for which the odor was perceptible beyond the restricted area fence.

A maximum hypothetical accident was considered in which an ammonia tank car being unloaded was struck by another railroad car rupturing the 1½-inch unloading line. It is assumed that the car is pressurized to 150 psi and liquid ammonia discharges onto the ground

6.6.2 Ammonia Release (continued)

forming a pool. It is assumed that 5000 gallons(one-half of a 10,000 gallon car) would be discharged in one hour and that all of the ammonia would be vaporized in that time. About 23 percent of the liquid would flash into vapor cooling the liquid well below the boiling point. The remaining ammonia on the ground would evaporate at a rate of 4 lbs. per square foot per hour which is sufficient to evaporate all of the spilled material within the first hour providing the liquid forms a pool about 100 ft. in diameter. The area influenced by a release of this magnitude is shown in Table 6.2.2(B).

Table 6.2.2(B)

Area of Influence for Hypothetical Ammonia Accident

Release Rate (lbs.hr)	Concentration (PPM)	Downwind Distance (M)	Downwind Area (acres)
32,000	700	360	4
	400	830	14
	100	8700	

In the event of such a hypothetical accident or other lesser accidental spills of ammonia which could have adverse off-site impact, the plant "disaster plan" would be utilized to minimize any potential exposure of the nearby population.

6.3 Transportation Accidents

6.3.1 Incoming Raw Materials

Incoming anhydrous ammonia, potassium hydroxide, hydrofluoric acid, and sulfuric acid are normally shipped to the plant in privately owned tank cars meeting DOT specifications. These shipments generally originate in Louisiana, West Virginia, Ohio and Illinois. Potassium Bifluoride is received in drums via truck. Bulk receipts of hydrated lime for use in the wastewater treatment facilities, are normally received in tank trucks. Table 6.3, Page 6-11 lists the inbound and outbound chemicals along with a brief description of the material, mode of transport, and approximate frequency of shipments.

The commodities shipped to Metropolis Works are commercial chemicals routinely used in a wide variety of industrial and agricultural applications. Anhydrous ammonia and lime are particularly important to agriculture and move in large quantities to the farms in Illinois. Packaging and transportation of these chemicals requires no special provisions beyond those now utilized except for changes which may evolve from possible future regulations promulgated by DOT in its continuing program to improve transportation safety.

The shipping volume of these chemicals to Metropolis represents a small fraction of the total industrial traffic in Southern Illinois. Under normal conditions, this shipping volume has an insignificant effect on the environment.

While the hazardous nature of some of these chemicals are well known, actual experience at Allied Chemical Company, for HF and NH_3, the more hazardous of the process chemicals used, demonstrates that transportation can be carried out safely. Based on accident statistics reported in the literature, one could expect ten train accidents (Collision-Derailment) per million train miles traveled. Assuming 100 cars per train, and 5 cars involved per accident, this would be one car accident per two million car miles.

Consumption of NH_3 and HF at Metropolis requires about 10,000 and 79,200 loaded tank car miles per year respectively. Therefore, based on statistics for maximum production at this UF_6 facility, one might expect one serious accident affecting an ammonia car every 1000 years and a hydrofluoric acid car every 126 years. These extremely low probabilities, along with current Federal programs to improve rail and highway safety, indicate that continued operation of the facility will not have a significant adverse impact on the environment or the safety of the public.

Empty UF_6 cylinders are returned from enrichment facilities at an average rate of 20 cylinders per week. Returned cylinders may contain small amounts of residual UF_6 and transport vehicles are placarded as required by Federal regulations for such radioactive materials.

Uranium ore concentrates are shipped to the plant site by rail cars and truck. Assuming all shipments are by rail car, the average frequency rate is five rail cars per week. This material is shipped in D.O.T. approved 55-gallon drums.

In our experience we have observed that containers and vehicles are properly labeled and placarded in accordance with D.O.T. regulations. An accident severe enough to rupture one of the 55-gallon drum shipping containers would result in little, if any dispersion of the material due to the high density and low solubility. Any spilled material would be picked up and re-drummed with little significant impact upon the environment.

6.3.2 Outgoing Shipments

The UF_6 product is packaged into 10 or 14 net ton U.S. Nuclear Regulatory Commission approved steel cylinders, (refer to quality assurance program in Chapter 7). After filling the cylinders with UF_6 in liquid form, the product is allowed to cool and solidify for a minimum of four (4) days before shipment. The shipments are normally made by sole-use vehicle. When loaded, the containers are inspected to assure that they have been properly prepared for shipment and fully comply with applicable regulations governing their use in transportation. Transport vehicles are placarded in accordance with DOT regulations. UF_6 is shipped from Metropolis Works primarily to the DOE gaseous diffusion plants at Paducah, Kentucky, Portsmouth, Ohio and Oak Ridge, Tennessee.

During the operating history of the plant, only two very minor accidents have been experienced. Both of these accidents resulted in the trailer sliding into a ditch. One mishap resulted from icy roads and the second resulted from avoiding a collision with another vehicle. In both cases there was no property damage to others. In each instance, the cylinder remained secure and undamaged on the trailer bed. The DOE has made thousands of shipments of UF_6 and there has not been a recorded accident where a container was damaged to the extent that material was released.

Shipments of UF_6 via highway transportation are carried out by qualified private or contract carriers and by experienced specialized common carriers duly franchised by either the U.S. DOT or the Illinois Department of Transportation. The vehicle trailer is specifically designed for attachment of the UF_6 cylinder to its chassis with a center of gravity as low as practical. This unit is used exclusively for UF_6 shipments and return of the empty cylinders.

In all cases, UF_6 truck shipments are routed to avoid heavily populated and congested areas as well as tunnels, bridges and toll roads which prohibit such shipments.

Based on past experience, insignificant environmental impact will result from transportation operations, or from infrequent transportation accidents, involving UF_6.

Other fluorine products produced at the plant include Antimony Pentafluoride, Iodine Pentafluoride, Sulfur Hexafluoride, and Liquid Fluorine. The fluorine products are all shipped in DOT approved cylinders, often in less than truckload lots, and represent no appreciable environmental hazard. The Liquid Fluorine is shipped in specially designed, DOT approved trailers over carefully selected routes to minimize the effect of any accident. In the past, although one trailer was involved in a minor accident, no loss of containment integrity resulted. Based on our past experience, these shipments represent an insignificant impact on the environment and the safety of the public.

Radioactive wastes are generated at the plant during routine operations. These wastes are dry solids which are packaged into 55-gallon drums. Approximately 75 truckload shipments are made annually to an N.R.C. licensed radioactive waste disposal firm. These wastes contain small quantities of residual uranium and daughter products, which are uniformly distributed throughout the inert material. These wastes are shipped as Radioactive LSA Material in "sole-use" vehicles.

The low radiation levels, coupled with the inert material, preclude any significant, environmental impact from the transportation of these materials. Packaging and transportation of these wastes are in accordance with applicable Federal regulations.

Allied Chemical has joined with other chemical companies as a participant in the activities of the National Chemical Transportation Emergency Center (CHEMTREC) which functions in the interest of promoting safety, and minimizing the danger to life and property in case of transportation emergencies involving hazardous chemicals. In addition, transportation accidents involving the Plant's product shipments are coordinated through a Company-wide emergency system designed specifically to cope with the hazards of the particular material should an emergency occur.

TABLE 6.3

Plant Shipments

Incoming Raw Materials

Commodity	Physical Description	Hazardous Nature As Defined by DOT if applicable	Packaging Requirements	Transportation Mode	Average Frequency of Shipments
Hydrogen Fluoride	Liquid	Corrosive	DOT Spec. Tank Cars	Rail - Tank Cars	11 C/L per month
Potassium Bifluoride	Solid, Dry	NA	Drums	Truck - LTL	170 drums per qtr.
Sulfuric Acid	Liquid	Corrosive	DOT Spec. Tank Cars	Tank cars and Tank Truck	8 C/L per month
Lime (Hydrated)	Solid, Dry	NA	Bulk	Tank Truck	276 T/L per year
Potassium Hydroxide	Liquid	Corrosive	DOT Spec. Tank Car	Rail - Tank Car	C/L per month
Anhydrous Ammonia	Liq. Comp. Gas	Non Flam. Comp. Gas	DOT Spec. Tank Cars	Rail - Tank Car	5 C/L per month
UF_6 Cylinders (empty)	Residual UF_6	Radioactive LSA	Radioactive LSA	Truck (Sole Use)	20 per week
Uranium Ore Concentrates	Solid, Dry	Radioactive LSA	Radioactive LSA	Truck & Rail Cars	5 rail cars per wee

Outbound Shipments of Products and Waste

Commodity	Physical Description	Hazardous Nature As Defined by DOT if applicable	Packaging Requirements	Transportation Mode	Average Frequency of Shipments
Uranium Hexafluoride (UF_6)	Solid	Radioactive LSA	Radioactive LSA	Truck (Sole Use)	20 per week
Wastes	Solid	Radioactive LSA	Radioactive LSA	Truck (Sole Use)	75 per year
Fluorine	Liquid	Oxidizer	DOT SP 1479	Truck (Sole Use)	1 per year
Antimony Pentafluoride	Liquid	Corrosive	DOT Spec. Cyls.	Truck (Common Carrier)	1 per month
Iodine Pentafluoride	Liquid	Corrosive	DOT Spec. Cyls.	Truck (Common Carrier)	1 per month
Sulfur Hexafluoride	Gas	Non Flam. Gas	DOT SP 4168	Truck (Common Carrier)	10 per week

Notes: Typical carload (C/L) is 80,000 - 120,000 lbs. net

Typical Truckload (T/L) is 30,000 - 40,000 lbs. net

7. Quality Assurance

The quality of the UF_6 production operation is continuously monitored to assure a quality product with minimal employee health or environmental impact. The primary responsibility for auditing the routine safe operation of process equipment is delegated to the employee performing the job and his immediate supervisor.

Each operating section of the facility is under the supervision of a technical supervisor who has a minimum of a bachelors degree in chemistry or chemical engineering. Written procedures and training are provided for the conduct of operations. In addition, periodic quality assurance audits are performed by Company headquarters personnel. Deviations from established operating conditions are expeditiously corrected. If the abnormal condition cannot be readily corrected, the unit is shut down until the abnormality has been corrected.

The performance of equipment, piping and instrumentation to operate within designed specifications is determined by routine testing, inspection and calibration. Inspection schedules are established for specific pieces of equipment and instruments that are critical to the safety and quality of the operation. The inspection frequency is determined by operating experience, company engineering and/or vendor specifications, or a combination of these.

Containers used to package UF_6 are approved containers and comply with Metropolis Works "Quality Assurance Program for Uranium Hexafluoride Cylinders", NRC Approval No. 0277. The cylinders are inspected for visible defects when received, prior to filling and prior to shipment in accordance with The Quality Assurance Program.

Quality assurance for analytical reliability is maintained through participation in the NRC "Confirmatory Measurements Program". The basic program consists of splitting plant and environmental samples, in the presence of a regional NRC inspector, and performing appropriate radioactivity analyses. The analyses are performed by the NRC official laboratory and the plant Health Physics laboratory. The results from this program indicate that of six sets exchanged, 12 separate analyses were performed by each laboratory and agreement between the two laboraties were obtained for 11 analyses. Possible agreement was obtained for the remaining analysis.

8. Evaluation of Alternatives

The Metropolis UF_6 plant represents an essential link in the production of nuclear power. High purity UF_6 feed is required by the gaseous diffusion plants to assure continuity of the nuclear fuel cycle. The Metropolis facility provides this UF_6 conversion service for the private sector of the nuclear power program and until 1970, was the only privately owned UF_6 conversion plant in the United States.

The present site was selected with consideration of isolation, population density, local recreation, historical factors, and farming activity in the area. Supporting services such as transportation, power, water, labor supply, and geograpical distance to diffusion plants were also key factors in site selection. Alternate locations were evaluated on the basis of these criteria and it is felt that the choice made in 1956 would also be the best choice today.

The most obvious alternative to continuation of operations is to shut down the UF_6 plant. Approximately two thirds of the domestic UF_6 conversion capacity is represented by the Metropolis plant. Since UF_6 conversion is an essential segment of the nuclear fuel cycle, shutdown of this facility would have a significant adverse impact upon the entire nuclear power program. A serious adverse economic impact would also be produced in the local area.

