NUREG-1071

Environmental Impact Appraisal
for renewal of Source Material License No. SUB-526

Docket No. 40-3392

Allied Chemical Company
UF_6 Conversion Plant

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

May 1984

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ABBREVIATIONS AND ACRONYMS

ALARA	As low as reasonably achievable
AMAD	Activity median aerodynamic diameter
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DOE	Department of Energy
DOT	Department of Transportation
EIA	Environmental Impact Appraisal
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPDM	Ethylene-Propylene Diene Monomer
EPF	Environmental Protection Facility
HF	Hydrogen fluoride
ICRP	International Commission on Radiological Protection
LPG	Liquid petroleum gas
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
PGDP	Paducah Gaseous Diffusion Plant
TLD	Thermoluminescent dosimeter
s	seconds
min	minutes
h	hours
d	days

LIST OF FACTORS FOR CONVERSION OF ENGLISH TO INTERNATIONAL SYSTEM OF UNITS (SI)

The following table gives the factors used in this document for the conversion of conventional English units to the equivalent International System of Units (SI) now being adopted worldwide or conventional metric units. The conversion factors have been obtained from the ASTM publication *Standard for Metric Practice** and are used to four-digit accuracy, since most of the values in this document are not known to any more exactness. After conversion, the SI values have been rounded to reflect an accuracy sufficient for the requirements of this document. Most of the values will be presented in SI units with the equivalent English unit following within parentheses.

Conversion of English to SI Units

To Convert From	To	Multiply By
acre	hectare (ha)	0.4047
barrel (bbl)	cubic meter (m^3)	0.1590
cubic feet/min (ft^3/min)	m^3/min	0.02832
feet (ft)	meters (m)	0.3048
cubic feet (ft^3)	cubic meters (m^3)	0.02832
cubic yards ($yards^3$ or yd^3)	m^3	0.7645
gallon (gal)	cubic meters (m^3)	0.003785
gal/min	m^3/min	0.003785
gal/min	m^3/h	0.2271
gal/min	liters/s (L/s)	0.06309
inch (in.)	centimeters (cm)	2.54
inch (in.)	meter (m)	0.0254
mile (statute)	kilometer (km)	1.609
square mile ($mile^2$)	square kilometer (km^2)	2.590
pound (lb)	kilograms (kg)	0.4536
ton (short)	kilograms (kg)	907.2

*American Society for Testing and Materials, Standard E-380, *Standard for Metric Practice*, February 1980.

1. PURPOSE OF AND NEED FOR ACTION

1.1 INTRODUCTION

Allied Chemical Company operates a privately owned UF_6 production facility at Metropolis, Illinois. At this facility, uranium ore concentrates are converted into uranium hexafluoride (UF_6). The UF_6 product from this facility is shipped to Department of Energy (DOE) gaseous diffusion plants for enrichment of the ^{235}U isotope.

In response to an application (July 1, 1982) by Allied Chemical Company for renewal of Source Material License No. SUB-526, the U.S. Nuclear Regulatory Commission (NRC), with the technical assistance of Oak Ridge National Laboratory (ORNL), prepared this environmental assessment pursuant to Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508) and NRC regulations (10 CFR Part 51), which implement requirements of the National Environmental Policy Act (NEPA) of 1969 (P.L. 91-190). Paragraph 1508.9 of the CEQ regulations (40 CFR) defines "environmental assessment" as follows:

1. An environmental assessment is a concise public document, for which a federal agency is responsible, that serves to

   - briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a finding of no significant impact,
   - aid an agency's compliance with the Act when no EIS is necessary, and
   - facilitate preparation of an EIS when one is necessary.

2. An environmental assessment shall include brief discussions of the need for the proposal, of alternatives as required by Sect. 102(2)(E) of NEPA, and of the environmental impacts of the proposed action and alternatives. It shall also include a listing of agencies and persons consulted.

An Environmental Impact Appraisal (EIA) of the Allied Chemical Company UF_6 production facility was issued by the NRC on August 15, 1977, at the same time that License SUB-526 was renewed for a five-year period. Subsequently, the applicant made several changes in the physical plant and its operations and in the environmental monitoring procedures:

1. installed double fencing of the plant to increase security,
2. increased the storage areas for both uranium ore concentrates and UF_6 product,
3. increased the pond area for calcium fluoride storage,
4. installed a calcium fluoride recovery unit to prepare material for offsite shipment, and
5. installed equipment to provide improved radiological monitoring on and near the plant site.