MTW-1963-A

METROPOLIS WORKS SAMPLING PLANT ~ FLOW DIAGRAM

1-30-78

DWG. MTW-1963

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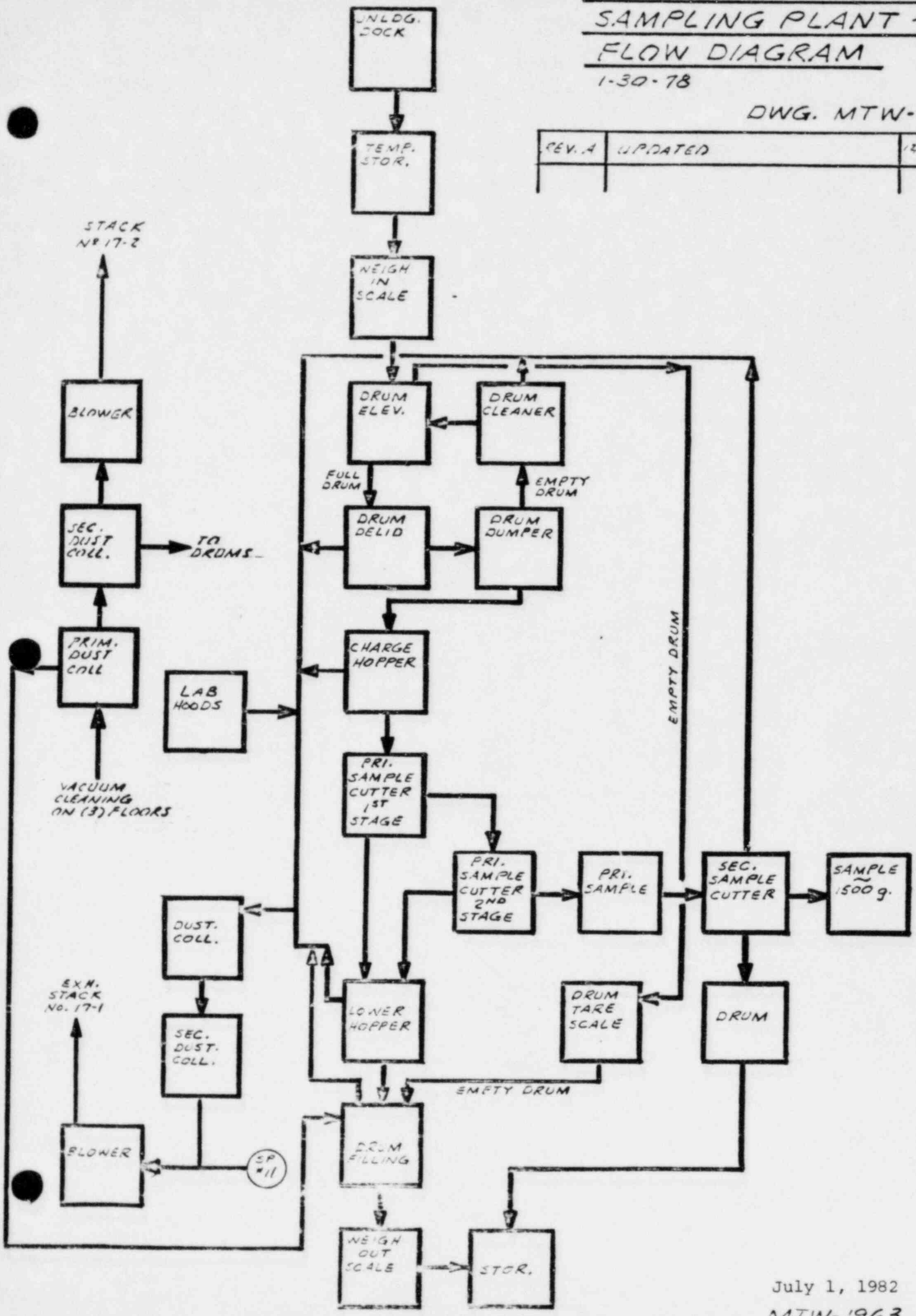

July 1, 1982

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APPENDIX "B"

ILLINOIS EPA

Environmental Protection Agency

2200 Churchill Road, Springfield, Illinois 62706

217/782-0610

Allied Chemical
NPDES Permit No. IL0004421

March 14, 1980

Mr. J.H. Thomas
Plant Manager
Specialty Chemicals Division
Allied Chemical
Post Office Box 430
Metropolis, Illinois 62960

Dear Mr. Thomas:

The Illinois Environmental Protection Agency has reviewed your request dated November 29, 1979 for renewal of the subject NPDES Permit.

The new NPDES regulations (June 7, 1979) Section 122.12(b)(4) generally provide that where a timely application has been received and through no fault of the permittee a new permit cannot be reissued then the permit is automatically continued. Permits continued in this fashion remain fully effective and enforceable against the discharger. Because of the complexities involved in the reissuance of this permit, it is anticipated that reissuance may not occur before the expiration of Allied's existing permit. In this case then Allied's permit will be continued pursuant to the aforementioned federal regulations.

Should you have any questions or comments concerning the content of this letter, please contact Dale R. DeClue of my staff.

Very truly yours,

Lawrence W. Eastep

Lawrence W. Eastep
Manager, Industrial Unit, Permit Section
Division of Water Pollution Control

LWE:DRD:bl/2617b/17

cc: USEPA
    Region VII
    Records Unit
    Compliance Unit
    Allied Chemical - Dennis Hatfield

NPDES Permit No. IL0004421

Illinois Environmental Protection Agency

Division of Water Pollution Control

2200 Churchill Road

Springfield, Illinois 62706

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Modified (NPDES) Permit

Expiration Date: May 31, 1980

Issue Date: May 16, 1975
Effective Date: June 16, 1975
Modified: April 15, 1980

Permittee: Allied Chemical Corporation

Facility Name and Address: Allied Chemical Corporation, Metropolis Works, Post Office Box 430, Metropolis, Illinois 62960

Receiving Waters: Ohio River

In compliance with the provisions of the Illinois Environmental Protection Act, the Chapter 3 Rules and Regulations of the Illinois Pollution Control Board, and the FWPCA, the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Thomas G. McSwiggin, P.E.
Manager, Permit Section
Division of Water Pollution Control

TGM:DRD:mam/sp2880b

Page 2 of 14

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on the effective date of this permit and lasting until March 31, 1976 the permittee is authorized to discharge from outfall(s) serial number(s) 001.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day) Daily Avg	Daily Max	Other Units (Specify) Daily Avg	Daily Max	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Daily	calculated
Total Suspended Solids	-	-	-	90 mg/l	2/week	composite
Total Dissolved Solids	-	-	-	-	"	"
Fluoride	-	-	-	45 mg/l	"	"
*Arsenic	-	-	-	0.5 mg/l	"	"
*Silver	-	-	-	0.13 mg/l	"	"

There shall be no discharge from outfall 001 after March 31, 1976.

*See page 14 of 14.

The pH shall not be less than 5.0 nor greater than 13.8 and shall be monitored twice per week by reporting the minimum and maximum values determined from a series of grab samples.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at a point representative of the discharge but prior to entry into the Ohio River.

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on the effective date of this permit and lasting until March 31, 1976, the permittee is authorized to discharge from outfall(s) serial number(s) 002.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
	kg/day (lbs/day)		Other Units (Specify)		Measurement	Sample
	Daily Avg	Daily Max	Daily Avg	Daily Max	Frequency	Type
Flow-M^3/Day (MGD)	-	-	-	-	Daily	continuous
Total Suspended Solids	-	-	-	200 mg/l	2/week	composite
Total Dissolved Solids	-	-	-	-	"	"
Fluoride	-	-	-	545 mg/l	"	"
*Arsenic	-	-	-	0.5 mg/l	"	"
*Silver	-	-	-	0.12 mg/l	"	"

*See page 14 of 14.

The pH shall not be less than 1.8 nor greater than 10.4 and shall be monitored twice per week by reporting the minimum and maximum values determined from a series of grab samples.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at a point representative of the discharge but prior to entry into the Ohio River.

PART I
mam/sp2880b

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning April 1, 1976 and lasting until the expiration date, the permittee is authorized to discharge from outfall(s) serial number(s) 002.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency**	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Continuous	-
Total Suspended Solids	-	-	-	15 mg/l	2/week	Composite
Total Dissolved Solids	-	-	-	3500 mg/l	2/week	Composite
Fluoride	-	See limit below		-	2/week	Composite

Unless a variance from the fluoride standards is obtained from the IPCB, the daily maximum concentration that may be discharged shall be 15 mg/l.

*See page 14 of 14.

The pH shall not be less than 6.0 nor greater than 9.0 and shall be monitored twice per week by reporting the minimum and maximum values determined from a series of grab samples.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the discharge but prior to entry into the Ohio River.

B. MONITORING AND REPORTING

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. Reporting

Monitoring results obtained during the previous three months shall be summarized on a monthly basis and reported on Discharge Monitoring Report Forms (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on July 28, 1975. Duplicate signed copies of these, and all other reports required herein, shall be submitted to the Regional Administrator and the State at the following addresses:

U.S. Environmental Protection Agency
Region V, Enforcement Division
ATTN: Chief, Compliance Section
230 South Dearborn
Chicago, Illinois 60604

Environmental Protection Agency
State of Illinois
Division of Water Pollution Control
2200 Churchill Road
Springfield, Illinois 62706

3. Definitions

a. "Daily Average" Discharge

1. Weight Basis - The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

2. Concentration Basis - The "daily average" concentration means the arithmetic average (weighted by flow value) of all the daily determinations of concentration made during a calendar month. Daily determinations of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the daily determination of concentration shall be the arithmetic average (weighted by flow value) of all the samples collected during the calendar day.

b. "Daily Maximum" Discharge

1. Weight Basis - the "daily maximum" discharge means the total discharge by weight during any calendar day.

2. Concentration Basis - the "daily maximum" concentration means the daily determination of concentration for any calendar day.

4. Test Procedures

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(g) of the Act, under which such procedures may be required.

5. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The dates the analyses were performed;

c. The person(s) who performed the analyses;

d. The analytical techniques or methods used; and

e. The results of all required analyses.

6. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report From (EPA No. 3320-1). Such increased frequency shall also be indicated.

7. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the State water pollution control agency.

C. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

Report of construction progress by	September 1, 1975
Completion of construction of	
a. KOH regeneration system by	December 1, 1975
b. HF neutralization system by	December 1, 1975
c. Sulfide liquor waste abatement system by	January 1, 1976
Attainment of final operational level for all systems and the elimination of the discharge from outfall 001 by	April 1, 1976

2. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or. in the case of specific actions being required by identified dates, a <u>written</u> notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken. and the probablility of meeting the next scheduled requirements.

PART II

A. MANAGEMENT REQUIREMENTS

1. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

3. Facilities Operation

The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

4. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying disharge.

5. Bypassing

Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Regional Administrator and the State in writing of each such diversion or bypass.

6. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed from or resulting from treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

7. Power Failures

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. In accordance with the Schedule of Compliance contained in Part I, provide an alternative power source sufficient to operate the wastewater control facilities;

or, if no date for implementation appears in Part I,

b. Halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of one or more of the primary sources of power to the wastewater control facilities.

B, RESPONSIBILITIES

1. Right of Entry

The permittee shall allow the head of the State water pollution control agency, the Regional Administrator, and/or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. Transfer of Ownership or Control

In the event of any changes in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Regional Administrator and the State water pollution control agency.

3. Availability of Reports

Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the State water pollution control agency and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

4. Permit Modification

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

5. Toxic Pollutants

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. Civil and Criminal Liability

Except as provided in permit conditions on "Bypassing" (Part II, A-5) and "Power Failures" (Part II, A-7), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

7. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

8. State Laws

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

9. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART III

OTHER REQUIREMENTS

1. Additional Reporting of Monitoring to Illinois Environmental Protection Agency

Monitoring results obtained during the previous one month shall be summarized and reported on a Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 15th day of the month following the completed reporting period. The first monthly report is due on July 15, 1975 . The signed reports required herein, shall be submitted monthly to the State at the following address:

Environmental Protection Agency
State of Illinois
Division of Water Pollution Control
2200 Churchill Road
Springfield, Illinois 62706

2. Rules and regulations regarding handling and discharge of radioactive materials promulgated by the Atomic Energy Commission and any other Agency shall be applicable to this discharge.

3. This permit is subject to all conditions of the IPCB order 73-382 dated February 28, 1974.

4. Additional Monitoring Requirement

*If the permittee, after monitoring for at least three months after the effective date of this permit, demonstrates to the satisfaction of the Regional Administrator and the Illinois Environmental Protection Agency that there is no significant discharge of the designated parameters and that, in that time, the parameters have not exceeded the effluent limits set for said parameters, upon written request by the permittee, the Regional Administrator and the Illinois Environmental Protection Agency shall review the monitoring requirements and may, at its discretion, revise or waive these monitoring requirements by letter without public notice or opportunity for hearing.

5. Ammonia

The effluent Ammonia (as N) concentration in the subject discharge shall be limited to a level that will not cause the receiving stream to exceed the water quality standard limit in Rule 203 of the Water Pollution Regulations of Illinois, Chapter 3.

APPENDIX "C"

Qualifications of Radiation Protection Staff

Radiation Protection Officer - R. W. Yates, Health Physicist

Type of Training	Where Trained	Duration	On The Job	Formal
Health Physics	Allied Chemical Metropolis Works	14 years	Yes	No
Analytical Chemistry and Principles and Practices of Radiation Protection	Metropolis Works	9½ years	Yes	No
Basic Radiological Health	USPHS	2 weeks	No	Yes
Occupational Radiation Protection	USPHS	2 weeks	No	Yes
Industrial Hygiene Measurements	NIOSH	2 weeks	No	Yes
Industrial Hygiene Engineering	NIOSH	2 weeks	No	Yes
Biology	Southern Illinois University	4 years	No	Yes

Qualifications of Radiation Protection Staff

Assistant Radiation Protection Officer - H. C. Roberts, Assistant Health Physicist

Type of Training	Where Trained	Duration	On The Job	Formal
Health Physics	Allied Chemical Metropolis Works	8 years	Yes	No
Analytical Chemistry and Principles and Practices of Radiation Protection	Metropolis Works	6 years	Yes	No
Ionizing Radiation	NIOSH	1 week	No	Yes
Basic Radiological Health	University of Lowell	2 weeks	No	Yes
Aerosol Measurements	University of Minnesota	3 days	No	Yes
Occupational Respiratory Protection	NIOSH	1 week	No	Yes
In-stack Impactor Workshop	University of Florida	3 days	No	Yes
Whole-Body Counting	RMC at Chicago	1 week	No	Yes
DOT Hazards Transportation Workshop	U. S. Ecology	3 days	No	Yes
Biology and Chemistry	Murray State University	4 years	No	Yes

APPENDIX "D"
Metropolis Works Health Physics Guide

INTRODUCTION:

In working with uranium you probably have several questions to ask about health and safety. You have heard about radiation and want to know something about it. We will try to answer some of your questions in this booklet. Allied has many years of experience in chemical safety; the hazards at this plant are no greater or less than at any other similar chemical plant. Allied is proud of its excellent safety record not only at this plant but through out all of the plant sites. There are some special precautions that are needed to make sure you are fully protected.

The potential hazards involved in the use of solid uranium salts, toxic gases such as HF, fluorine, and UF_6, make it necessary for all personnel in the plant to observe strict safety rules.

Metropolis Works has been designed with safe operation as a primary objective. Safety devices are incorporated into the design, and special protective equipment is provided by the company for employees to use. Training is provided to make sure you know the safe way to use all equipment necessary in performing your job.

There is no subtitute for an alert awareness on the part of each individual. You must be aware of the job you are performing as well as the work being performed by others in the same area.

Follow instructions; don't take chances or take unsafe short cuts. Above all, if you don't know, ASK!!!

Please remember there is a great difference in doing a dangerous job and doing a job dangerously. Recognizing the hazards that exist and taking adequate precautions will make working with hazardous materials a safe job. Working with harmless materials in an unsafe manner could cause you to be gambling with your life.

It is Allied's policy that while employees work with hazardous materials, they will not be permitted to work without adequate provisions to make the job safe.

OPERATING AREAS:

All persons entering operating areas must comply with the rules designated for the area. All areas are considered operating areas except the following:

Administration Building

Control Rooms

Dispensary

Locker Rooms

Lunch Rooms

Offices

HEALTH PHYSICS:

Uranium compounds have a two-fold hazard, poisoning and radiation. Uranium is a "heavy metal" and its compounds have a toxicity similar to that of compounds of lead or mercury. Natural uranium compounds are not a significant external exposure hazard; however inside the body, it becomes a very significant hazard. Our purpose then is to keep uranium out of the body.

Radiation is the release of energy in the form of particles or rays caused by disintegration (decay) of an atom. These particles or rays can penetrate the body and interact with the cells of the body which may cause injury or death of the cell. Urnaium and its decay products release three types of radiation; alpha particles, beta particles, and gamma rays.

ALPHA PARTICLES

Alpha particles are physically identical to helium nuclei in that they contain two neutrons and two protons. Because of their large size and double positive charge these particles do not penetrate matter easily. They have a maximum range in air of about two inches. They are easily stopped by a sheet of paper or by the outer layer of skin. Alpha particles are not a hazard outside the body but if they are inhaled, ingested, or absorbed into the body they are considered hazardous.

BETA PARTICLES

Beta particles are high energy electrons that are ejected from a nucleus of an atom. Beta particles have a wide range of penetration depending on their initial energy and the density of matter through which they are traveling. Beta particles have less mass than alpha particles and therefore, they are harder to stop. They have a range of a few feet in air. They can be stopped by a thin sheet of aluminum and can be stopped in the skin layer. Beta particles are both an external and internal hazard.

GAMMA RADIATION

Gamma rays are similar to x-rays. Gamma rays are emitted from the nucleus of an atom during particle annihilation (decay), x-rays come from the extranuclear part of the atom. Gamma radiation is very penetrating and have a range of several feet in air. Gamma radiation can be stopped by concrete, steel or other high density materials.

RADIATION LIMITS

The Nuclear Regulatory Commission (NRC) has set limits on the amount of radiation that an employee can be exposed to annually:

External Exposure Whole Body

1. Whole body, blood-forming organs, lens of eyes, gonads = 1.25 rem/qtr (5 Rem/year)
2. Hands and feet = 18.75 rem/qtr (75 Rem/year)
3. Skin = 7.5 Rem/qtr (30 rem/year)

These external exposures are measured by your TLD badge.

Internal Exposures

1. Lungs (insoluble uranium) = 15 Rem/year
2. Bone (soluble) = 30 Rem/year
3. Kidneys (soluble) chemical toxicity = 2.7 mg/day

Internal exposures are measured by urinalysis and lung counting (WBC).

PLANT AREAS:

There are several areas or buildings that contain uranium at Metropolis Works. The relative hazards of the uranium compounds in these areas are listed as follows:

1. Sampling Plant - Uranium comes into the plant in 55 gallon drums. The uranium oxide is called "yellow cake" but the color of the compound may be orange, dark green or yellow depending on which mill the uranium came from. This uranium concentrate presents mostly an internal hazard which can be controlled by keeping the material enclosed and wearing respirators.
2. Sodium Removal and Uranium Recovery - This area contains several large tanks where high sodium ore concentrates are treated to remove this

impurity and where scrap materials that contain uranium are reprocessed to recover the uranium. There is very little radiation hazard in this area because the materials are normally wet; however, tracking of these materials into other parts of the plant where they may dry can create hazards.

3. Cylinder Wash Building - UF_6 cylinders are washed to remove residual contaminants. The hazards are external radiation due to the different daughter products that emit gamma radiation.
4. Feeds Material Building - This area contains several compounds of uranium that are hazards both internal and external.
    - A. Ore Preparation Section - This area is mostly an internal hazard. This material is soluble in body fluids and therefore the chemical toxicity to the kidmey must be considered.
    - B. Green Salt Section - This area presents both an internal and external radiation hazards. This material is not as soluble in body fluids and therefore remains in the body for a longer period of time.
    - C. Fluorination Section - Due to the decay products of uranium and thorium which are behind in the fluorinator bed material, it is quite radioactive and has an internal and external radiation hazard. Most of the vessels that contain large quantities of bed material are marked off on the floor around the equipment with yellow and magneta strips.
    - D. Distillation Section - Uranium hexafluoride is a gas which presents very little external radiation hazard. Due to the reaction of UF_6 in moist air, UF_6 is a two-fold hazard from possible HF burns, and chemical toxicity to the kidney from the soluble uranium. The uranium

enters the body it goes from the lung to the blood stream and to either the kidney where it is eliminated from the body, or to the bone, where it is "fixed". When the uranium is "fixed" it irradiates the body for a longer period of time before being eliminated.

PROTECTIVE EQUIPMENT:

1. TLD Badges - Metropolis Works personnel are required to wear a TLD badge. These are used to measure the amount of beta and gamma radiation your body has been exposed to. The badge is to be worn between your neck and waist with your name facing outward. The badge is to be placed on the rack when leaving the plant. Do not place the badge in your locker. Hourly employees will have their badges changed monthly, salaried employees quarterly. If you lose your badge please notify the Health Physics Dept.
2. Respirators - Each employee that may be required to wear a respirator will be respirator fit tested to determine which brand and size of respirator gives the best protection. Do not change brands or size of respirators without being tested again by the Health Physics Department.

   Respirators with radionuclide cartridges are required on all individuals entering the Feeds Material Building and the Sampling Plant. This is a condition of MTW's license with the Nuclear Regulatory Commission in processing uranium. A respirator is required to be worn any time you are handling uranium compounds that are not enclosed. You must wear a respirator if you are in an area that is roped off with radiation tape (magneta and yellow) or if the "red lights" are activated.

   The radionuclide cartridge will not offer any protection against a vapor or gas. If you require protection from other contamination you must select the proper cartridge at the safety area in the west end of the powerhouse. These cartridges are color coded for your ease of selection.

Color	Contaminant
Magneta	Any particulate (asbestos, lime, uranium, etc.)
Yellow	Acid gases and organic vapors
Green	Ammonia

Anytime you are wearing a respirator and smell gases or vapors; it is time to get out of the contaminated area and replace the cartridges. The old cartridges should be thrown away - they are not to be reused.

Each time you put on a respirator check the facepiece fit by either the Positive Pressure Test or Negative Pressure Test.

Positive Pressure Test - Place your palm of the hand over the exhalation valve and exhale gently into the facepiece. The facepiece fit is satisfactory if a slight positive pressure builds up inside the respirator.

Negative Pressure Test - Close off the inlets of the cartridges with the palm of the hands and inhale, holding your breath for a few seconds. You have a satisfactory fit if you feel a slight negative pressure on the respirator and no inleakage is detected.

Respirators are stored in the locker rooms and the safety area of the powerhouse. If a respirator is dirty or contaminated, place it in a yellow safety drum for repair and cleaning. Canister Gas Masks or full face masks offer more protection then half-face respirators. Full face masks with air line supplied breathing air provide complete respiratory protection against acid fumes, particulate radioactive materials, etc.

BIOASSAY SAMPLING:

Bioassay data is collected to determine the amount of airborne radioactive materials you have breathed. Bioassay results include urinalysis and invivo counting (Whole Body Counting).

1. Urinalysis - A routine urine specimen is required from all hourly employees twice per month and once per month for salaried employees. These are pre-shift samples that are collected in the guard area before reporting to your work area. The urine sample reminder cards are posted on the TLD rack according to the individual's work schedule. These routine samples are required after the individual has been away from the plant for 48 to 96 hours. If high values are found, the results will be made known to you by either your supervisor or the Health Physics Department, so that condition or actions causing this uptake may be corrected. It may be necessary to get a second specimen to confirm the results. If this is necessary a "repeat" urine card will be posted for you to leave another specimen.

   A special urine specimen is required if you have been exposed to a UF_6 release.

   1. Empty your bladder within 30 minutes after the release.
   2. Leave the first urine sample 3 to 6 hours after the exposure.
   3. Leave another sample (second sample) 16 to 20 hours after the exposure.

   It is very important that you record your name, date, and time on each of these two urine samples.