The purpose of this assessment is (1) to review the operation of the facility during the recent license period by comparing the plant effluent releases or environmental monitoring data with permissible levels of contaminants and (2) to determine the impact on the environment from continued operation of the facility in its current configuration.

1.2 SUMMARY OF THE PROPOSED ACTION

The proposed action is the renewal of the license necessary for continued operation of Allied Chemical Company's production plant at Metropolis, Illinois. The Allied facilities are in operation and have been authorized to use source material for the production of uranium hexafluoride since 1958. In addition to production and storage of UF_6, the site also includes (1) a storage area for uranium ore concentrates received from uranium mills; (2) a uranium sampling facility; (3) bulk storage of hazardous chemicals such as hydrofluoric (HF) and sulfuric (H_2SO_4) acids; (4) a facility for electrolytic production of fluorine from HF; (5) production of other commercially important fluorides such as SF_6, IF_5, and SbF_5; and (6) separate treatment systems and storage ponds for radiological and nonradiological liquid wastes. The present application for renewal of the license involves no increase in scope of the current authorization. If any major new facilities or expanded operations are proposed during the next license renewal period, the applicant is required to provide environmental evaluations for NRC review.

1.3 NEED FOR ACTION

The Allied Chemical Company UF_6 Conversion Plant is one of only two such facilities in the United States. The UF_6 production is one phase (see Fig. 1.1) of the overall fuel cycle leading to production of fuel elements for nuclear reactors. Currently, the Metropolis facility supplies UF_6 conversion services for the commercial nuclear power industry.

As long as the current demand for uranium continues, the UF_6 production rate must keep pace. Denial of license renewal for the UF_6 conversion activity at the Metropolis site would require that similar activities expand at the only other existing UF_6 facility, or at a new site. Although denial of renewal of the source material license for the Allied Chemical Company plant is an alternative available to the NRC, it would be considered only if issues of public health and safety cannot be resolved to the satisfaction of the regulatory authorities involved.

1.4 THE SCOPING PROCESS

The overall operations and impacts of the Allied Chemical Company UF_6 conversion facility were appraised in August 1977.[1] In connection with the current application for license renewal, the applicant submitted a supplemental environmental report[2] that includes an updated description of the facility, the affected environment, and a tabulation of effluent releases and environmental monitoring data for recent years. In conducting this assessment, the staff toured the site and surrounding area (April 13, 1983) and met with the applicant to discuss items of information related to facility operations and to seek additional information that might be needed for an adequate assessment.

The applicant submitted a response to the staff's questions.[3] The staff also obtained information from other sources to assist in the evaluation. Because of the previous documentation and the very limited impacts associated with the operation of this facility (see Sect. 4), the staff determined that a formal scoping process was unnecessary.

The principal environmental impacts of current operation of the UF_6 conversion facility result from release of fluorides and radioactive gases or particulates to the atmosphere and of contaminated liquids to the adjacent Ohio River. The actual gaseous and liquid effluent released during normal operation of the plant has been measured, and the concentration of contaminants has been monitored at on-site and off-site locations. Because the proposed license renewal for the plant