   If a known exposure occurred due to an ore spill (Ore, UF_4, Prep. Feed, etc.) a special sample is required either the next day or after a two day break. Again make sure you record your name, date, and time on the urine sample bottle.

It is important when leaving urine samples at work not to contaminate the sample due to uranium on your clothes or hands. Special samples may be placed in the refrigerator in the clock alley. If more samples are required a Urine Sample Reminder card will be posted in your TLD rack.

2. Invivo or Whole Body Counting - Each potentially exposed individual will have a WBC performed annually. This will determine how much uranium is in the lungs. In the event the count exceeds 50% of the maximum allowable, you will be required to re-shower and a confirming re-count is obtained.

Based on the bioassay data an individual may be assigned to work in non-uranium areas until the data indicates the uranium level has been reduced to normal.

10 CFR PART 19:

This section of the US Nuclear Regulatory Commission Rules and Regulations applies to notices, instructions, reports and inspection. As an employee at Metropolis Works you are encouraged to report to your foreman or supervisor any condition which may be unsafe, or lead to an unnecessary exposure. It is the responsibility of the company to provide the necessary tools, safety equipment and proper procedures to perform work in a safe manner. It is also your responsibility to use this equipment and perform your duties in a safe manner.

Anytime you would like to review the license, your exposure data or any individual hygiene data that has been taken on you, contact the Health Physics Department. Copies of current regulatory notices are posted in the guard area for your review.

REGULATORY GUIDE 8.13:

A special situation arises when an occupationally exposed woman is pregnant. A number of studies have indicated the fetus is more sensitive to radiation than an adult. Therefore, it is necessary to keep the radiation dose to a pregnant woman below 0.5 rem for the full nine-month pregnancy. It is necessary to notify the Health Physicist or Assistant Health Physicist as soon as possible when you suspect that you are pregnant or have confirmed your pregnancy.

UF_6 RELEASE CONTROL:

Due to the chemical and radiological toxicity of UF_6, it is important that any release be contained as soon as possible. It is equally important that all personnel follow the proper procedures to make sure that no one receives an exposure due to the release.

The UF_6 release control procedure consists of:

Evacuation of the Feeds Material Building and accounting of affected personnel during A UF_6 release which may not be under control.

The building evacuation alarm in the building will be activated along with a disaster siren over the foreman's offices. You will be required to report to a designated area as soon as possible in order to account for your safety. Your foreman or supervisor will tell you where to report for a head count during a UF_6 release or test drill.

All personnel will wear respirators when entering the Feeds Material Building after the all clear announcement has been made. Affected floors will remain on respirators until air activity determinations are completed by the Health Physics Department.

The Feeds Material Building is not evacuated for spills of uranium compounds such as green salt, ore concentrates, etc. For spills it is necessary to activate the "red lights" and decontaminate the area; the Health Physics Department will notify the foreman when the area car be taken off of respirators.

INDUSTRIAL HYGIENE IN GENERAL:

Any time you are handling chemicals or compounds that are classified as a "hazardous material" be sure and follow the proper procedures. If you do not know the hazards of the materials you are working with, see your foreman or Safety Supervisor or the Health Physicist. Do not rely on someone giving you their opinion on how to handle the material safely. Many of the chemicals you may be handling today, if handled improperly, could cause health problems years later.

Take the time to do the job right by following the rules and procedures that are set up to protect you and your fellow employee.

APPENDIX "E"

Radiation Detection Instruments

Type Manufacturer	Number Available	Radiation Detected	Sensitivity	Use
Geiger Eberline E-530	3	Beta and Gamma	0-200 mr/hr	Survey
Cutie-Pie Eberline RO-3	1	Beta and Gamma	0-5000 mr/hr	Survey
Victoreen 440	1	Alpha, Beta, Gamma	0-300 Rem/hr	Survey
Eberline RM-14	3	Beta, Gamma	0-50,000 cpm	Survey and Laundry
Eberline RM-19	1	Beta, Gamma	0-500K cpm	Survey
Constant Air Monitor Radeco Model 442A	1	Alpha	0-5000 cpm	Air Monitor
Dosimeters Bendix	12	X-gamma	0-200 mr	Personnel Monitoring

Laboratory counters for smear, air filter, and accountability sampling include:

Eberline Mini Scaler Model MS-2 and Proportional Gas Flow Counter, Model FC-2

Eberline Instrument Corporation, SAC-4 Alpha scintillation counter.

Baird-Atomic Automatic Planchet Counting System, Model Polyspec including planchet changer and spectrometer, and printer.

Beta -gamma survey instruments routinely used are calibrated quarterly using a 100 mCi ^{137}Cs source supplied by Amersham-Searle. The alpha instruments are checked against a U^{238} source. Instruments not routinely used are calibrated prior to use.

CALIBRATION OF GEIGER-MÜLLER PORTABLE RADIATION SURVEY INSTRUMENTS

SCOPE:

The following procedure should be performed quarterly to determine instrument response to gamma radiation fields of various intensities. The gamma dose rate indicated by the instrument is plotted against the calculated gamma dose rate from a primary gamma point source standard to determine the instrument calibration.

EQUIPMENT:

1. Geiger-Müller Portable Survey Instrument
2. One-hundred (100) mc Cs^{137} gamma point source standard or equivalent.
3. Tape measure.
4. Ring stand.

PROCEDURE:

1. Using a tape measure, mark off several distances from the point where the radiation source will be located.
2. Install new batteries in the instrument before starting the calibration.
3. Turn the instrument on and record the natural background in the area where the calibration is to be performed.
4. The encapsulated point source should be removed from the "pig" with caution. Handle the source at arm's length and minimize exposure time near the source. The source should be suspended from the

ring stand to minimize gamma ray scattering.

5. Readings should be taken over as much of the range of the instrument as possible at each location.
6. Record the Dial Reading and the Range Selector Setting at each location. The Beta shield should be closed for all readings. (Note attached Data Work Sheet).
7. After the instrument calibration is completed, make a smear of the encapsulated source using a 10.0 cm^2 smear paper before replacing the Source in the "pig" and locked storage room. Refer to the procedure for source leak testing.

CALCULATIONS:

1. The activity of the source must be corrected for decay to the day of instrument calibration. The following formula may be used to determine the activity of the source:

$$A_t = A_o \, e^{\frac{-0.693t}{T_{1/2}}}$$

A_t = activity remaining after a time interval, t.

A_o = activity of source at some original time.

e = base of natural logarithms; 2.718

t = elapsed time

$T_{1/2}$ = half-life of radioactive source.

NOTE: t and $T_{1/2}$ must be in the same units.

2. In order to determine the gamma exposure rate or true mR/Hr the following formula may be used:

$$mR/Hr = \frac{nI_r}{S^2}$$

n = number of millicuries (A_t).

I_r = mR/Hr. at 1 meter per mCi (0.33 for CS^{137} (see Radiological Health Handbook, page 131)

S = distance (meters)

3. All data obtained should be recorded on the Data Work Sheet and a calibration curve should be prepared for each instrument.

CALIBRATION of SURVEY INSTRUMENT

DATA WORK SHEET

Date__________ Source_______ Calibrated by__________ Inst.Serial No.____

Manufacturer_____________________________Cal. A_t _______

Exposure Rate mR/Hr. $= \frac{nI_R}{S^2}$

Distance (Meters)	Range Selector Setting *				Calculated mR/Hr.
	x.01	x.1	x1.0	x10.	

*Record the Dial Reading for each Setting.

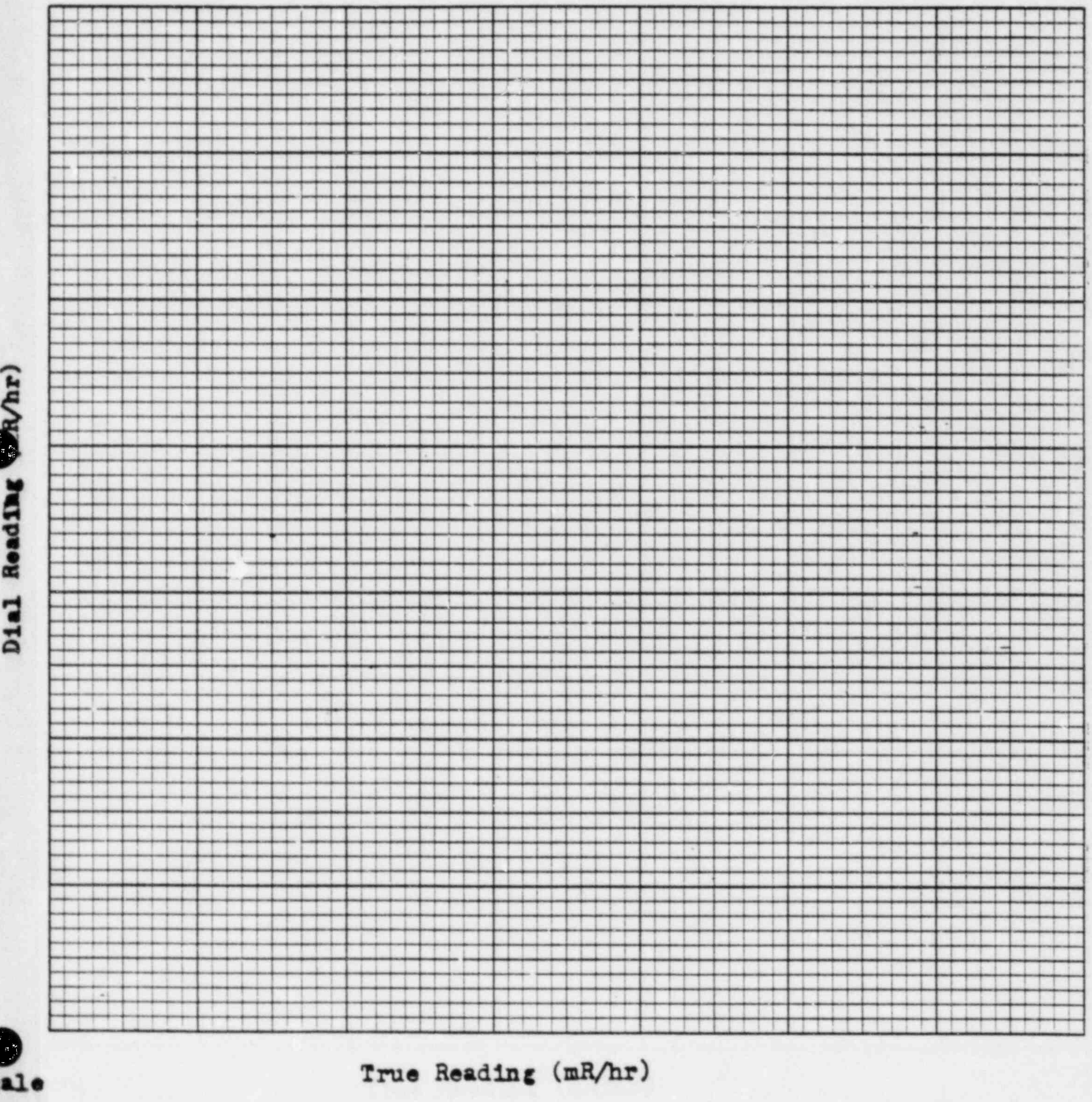
CALIBRATION CURVE

Date of Calibration ____________

Source ______________ A_o ____________ A_t ____________

Type of Instrument ________________ Serial # ________

Manufacturer _________________________ Model # __________



Scale

X 0.1 — — — — — — —

X 1.0 — — — — — — —

X 10.0

ANALYTICAL METHOD

AIRBORNE RADIOACTIVITY

SCOPE:

The airborne radioactivity level in the breathing zone is determined for fifty-seven fixed sample points in the UF_6 facility, three in the Sodium Removal facility, one in wet process, and two in the drum dumping area. The procedure involves drawing a known volume of air through a filter and counting the alpha activity approximately 90 minutes after termination of sampling. This delay in counting allows for time for approximately 80-85% of the radon and thoron content to decay out, thus giving a count rate more representative of uranium concentration, plus other long-lived alpha emitters which might be present. Air activity is calculated and reported in $\mu c/ml \times 10^{-11}$. During normal operation, air sample points are changed and counted daily. After spills or leaks the sample points are changed after decontamination is complete and at two-hour intervals until the air is free of significant air activity.

EQUIPMENT:

1. Breathing Zone Sampler: Each sampler is located approximately five feet above the floor and consists of a 25 mm open-face filter holder, filter, flowmeter, and associated fittings for connection to a central sample vacuum system. The flowmeters utilized for regulating the sampler air flows are checked quarterly by comparing flow rates with a secondary standard flowmeter which has been calibrated using a dry test meter.

2. Filters: 25 mm membrane filters (0.6-0.8 micron pore size) are used for all points except 2-3 which uses a Type A-E fiber glass filter.
3. Counting Equipment: Baird-Atomic automatic planchet counting system, Internal Proportional Counter which is calibrated monthly using a U_3O_8 standard source.

PROCEDURE:

1. Exchange the filter holder containing a new membrane or fiber glass filter (point 2-3) daily. (In the UF_6 facility there are eight points on each floor and one point in the basement lab. All points are in approximately the same position on each floor. Three additional sample points are located in the Sodium Removal facility, one in Wet Process, and two in the drum dumping area.)
2. Adjust the flowmeters to the calibrated sampling rate which is equivalent to 40 SCFH. It may be necessary to initiate sampling at a higher flow rate when new filters are installed to provide an average flow rate for the 24 hour period of 40 SCFH.
3. Make any necessary minor repairs of the sampling equipment.
4. Approximately 90 minutes after termination of sampling count the samples on the automatic planchet counter using the U-238 source as a reference and a clean paper as a blank.

5. Replace each sample in the holder with a clean filter.
6. Calculate the alpha activity for the health physics air samples as follows:

$$\text{Activity}(\mu c/ml \times 10^{-11}) = \frac{(\text{CPM-BKG}) \times 4.505 \times 10^{-7}\ \frac{\mu c}{\text{DPM}}}{\text{Instrument Efficiency} \times \text{Sampling Time in Hrs.} \times \text{Sampling Rate in SCFH} \times 28{,}320\ \text{ml/Cu Ft.}}$$

Since sampling time and rate, instrument efficiency and the conversion factors are all constants, they are combined to form a new constant (health physics factor). Thus the following simplified equation results:

$$\text{Activity } (\mu c/ml \times 10^{-11}) = (\text{CPM-BKG}) \times \text{Health Physics factor}$$

Health physics factors are calculated for both normal operating conditions (24 hr samples) and for abnormal conditions (2 hr samples). Recalculation is necessary each month after counter calibration.

7. Record results on the Health Physics Air Activity Report Sheet.
8. Report high points or high floors (activity above 4×10^{-11} µc/ml) to the foreman in UF_6 facility and to Health Physics Supervision.
9. Upon notification of a spill or leak, the sample points should be changed as soon as decontamination is complete. Calculate the air activity as though all activity present on the filter was collected subsequent to the spill and time at decontamination.

10. Continue to change the filters at two hour intervals until results indicate that the area is free of significant air activity.

CALIBRATION OF
INTERNAL PROPORTIONAL COUNTERS

SCOPE:

Internal proportional counters must be calibrated periodically to determine the optimum operating voltage (plateau) for alpha and beta detection. The counter efficiency is determined by counting a certified alpha and beta point source standard.

EQUIPMENT:

1. Gas flow proportional counter, Baird-Atomic Planchet Internal Proportional Counter or equivalent.
2. Alpha standard source, certified U_3O_8 standard, Eberline Instrument Corporation.
3. Beta standard source, certified Technetium^{99} Beta standard, Eberline Instrument Corporation.
4. P-10 Gas, 90% Argon, 10% Methane, Matheson Corporation.
5. Aluminum planchets, two-inch internal diameter, Planchets Inc.
6. Linear graph paper.

PROCEDURE:

1. Assure that the instrument high voltage is off. Turn on the scaler master switch.
2. Turn the high voltage control to its lowest setting, then turn on the high voltage.
3. Allow the instrument to warm up for five to ten minutes.

4. Turn on the P-10 purge gas, assure that gas is being purged through the sample chamber.

5. Place the alpha U_3O_8 standard in the center of an aluminum planchet and insert into the counting chamber.
6. Purge the sample chamber for a minimum of thirty seconds.
7. Turn on the counting switch and gradually increase the high voltage until the first counts are detected.
8. Turn off the count switch and clear the scaler, adjust the voltage to the nearest 50 volt increment.
9. Count the standard for one minute at this voltage setting.
10. Record the value of the high voltage setting (volts) and the corresponding count rate (CPM).

    Note: The positon of the standard source must not be changed throughout the entire measurement sequence.
11. Increase the high voltage by increments of 50 volts and repeat steps 9 and 10 for each voltage setting.

    Note: A voltage will be reached for which the counting rate will show an abnormally large increase compared to the rate observed for the previous voltage. This is the beginning of the region where alpha plus beta is counted. It is unnecessary to go beyond this voltage for counting alpha only.

12. Select the optimum voltage for alpha counting on the alpha plateau; refer to calculations.
13. Adjust the voltage to the optimum volts for alpha counting and set the timer for a twenty-minute count.
14. Count the U_3O_8 source for twenty minutes; record the total counts.
15. Remove the U_3O_8 standard from the planchet.
16. Purge the sample chamber for thirty seconds and count the alpha background for twenty minutes as in steps 13 and 14.
17. Determine the alpha counting efficiency as outlined in calculation.
18. Place the technetium^{99} beta standard in the aluminum planchet.
19. Repeat steps 6 through 17 using the tc^{99} beta standard.

    Note: A voltage will be reached for which the counting rate will show an abnormally large increase compared to the rate observed for the previous voltage. Do not operate the tube past this voltage as the counter may go into continuous discharge and be damaged.

Calculations:

1. Plot on linear graph paper the count rate (counts per minute) versus high voltage (volts).

2. Select the optimum operating voltage from the alpha and beta plateaus. This is generally 50 to 75 volts above the plateau threshold.
3. Calculate the counter efficiency for alpha and beta counting using the following equation:

$$E = \frac{\frac{C_1}{t_1} - \frac{C_2}{t_2}}{A}$$

Where: E = counter efficiency, CPM/DPM

C_1 = Total counts from standard source

C_2 = Total counts from background

t_1 = Counting time for standard (Min.)

t_2 = Counting time for background (Min.)

A = Total (4 pi) certified disintegration rate (DPM) of standard source.

CALIBRATION OF ROTAMETERS

SCOPE:

This procedure is based upon calibration of a Rotameter (secondary standard) against a wet or dry test meter (primary standard). The calibrated secondary standard rotameter is subsequently used to adjust the indicated flow rates of rotameters routinely used for Health Physics and Accountability air sampling.

EQUIPMENT:

1. American wet or dry test meter.
2. Rotameter (0-100 SCFH range.)
3. Rubber tubing.
4. Vacuum pump, Gast model 0211 or equivalent.
5. Needle valve.

PROCEDURE:

1. Assemble the rotameter calibration train as shown in Figure 1. Use a minimum amount of tubing from the test meter discharge to the inlet of the rotameter; this will insure a smaller pressure loss.
2. Open the vacuum pump by-pass valve and turn on the vacuum pump.
3. If the test meter sweep-hand indicates a flow, record the meter reading versus time through two revolutions of the sweep-hand.

4. If the test meter sweep-hand does not indicate a flow, close the by-pass valve slowly until a reading is obtained at the lowest mark on the rotameter.
5. Step 4 of this procedure should be performed for each 10SCFH division on the rotameter by successively closing the vacuum by-pass valve.
6. All data should be recorded on the Data Sheet. A calibration curve for the secondary standard should be plotted on graph paper using actual Flow Rate versus indicated Rotameter Reading.

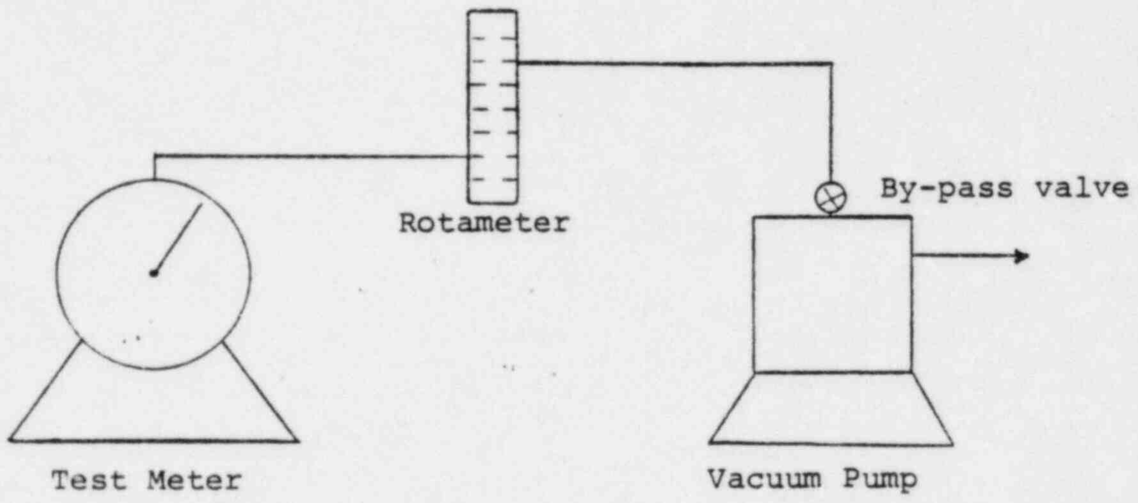


Figure 1

Rotameter Calibration Train

ROTAMETER CALIBRATION

DATA SHEET

No. of Rev's.	Total Time	Flow Rate	Rotameter Reading

FLUORIMETRIC DETERMINATION OF URANIUM IN URINE

SCOPE:

This procedure is based upon fusion of a urine sample aliquot with pure sodium fluoride. The fused sample is exposed to ultra-violet light in a fluorimeter and the uranium content determined from a standard calibration curve.

This method may be used to measure uranium in urine at concentrations greater than 2 ug/L. If high precision or a lower detection limit is required, the uranium may be concentrated by anion exchange or solvent extraction prior to fluorimetric analysis.

This method may also be used to determine the uranium content of the additional samples described at the end of the procedure.

EQUIPMENT:

1. Jarrell-Ash fluorimeter, model Galvanek-Morrison Mark V or equivalent.
2. Platinum fluorimeter dishes, 20 MM I.D.
3. Custom fabricated pellet maker - This may be fabricated by cutting a 1 ml. hypodermic syringe to leave the full bore open. The plunger is fitted with a stop so the maximum opening will contain 100 ± 10 mg of sodium fluoride.
4. Automatic non-electric 0.1 ml. pipetter, obtain from BBL division of Bio Quest Corp.
5. Fibro tip disposable pipette tips, 0.1 ml.
6. Standard fluorescence reference source.

REAGENTS:

1. Sodium Fluoride, Fluorimetric grade, Matheson, Coleman and Bell, No. S x 552 - 11209.
2. U_3O_8, National Bureau of Standards, Standard No. 950 a
3. Nitric Acid - Reagent grade

PROCEDURE:

1. Add 2 mls. of nitric acid to each urine sample.
2. Prepare a blank NaF pellet for each sample to be analyzed. Place the pellet in a clean, dry platinum dish (Note 1). Fuse for 80 seconds over a Meaker burner (Note 2).
3. Zero the instrument on the empty slide chamber. Insert the artificial reference source, depress the range one scale key and adjust the fine voltage control to obtain approximately the same reading as was obtained at the time the calibration curve was prepared.
4. Remove the reference source and insert a clean platinum dish. Depress the most sensitive scale key and adjust the background control until the minimum background reading is obtained (Note 3).
5. Determine and record the fluorescence of each blank pellet prepared.
6. Using the automatic pipetter and disposable 0.1 ml. pipette tips, pipette 0.1 ml. of each urine sample into each corresponding blank pellet dish prepared in step 2 and dry under a heat lamp.

7. Fuse the sample pellet for 80 seconds over the Meaker burner and cool for approximately 15 minutes (Note 4).
8. Read the fluorescence of each sample.
9. Subtract the blank pellet reading from each corresponding sample reading and determine the micrograms of uranium per pellet from the calibration curve.

CALCULATIONS:

Corrected Reading = (Sample reading x range)-(blank reading x range

Use the corrected reading to determine the ug U/pellet from the calibration curve.

ug U/liter = ug U/pellet x 1000 x 10

CALIBRATION:

Prepare the following standard uranium solutions from the U_3O_8 standard:

Std #1 (500 ug U/ml.): Dissolve 0.0589 gms. U_3O_8 in 2 mls. of nitric acid and evaporate to dryness. Add 10 drops HNO_3, and transfer to a 100 ml. volumetric flask. Dilute to volume (Note 5). Add 10 drops of HNO_3 to each standard subsequently prepared from standard #1.

Std #2 (100 ug/ml) - 10/50 ml. aliquot of Std. #1.

Std #3 (20 ug/ml) - 20/500 ml. aliquot of Std. #1.

Std #4 (10 ug/ml) - 10/500 ml. aliquot of Std. #1.

Std #5 (5 ug/ml) - 25/100 ml. aliquot of Std. #3.

Std #6 (2 ug/ml) - 10/100 ml. aliquot of Std. #3

Std #7 (1 ug/ml) - 10/100 ml. aliquot of Std. #4

Std #8 (0.5 ug/ml) - 5/100 ml. aliquot of Std. #4

Std #9 (0.3 ug/ml) - 3/100 ml. aliquot of Std. #4

Std #10 (0.1 ug/ml) - 10/100 ml. aliquot of Std. #7

Std #11 (0.06 ug/ml) - 20/100 ml. aliquot of Std. #9

Std #12 (0.04 ug/ml) - 4/100 ml. aliquot of Std. #7

Std #13 (0.02 ug/ml) - 20/100 ml. aliquot of Std. #10

Std #14 (0.01 ug/ml) - 10/100 ml. aliquot of Std. #10

Std #15 (0.001 ug/ml)- 10/100 ml. aliquot of Std. #14

NOTES:

1. Platinum dishes should be cleaned as follows: Wash with warm water until all flux is removed; boil in water for 30 minutes; boil in sulfuric acid 30 minutes; boil in nitric acid 30 minutes; wash and store in distilled water. Select 3 dishes at random and run blank determinations. If one or more show an abnormal reading, reclean the entire batch of dishes.
2. A booster pump may be required to obtain the 45 cm Hg gas pressure necessary to obtain complete fusion.
3. The background should be checked periodically during routine analysis and readjusted as required.
4. After fusion allow the dish to cool at least 10 minutes but not more than 30 minutes before reading.
5. It is important that the standard solutions be slightly acid to prevent hydrolysis and absorption of uranium.

They should be stored in polyethylene bottles.

ADDITIONAL SAMPLES FOR FLUORIMETRIC ANALYSIS:

Air Sampling Filters:

1. Dissolve or leach the filter paper in nitric acid and dilute to 100 mls. Additional dilution may be required for samples with high uranium content.
2. Analyze the sample beginning with step 2 of the procedure.

ug U/filter = ug U/pellet x 10 x 100

Effluent Water Samples:

1. Analyze each sample in duplicate beginning the step 2 of the procedure.

ug U/ml (PPM) = ug U/pellet x 10

Liquid Impingement Air Samples:

1. Dilute total sample volume to 300 mls. and proceed to step 2 of the procedure. Analyze each sample in duplicate.

$$\text{uc/ml} = \frac{\text{ug U/pellet} \times 10 \times 300}{20 \times 24 \times 2.832 \times 10^{4}} \times 0.677 \times 10^{-6} \text{ uc/ug}$$

OR

$$\text{uc/ml} \times 10^{-11} = \text{ug U/pellet} \times 14.9 \times 10^{-11}$$

DETERMINATION OF REMOVABLE SURFACE CONTAMINATION

SCOPE:

This method describes the procedure for measuring removable alpha surface contamination using "smear" techniques.

EQUIPMENT:

1. Two rubber laboratory stoppers, size 5½. Tape the stoppers together back-to-back. Place a small piece of double-sided tape on each end of stopper.
2. Double-sided tape (carpet tape), one-inch roll.
3. One-inch filter paper, hard surface, Watman No. 42 or equivalent.

PROCEDURE:

1. Attach a pre-numbered smear paper to the adhesive end of the rubber stopper.
2. Record the smear paper number on a floor plan drawing to show the location of the smear sample.
3. Wipe or smear the area or article to be measured by pressing and moving the paper across the surface. If one-inch paper is used, the surface area of the paper is 5 cm^2 and:

   $$\frac{100\ cm^2}{2.54\ cm} = 39.4\ cm\ (15.5\ inches)$$ is the

   required length of smear to be taken to sample 100 cm^2 of the surface to be measured. This smear may be taken in one area, or equally divided over a general area if relative contamination levels are desired.

4. Count each smear paper for alpha radioactivity. Convert the count rate to DPM using the counter alpha efficiency.
5. Record the removable alpha surface contamination as DPM/100 cm^2 for the appropriate area where the smear was taken.
6. Notify Health Physics supervision of each contamination measurement which exceeds the Plant administrative limit.

DETERMINATION OF GROSS ALPHA AND BETA RADIOACTIVITY IN WATER SAMPLES

SCOPE:

This method describes the procedure used to determine the gross alpha and beta radioactivity in water samples.

EQUIPMENT:

1. Gas flow proportional counter.
2. 2-liter beaker.
3. 400 ml. platinum dishes.
4. 250 ml. graduate.
5. Hot plate and asbestos pads.
6. 2-inch aluminum planchets.

PROCEDURE:

1. Thoroughly mix the water sample and with continuous mixing, pour 200 mls. of sample into a 250 ml. graduate (Note 1).
2. Transfer the 200 ml. sample into a 400 ml. platinum dish. Wash-out the graduate with a small quantity of double distilled water.
3. Pour 200 mls. of tap water into a second platinum dish. This blank sample is used for background counting.
4. Place the sample and blank on a hot plate. Use asbestos pads to prevent boiling and evaporate down to approximately 15 mls.
5. Carefully transfer small portions of the sample and blank into marked aluminum planchets.

6. Slowly evaporate the planchet samples. As the planchet volume is reduced, add more sample from the platinum dish.
7. Wash the platinum dish with small quantities of double distilled water and transfer this to the planchet.
8. Evaporate the samples to dryness. Continue drying on the hot plate for approximately thirty minutes.
9. Count each sample twenty minutes, using the gas flow internal proportional counter. Purge the sample chamber for thirty seconds and count each sample at the optimum operating voltage for Alpha, and then for Beta.
10. Record the total counts and counting time for each sample.

CALCULATIONS:

Calculate the gross Alpha and Beta radioactivity using the following equations:

Alpha Radioactivity

$$A = \frac{\dfrac{N_{sa}}{T_{sa}} - \dfrac{N_{ba}}{T_{ba}}}{(V)\ (E_a)\ (F_a)\ (2.22)}$$

Where: A = Activity (pci/ml.)

N_{sa} = Alpha count.

N_{ba} = Alpha background count.

T_{sa} = Alpha counting time (min.)

T_{ba} = Alpha background counting time (min.)

V = Volume of sample (Ml.)

E_a = Alpha counting efficiency.

2.22 = Disintegrations/Picocurie.

F_a = Alpha self absorption factor.

Beta Radioactivity: (Note 2)

$$A = \frac{\dfrac{\frac{N_{sb}}{T_{sb}} - \frac{N_{bb}}{T_{bb}}}{E_b} - \dfrac{\frac{N_{sa}}{T_{sa}} - \frac{N_{ba}}{T_{ba}}}{E_a}}{(V)\ (F_a)\ (2.22)}$$

Where: A = Activity (pci/ml.)

N_{sb} = Beta count.

N_{bb} = Beta background count.

N_{sa} = Alpha count.

N_{ba} = Alpha background count.

T_{sb} = Beta counting time (Min.)

T_{bb} = Beta background counting time (Min.)

T_{sa} = Alpha counting time (Min.)

T_{ba} = Alpha background counting time (Min.)

E_a = Alpha counting efficiency.

E_b = Beta counting efficiency.

V = Volume of sample.

2.22 = Disintegrations/picocurie.

F_a = Beta self absorption factor.

<u>Calculate the self-absorption factor (F_a) as follows:</u>

$$\underset{(\mathrm{mg/cm^2})}{\text{Sample thickness}} = \frac{(T_s)\,\dfrac{M_s}{1000}}{20.3\ \mathrm{cm^2}}$$

Where: Sample thickness = Mg/cm^2

T_s = Total solids content (dissolved and suspended,) of water sample (Mg/Liter).

M_s = Mls. of sample counted.

20.3 = Area (cm^2) of 2" diameter planchet.

Determine the sample thickness and read the corresponding self-absorption factors (F_a) from the calibration curve.

<u>NOTES</u>:

1. A smaller or larger sample may be used depending upon the total solids content of the sample. Alpha particles are easily attenuated by dried solids in the planchet. A sample thickness of greater than 5.0 mg/cm^2 should not be used for Alpha counting.

Notes (continued)

2. When counting samples which contain both Alpha and Beta activity, it is necessary to subtract the Alpha contribution from the total counts obtained on the Beta plateau (more accurately termed the Alpha plus Beta plateau).

DETERMINATION OF URANIUM IN ENVIRONMENTAL MATERIALS

SCOPE:

This procedure describes the method for the determination of uranium in environmental materials. A dry, weighed, homogenous aliquot of soil, mud, or vegatation is dissolved in nitric acid and the uranium concentration of the sample is determined fluorometrically. The uranium concentrations thus obtained are then applied to the respective sample weights to determine the total uranium content.

EQUIPMENT:

1. Jarrell-Ash Fluorometer Model Galvanek-Morrison Mark V
2. Platinum fluorometer dishes, 20 mm I.D.
3. Sodium fluoride pellet dispenser
4. Hotplate
5. Muffle furnace
6. Meker burner
7. 250-ml beakers
8. 250-ml platinum dishes
9. 25-ml graduated cylinders with glass stoppers
10. Automatic non-electric 0.1 ml pipetter
11. Fibro tip disposable pipette tips, 0.1 ml.

REAGENTS:

1. Sodium fluoride
2. Concentrated nitric acid
3. Nitric acid - 50% by volume
4. Potassium pyrosulfate - fused power ($K_2S_2O_7$ - $KHSO_4$)

5. Uranium stock solution, 500 µg U/ml. Dissolve 58.9 mg of pure U_3O_8 in 2 ml of concentrated nitric acid and evaporate to dryness. Dissolve the residue in water containing 0.5 ml concentrated nitric acid and quantitatively transfer to a 100ml volumetric flask. Dilute to volume with demineralized water and store in polyethylene bottle.

PROCEDURE:

A. Sample Preparation

1. Water

   a. Water samples which are clear solutions may be pipetted directly and analyzed with no previous preparation.

   b. Samples containing suspended solids should be evaporated to dryness with an equal volume of concentrated nitric acid, diluted to the - original volume with 1.0 N nitric acid and then analyzed.

2. Vegetation

   a. Spread a thin layer of the sample on a large tray and dry in an oven at 105°C for at least 8 hours.

   b. Cut or crumble dry sample into small pieces.

   c. Weigh a 10-gram portion to the nearest 0.1 mg and place in a 250-ml platinum dish.

   d. Reduce the sample to an ash over a Meker burner. Care must be taken, the vegetation should smoulder and never be permitted to catch on fire. Otherwise there is danger of particles of vegetation being swept out.

e. Place the samples in a muffle furnace at 500°C for at least 3 hours.

f. Allow the dishes to cool and transfer the ash with 1:1 HNO_3 into a 250-ml beaker.

g. Bring volume to about 50 mls with 1:1 HNO_3, evaporate to near dryness.

h. Repeat step (g), dilute to 15 mls with 1:1 HNO_3.

i. Filter into a 25-ml graduated cylinder.

j. Rinse beaker and filter paper with 1:1 HNO_3 and dilute sample to 25 mls with demineralized water.

3. Soil and Mud

a. Spread samples on a large tray and dry in an oven at 105° C for about 8 hours.

b. Grind samples and sift through a No. 20 U.S. standard sieve to produce a homogenous sample.

c. Weigh a 2-gram portion to the nearest 0.1 mg and place in a 150 ml beaker.

d. Add 40 to 50 ml concentrated HNO_3 and evaporate on low heat to a volume of 15-20 ml.

e. Repeat step (d).

f. Filter samples into 25 ml graduated cylinders.

g. Rinse beaker and filter paper with 1:1 HNO_3 and dilute sample to 25 ml with demineralized water.

4. Environmental Filters

    a. Place environmental filters in a 250 ml polyethylene beaker, sample side up and cover with 1N HNO_3, approximately 10 mls. Treat an unused filter in the same manner to serve as a blank.

    b. Cover the beakers and allow the filters to leach for 2 to 3 hours.

    c. Transfer the solution to a 25 ml graduated cylinder.

    d. Rinse the filter twice with 5 ml portions of 1N HNO_3, transferring each rinse to the graduate.

    e. Dilute the sample solution to 25 mls with demineralized water.

B. Calibration

The procedure for preparing standard solutions and the calibration curve is described in the "Fluorimetric Determination of Uranium in Urine". The standards and calibration curve are routinely prepared each month. Both the equipment for uranium analysis and calibration curve are available in the fluorometer lab.

C. Determination

1. Place sodium fluoride pellets from the dispenser into clean dry platinum dishes.

2. Place the dishes into the platinum loop holder and fuse for 80 seconds over a Meaker burner.

3. Remove the dishes and allow to cool for at least 10 minutes.

4. Measure the fluorescence of each dish. Record the blank

reading.

5. Using the automatic pipetter and disposable 0.1 ml pipette tips, pipette 0.1 ml of the well mixed sample solution into a blank pellet dish.
6. Evaporate the sample solution on the pellet to dryness under a heat lamp.
7. Fuse the sample pellet for 80 seconds over a Meaker burner and cool for approximately 15 minutes.
8. Read the fluorescence of each sample.
9. Subtract the blank pellet reading and determine the micrograms of uranium per pellet from the calibration curve.

D. Calculations

Calculate the uranium concentration in samples by the following formula:

1. Water

   $\mu g\ U/ml = ppm = \mu g\ U/pellet \times 10$

2. Soil or mud

   $$\mu g\ U/gm = ppm = \frac{\mu g\ U/pellet \times 10 \times 25}{\text{Sample weight in grams}}$$

3. Vegetation

   $$\mu g\ U/gm = ppm = \frac{\mu g\ U/pellet \times 10 \times 25}{\text{sample weight in grams}}$$

4. Environmental Filters

   $\mu g\ U/filter = \mu g\ U/pellet \times 10 \times 25 \times 1/0.9$

5. Record and report results. Minimum sensitivity for each sample media using standard volumes and weights given in this procedure are as follows:

Mud and Soil	<0.03 ppm
Vegetation	<0.01 ppm
Water	<0.005 ppm
Environmental	<0.125 µg

REFERENCE:

1. "Procedure for the Fluorimetric Determination of Uranium", Nuclear Power Systems, Combustion Engineering, Inc., Windsor, Connecticut.
2. "Fluorimetric Determination of Uranium in Urine", Metropolis Works, Nuclear Services Division, Allied Chemical Corporation, Metropolis, IL.

NOTE:

1. Results for environmental filters are divided by 0.9 because it was determined that a 1.0 N HNO_3 leach was only 90% efficient.

DETERMINATION OF FLUORIDE IN ENVIRONMENTAL MATERIALS

SCOPE:

This procedure describes the method for the determination of leachable fluoride in environmental materials. A dry, weighed, homogenous aliquot of soil, mud, or vegetation is leached with 2N nitric acid. The fluoride concentration of the sample solution is determined using a specific ion electrode method. The fluoride concentrations thus obtained are then applied to the respective sample weights to determine the fluoride content.

EQUIPMENT:

1. pH meter - Orion research model 601A
2. Calomel reference electrode - Orion model 90-01
3. Fluoride ion selective electrode - Orion model 94-09
4. Polyethylene beakers (250 ml, 50 ml)
5. 100-ml graduated cylinder
6. 1-liter polyethylene bottle to store stock fluoride solution
7. 1-liter volumetric
8. 3-ml pipet

REAGENTS:

1. Stock Fluoride Solution - Dissolve 0.221 gm of anhydrous sodium fluoride (NaF) in deionized water and dilute to 1 liter. Solution contains 100 ug F^-/ml. Store in a polyethylene bottle.

2. 2N Nitric Acid Solution - Add 125 mls of concentrated nitric acid (HNO_3) to approximately 500 mls of deionized water. Dilute to 1 liter with deionized water.
3. Total Ionic Strength Adjustment Buffer (TISAB).

PROCEDURE:

A. Sample Preparation

1. Soil and Mud
    a. Spread samples on a large tray and dry in an oven at 105°C for about 8 hours. Note 1.
    b. Grind samples and sift through a No. 20 U.S. standard sieve to produce a homogenous sample.
    c. Weigh out two 2-gram aliquots of the sample.
    d. Place sample in a 250-ml polyethylene beaker and add 50 ml of 2N HNO_3 solution.
    e. Stir occasionally to ensure complete contact of soil with acid.
    f. Cover and allow to stand overnight.
    g. Proceed to Section C.
2. Vegetation
    a. Spread a thin layer of the sample on a large tray and dry in an oven at 105°C for at least 8 hours. Note 1
    b. Cut or crumble dry sample into small pieces.
    c. Weigh out two 5-gram aliquots of sample.
    d. Place sample into a 250-ml polyethylene beaker and add 200 ml of 2N HNO_3 solution.

   e. Stir occasionally to wet all of the sample. Cover and allow to stand overnight.
   f. Proceed to Section C.

3. <u>Water</u>
   a. No special Sample preparation is required; however, dilutions may be necessary to bring fluoride concentrations into the range of the calibration curve.
   b. Proceed to Section C.

4. <u>Environmental Filters</u>
   a. Place environmental filters in a 250 ml polyethylene beaker, sample side up and cover with 1N HNO_3, approximately 10 mls. Treat an unused filter in the same manner to serve as a blank.
   b. Cover the beakers and allow the filters to leach for 2 to 3 hours.
   c. Transfer the solution to a 25 ml graduated cylinder.
   d. Rinse the filter twice with 5 ml portions of 1N HNO_3, transferring each rinse to the graduate.
   e. Dilute the sample solution to 25 mls with demineralized water.
   f. Proceed to Section C.

B. <u>Calibration</u>

1. Pipette 0.1, 0.5, 1.0, 2.0, 3.0, 5.0, 7.0, and 10 mls of the fluoride stock solution into 100 ml volumetric flasks and dilute each to the mark with double distilled water. These standards contain 0.1,

0.5. 1.0, 2.0, 3.0, 5.0, 7.0, and 10.0 ppm F respectively.

2. Pipette 3 mls of each standard into a 50 ml polyethylene beaker and dilute to 10 mls with water. Add 10 ml of TISAB and mix well. Measure and record the potential of each solution in millivolts.

3. Prepare a calibration curve by plotting the millivolts on the linear axis and ppm F^- on the logarithmic axis of 2 cycle semilogarithmic graph paper. Note 2.

C. Determination

1. Dilute 3 mls of the sample to 10 ml with water and add 10 ml of TISAB. Mix well.

2. Determine the potential of the buffered sample in millivolts using a fluoride specific ion electrode.

3. Determine the sample fluoride concentration from the standard calibration curve.

D. Calculations

1. Soil -

$$\text{ppm F} = \frac{\text{ppm F}^- \text{ of solution x volume of solution in mls}}{\text{grams of soil}}$$

2. Vegetation -

$$\text{ppm F} = \frac{\text{ppm F}^- \text{ of solution x volume of solution in mls}}{\text{grams of vegetation}}$$

3. Water -

F^- ppm = mg F^-/ml = F^- ppm from curve

4. Environmental Filters -

F^- µg/filter = mg F^-/l in solution x volume of solution in mls

E. Record and report results. Minimum sensitivity for each sample media using standard volumes and weights are as follows:

Soil	<2.5 ppm
Vegetation	<4 ppm
Water	<0.1 ppm
Environmental Filters	<2.5 ug/filter

REFERENCES:

1. "Procedure for Determination of Fluorides in Soils, Mud, Vegetation, Gumpaper Fallout, Precipitation, Well Water and Surface Water," Nuclear Power Systems, Combustion Engineering, Inc., Windsor, Connecticut.
2. McQuaker, Neil and Gurney, Mary, Anal. Chem., 49, 53.
3. "Determination of Urinary Fluoride", Metropolis Works, Allied Chemical, Metropolis, IL.

Note 1: Samples may be air dried for several days if time permits.

Note 2: The standards and calibration curve are routinely prepared each month. Both the equipment for fluoride analysis and calibration curve are available in the fluorometer lab.

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APPENDIX "G"

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JAN 31 1980

FCUF:ALS
40-3392
SUB-526, Amendment No. 3

FEB 7 1980

Allied Chemical Corporation
Specialty Chemical Division
Nuclear Activities
ATTN: Mr. J. C. Bishop, General Manager, UF_6
P. O. Box 8005R
Morriston, New Jersey 07960

Gentlemen:

In accordance with your submittal dated August 14, 1978, and pursuant to Title 10, Code of Federal Regulations, Part 40, Condition No. 17 of Materials License No. SUB-526 is hereby amended to include your decommissioning and financial plans. Accordingly, the condition shall be changed to read as follows:

> Condition 17. At the end of plant life the licensee shall decontaminate the facility and site in accordance with the general decommissioning plan (except that approval for burial of radioactive contaminated material on-site is not granted) submitted in the enclosures to the letter dated August 14, 1978, so that the facility and site can be released for unrestricted use.
>
> The financial commitment, made by a corporate officer in a letter dated August 7, 1978, to ensure that funds will be available for decommissioning, is hereby incorporated as a condition of the license.

All other conditions of the license shall remain the same.

Please note that the above condition specifies that approval for on-site burial of radioactive contaminated material is not granted. At the time of decommissioning Allied Chemical may apply for on-site burial if such burial is permitted by the regulations.

The above condition was discussed and agreed upon between you and Mr. Nixon of my staff on January 10, 1980.

For your information, a copy of the Safety Evaluation prepared in support of this amendment is enclosed.

FOR THE NUCLEAR REGULATORY COMMISSION

R. G. Page

R. G. Page, Acting Chief
Uranium Fuel Licensing Branch
Division of Fuel Cycle and
Material Safety

Enclosure: Safety Evaluation

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JAN 31 1980

DOCKET NO.: 40-3392

APPLICANT: Allied Chemical Corporation

FACILITY: Metropolis, Illinois Nuclear Service Div.

SUBJECT: REVIEW OF LICENSE AMENDMENT APPLICATION FOR FUTURE DECOMMISSIONING PLAN, LICENSE NO. SUB-526, AMENDMENT NO. 3

REVIEWER: A. Soong

I. Introduction

Allied Chemical Corporation (Allied) is a multi-product chemical manufacturing facility producing sulfur hexafluoride, iodine and antimony pentafluorides, liquid fluorine and uranium hexafluoride. The production of uranium hexafluoride is the only operation requiring licensing by US NRC pursuant to the providions of 10 CFR 40.

Allied, by letter dated August 14, 1978, submitted a plan for the future decommissioning of the places of use and sites authorized by Materials License No. SUB-526, so that they could be released for unrestricted use.

II. Decommissioning Plan and Costs

The general decommissioning plan submitted by Allied has the following features:

1. Approximately 20,000 ft.^{2} of the plant site is considered to be a contaminated area which needs to be decontaminated.

2. The plan includes criteria for the disposition of equipment and facilities as follows:

    a. For sale to other NRC licensed persons.
    b. Release to unrestricted use.
    c. Burial in an approved site or on-site.

3. A detailed step-by-step decommissioning plan for the facility will be submitted to NRC for approval prior to the start of decontamination.

4. Upon completion of the decontamination operation, a radiological survey of the entire site will be conducted and the survey results will be submitted to NRC for termination of the license.

5. Based on Allied's previous clean-out experience for the entire plant in 1964, Allied estimates that 30 tons of uranium could be recovered in the course of decontamination and that sale of this recovered uranium would yield over two million dollars which would be committed to the decontamination effort.

III. Financial Plan

Allied, by an attachment to the August 7, 1978 letter, committed that adequate funds will be available for decontamination of the facility at the time of decommissioning.

IV. Conclusion

The staff has reviewed the decommissioning plan of Allied Chemical Nuclear Service Division and conclude that the plan is reasonable and appears to be adequate. Allied proposed in the plan that on-site burial of radioactive contaminated material be allowed as one of possible ways of disposing of the contaminated material. On-site burial of radioactive material cannot be approved at this time. Allied Chemical was informed, however, that application may be made for on-site burial at the time of decommissioning if such burial is permitted by the regulations at that time.

The staff has evaluated Allied's financial plan for decontamination of the facility and has accepted the letter commitment from the corporate vice president as adequate assurance that the facility will be decontaminated at the end of plant life so it can be released for unrestricted use.

On the basis of the findings in the current assessment, it is recommended that Condition No. 17 of Source Material No. SUB-526 be amended to include Allied's decommissioning and financial plans. The Condition should read as follows:

> Condition 17. At the end of plant life the licensee shall decontaminate the facility and site in accordance with the general decommissioning plan (except that approval for burial of radioactive contaminated material on-site is not granted) submitted in the enclosures to the letter dated August 14, 1978, so that the facility and site can be released for unrestricted use.

The financial commitment, made by a corporate officer in a letter dated August 7, 1978, to ensure that funds will be available for decommissioning, is hereby incorporated as a condition of the license.

Soong
A. L. Soong
Uranium Process Licensing Section
Uranium Fuel Licensing Branch
Division of Fuel Cycle and
Material Safety

Approved by: W. T. Crow
W. T. Crow, Section Leader

Allied
Chemical

Specialty Chemicals Division
Nuclear Activities
P O Box 8005R
Morristown New Jersey 07960

August 14, 1978

Mr. L. C. Rouse, Chief
Fuel Processing and Fabrication Branch
Division of Fuel Cycle and
Material Safety
United States Nuclear Regulatory
Commission
Washington, D.C. 20555

Reference: License SUB-526, Docket No. 40-3392

Dear Mr. Rouse:

On February 8, 1978, Allied Chemical submitted to you a Plan for decommissioning the uranium hexafluoride facility at Metropolis, Illinois (License SUB-526).

Attached Plan supersedes and replaces the earlier Plan in its entirety.

Also attached, is a letter signed by Mr. R. C. Ashley, Group Vice President, Allied Chemical Corporation relating to the Corporation's intent to decommission and its commitment to allocate funds then available to such activity.

Our previous conclusion, that the value of uranium recovered during decontamination and of the salvage of costly metals would be significantly greater than the costs of decontamination, remains unchanged.

Very truly yours,

RI Newman

R. I. Newman, Director
Nuclear Regulatory and
Governmental Affairs

RIN:cee
Attachment

BCC: J. C. Bishop
A. D. Riley✓
S. R. Stevinson

DECOMMISSIONING PLAN

METROPOLIS WORKS

URANIUM HEXAFLUORIDE FACILITY

License No. SUB-526

Docket No. 40-3392

SPECIALTY CHEMICALS DIVISION

ALLIED CHEMICAL CORPORATION

AUGUST 1978

(Replaces and supersedes January 1978 Plan)

Allied Chemical's Metropolis Works is a chemical plant that manufactures (or converts other materials to) a number of fluoride - containing materials, one of which is uranium hexafluoride (UF_6). It is probable that this plant will continue as a chemical manufacturing plant for many years. In this case, its premises will be excluded from uncontrolled access as is customary with chemical plants. However, in accord with the request of the U.S. Nuclear Regulatory Commission and in the event that Allied Chemical should wish to terminate its 10 CFR Part 40 License for the UF_6 plant and release it for uncontrolled access, a plan has been drawn up for its decontamination and decommissioning.

As now conceived, and if the decommissioning were done under today's regulations, the physical plan would be as follows (financial aspects are treated later):

1. A detailed step-by-step plan would be developed and submitted to NRC for review and approval. This would identify such activities as:

   a) What portions of the facility, such as concrete pads and floors, soil areas, etc. required survey to identify radiation levels. It would not be necessary to survey uranium-handling process equipment, all of which would be considered as needing decontamination. Based on radiation levels, radionuclide content, etc. determinations would be made as to, on a case-by-case basis, ship to licensed burial site, bury on-site*, decontaminate (scraping concrete to remove surface contamination, for instance) deep-plow (for soil)**, or leave as is.

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* Two modes of on-site burial could be utilized. One would be burial in an approved land-fill type operation. The other would be in accord with 10 CFR § 20.304 which permits, under certain conditions, burial of up to 325 lbs. uranium each of twelve times in any year. It is also assumed that there is a level of contamination recognized as sufficiently low as to be not of concern for unrestricted use.

** EPA in Report No. EPA 520/4-77-016, "Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the General Environment" sets forth (page 3) "Dilution by plowing or other similar techniques" as a recommended remedial measure for reduction of surface contamination.

b) The order in which items would be decontaminated. The program would be such as to yield uranium in its several chemical forms, so that the total value is maximized; i.e., as much specification UF_6 as possible.

2. Some specific activities would include:

   a) All uranium-handling metal process and ventilation equipment would be dismantled and decontaminated prior to release to a scrap dealer licensed by NRC to receive contaminated scrap. This decontamination would consist of one or more conventional methods such as vacuuming, scrubbing, use of high pressure water or steam, use of chemicals or sand blasting. As appropriate, provision would be made to minimize the spread of contamination. Material would be transported from the plant in accord with D.O.T. regulations.

   b) Non-metallic materials would also be decontaminated and shipped to a licensed burial ground or buried on-site depending on level of residual contamination.

   c) The building would be decontaminated to acceptable levels of contamination if it were to be used subsequently for another, unlicensed purpose. The methods of decontamination would be similar to those set forth above for process equipment, plus scraping of concrete or removal of concrete when, for instance, contamination had penetrated through cracks.

   d) The uranium settling ponds would be emptied of material, the liners cleaned (as was done in 1964), the liners removed and buried and the ground under the liners surveyed to determine the appropriate remedial action (plowing, removal for burial, etc.) to be taken.

   e) All sumps and underground lines which have handled uranium-bearing liquors will be surveyed, and on the basis of such survey, determination would be made as to which would be removed, decontaminated and buried.

3. Uranium removed in the course of the decontamination would be converted to a saleable form, depending on what equipment was still operable, and shipped to another licensed facility.

4. Health physics activities throughout the decontamination program would be at a high level. Continuing surveys would be made to guide the decontamination work (assessing level of residual contamination) and to minimize and quantify personnel exposures.

5. Rather than submitting reports to the NRC on progress of the work, it is anticipated that the NRC would keep up-to-date by on-site visits.

6. Upon completion of the decontamination, Allied Chemical would make a final radiation survey to assume it had met the criteria set forth in the Plan previously approved by NRC. It would then report the results of such survey to NRC and request that License SUB-526 be terminated.

There are several factors pertinent to the financial aspects of the decommission. However, inasmuch as Allied Chemical did, indeed, undertake a thorough decontamination of the facility in 1964 and knows both its cost and the amount of uranium recovered thereby, it is possible that it can be assured that the funds will exist in an amount much more than adequate to finance the operation.

Factors important to the financial considerations include:

1. After the contract processing of uranium for the AEC had ceased in 1964, the entire plant was cleaned of uranium. This experience yielded two areas of information which now permit Allied Chemical to look at decontamination through eyes of experience rather than through a speculative study. The first of the two areas is that of the cost in total labor, materials and overhead. The second is in the quantity of uranium expected to be recovered in such an operation.

2. Examination of records of costs related to the 1964 clean-out shows the labor cost to have been about $220,000 in 1964 dollars. The average hourly wage rate in 1964 was $4.00/hr., including fringe benefits. The average in early 1978 is over $10.00. This rate of escalation leads to the conclusion that the 1964 effort would cost, today, less than $600,000. The work in 1964 included dismantling much of the piping, conveyors, etc. to make possible full access for removing material. It also included clean-out of the ponds, etc.

3. The 1964 clean-out yielded some 70 tons of uranium from pipes, vessels, ponds, etc. Very conservatively assuming that only 30 tons is recovered in the final decontamination, its value, at also a conservative price of $40/lb. U_3O_8, would be over $2,000,000.

4. Much of the equipment in the UF_6 facility (because of the very hostile corrosive environment) consists of such high value materials as monel and nickel. (For instance, a single fluorinator filter train contains 10,000 lbs. of

monel and 8,200 lbs. of nickel.) As a result, the salvage value (assuming reasonable decontamination) exceeds the cost of dismantling. To verify this conclusion, Allied Chemical asked a reputable, NRC-licensed scrap metal dealer to make an independent assessment. His verification is stated in his letter of January 23, 1978, included here as attachment #1.

From the above, it can be seen that the uranium cleaned out of the process equipment will yield over $2,000,000, which will be committed (to the extent required) to the decontamination and decommissioning effort. Clean-out will cost, based on experience, some $600,000. The net cost of completing the dismantling and disposing of the metal in the facility will, at the worst, be zero -- with possibly a net income. This leaves over $1,400,000 available for plowing, removal of dirt and concrete, and disposal of other non-salvageable non-metallic parts of the facility. Using a very conservatively assumed $10/cu.ft. for handling and disposing of this material, it would be adequate to dispose of 140,000 cu.ft. of such material. To put this in perspective, it is likely that much less than 20,000 sq. ft. of the plant site will require any decontamination.* The 140,000 cu.ft., over this area, would allow total removal to a depth of over seven ft., clearly more than would be needed. This should leave no doubt that the funds committed are well in excess of the money which will be required for the decommissioning and decontamination.

*Based on a 1977 study involving analysis of ten core samples (0"-2", 2"-6", and 6"-10" sections of each) taken on the plant site and on knowledge of areas which, over the years, have been subject to contamination.

Allied Chemical

P.O. Box 3000R
Morristown, New Jersey 07960

R.C. Ashley
Group Vice President

August 7, 1978

Mr. L. C. Rouse, Chief
Fuel Processing and Fabrication Branch
Division of Fuel Cycle and
Material Safety
United States Nuclear Regulatory
Commission
Washington, D. C. 20555

Dear Mr. Rouse:

In regard to Allied Chemical's Metropolis, Illinois uranium hexafluoride facility (license SUB-526) Decommissioning Plan, this letter confirms Allied Chemical's commitment related to such decommissioning.

If, at some time in the future, Allied Chemical is required to decontaminate and decommission the Metropolis uranium hexafluoride facility because it is no longer being used for its intended purpose, and the site is to be no longer used, nor controlled by Allied Chemical or a successor, leaving the facility accessible to the public, Allied Chemical will assure through its management the financing and implementation of the work required to decontaminate and decommission the facility to the extent now required by law and/or regulation, according to its August 1978 Decommissioning Plan.

The foregoing commitment will continue until such time that the facility may be sold and the new owner has provided satisfactory assurance to the Nuclear Regulatory Commission (or successor thereto) with respect to decontamination and decommissioning.

Yours truly,

R. C. Ashley
Group Vice President

/cee

DAVID WITHERSPOON, INC.

901 OLD MARYVILLE PK. • KNOXVILLE, TENN.
P. O. BOX 806 • PHONE: 577-1613
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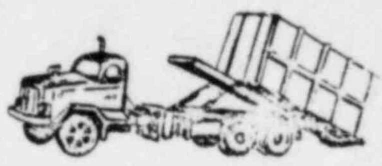
"Environmental Recycling Organization"



January 23, 1978

Mr. R. W. Yates
Allied Chemical Company
P. O. Box 430
Metropolis, Ill. 62960

Dear Mr. Yates:

In reference to my recent visit to your plant at which time I examined your UF_6 manufacturing buildings, process equipment, vessels lines, etc., I believe the following things can be done.

A large part of the scrap metal to be disposed of consists of building structural steel which could easily be decontaminated, if at all necessary, to meet NRC contamination release limits. This material could then be disposed of as non contaminated scrap.

Allied Chemical will provide clean-out of process equipment, vessels, lines, etc. to remove the bulk of the residual uranium. This would include, where feasible, washing or steming of the equipment. This scrap metal very likely would not meet the NRC contamination release limits and would require disposal as contaminated scrap.

In consideration of the items listed above, the salvage value of all metal contained in the UF6 manufacturing area would equal or exceed the labor cost of dismantling and decontaminating the metal.

Thank you for the courtesies shown to me on my visit. If I can be of further assistance, please do not hesitate to contact me.

Very truly yours,

D Witherspoon Jr

David Witherspoon, Jr.

DW,Jr./mg