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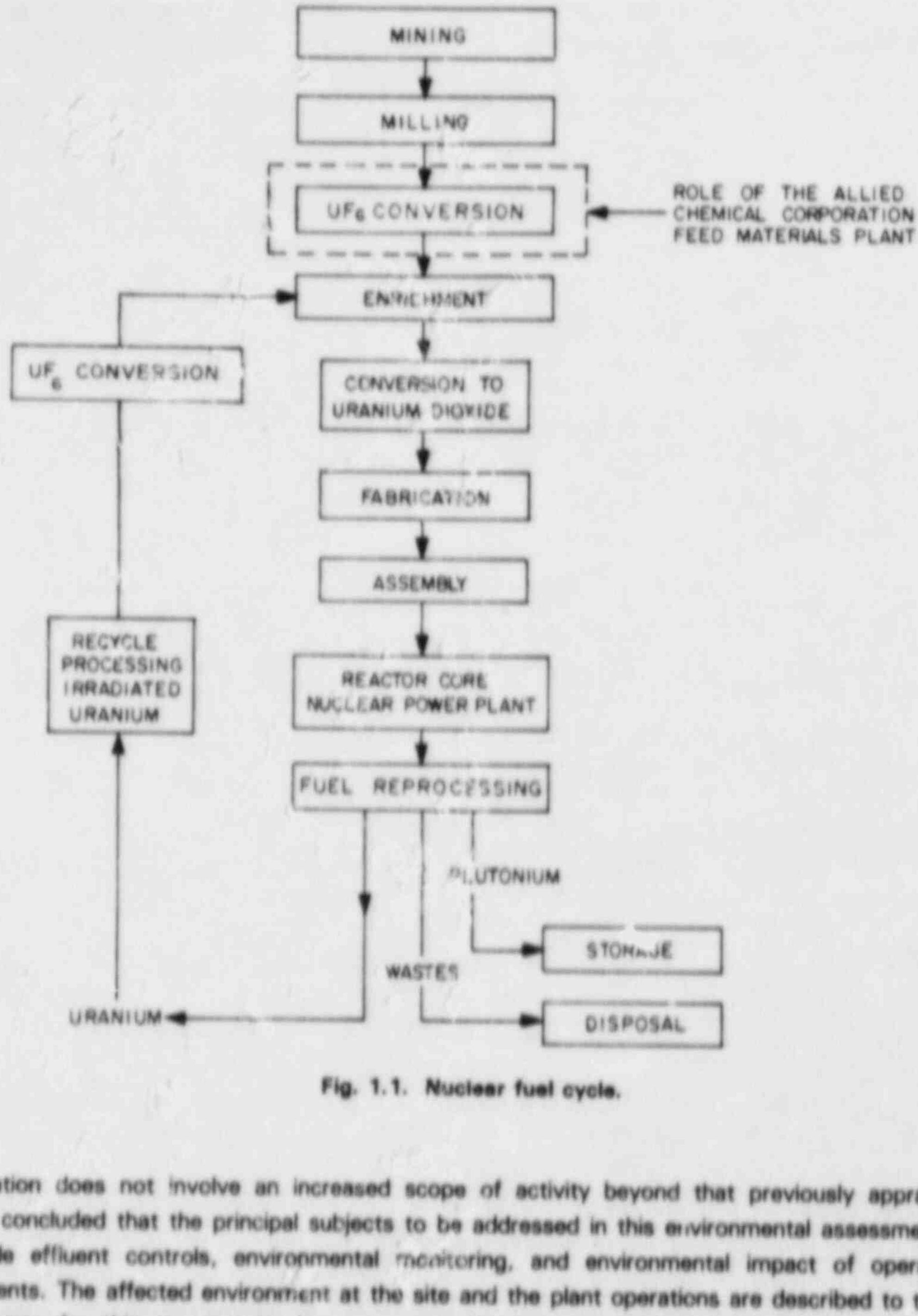

Fig. 1.1. Nuclear fuel cycle.

operation does not involve an increased scope of activity beyond that previously appraised, the staff concluded that the principal subjects to be addressed in this environmental assessment should include effluent controls, environmental monitoring, and environmental impact of operation and accidents. The affected environment at the site and the plant operations are described to the extent necessary for this assessment. In some cases, impacts can be shown to be insignificant. These impacts are identified but not evaluated in detail.

REFERENCES FOR SECTION 1

1. U.S. Nuclear Regulatory Commission, "Environmental Impact Appraisal of the Nuclear Services Division, Uranium Hexafluoride Conversion Facility, Metropolis, Illinois," Docket 40-3392, August 1977.

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 THE ALTERNATIVE OF NO LICENSE RENEWAL

Not granting a license renewal for the UF_6 conversion plant would cause Allied Chemical to cease production of UF_6 at this site. This alternative would be considered only if issues of public health and safety could not be resolved. Cessation of UF_6 conversion activities would probably result in closure of the facility because the other operations on the site (production of fluorine and other fluoride compounds) would not be economically justified. The benefits to be gained by such a course of action would be the cessation of the environmental impacts (as described in Sect. 4) that have been determined to be acceptably small. Since demand for UF_6 feed material in the uranium fuel cycle is expected to continue, closure of the Allied Chemical facility would require construction and operation of a new UF_6 conversion plant, thus merely transferring the impacts to another site.

2.2 THE ALTERNATIVE OF LICENSE RENEWAL

This alternative, which is the proposed action, would result in the continued operation of the Allied Chemical facility for another five years essentially as it has been operated for the past six years. Following is a description of the current operation, including waste confinement and effluent control systems. Impacts of little consequence are identified and discussed in this section. More important impacts are assessed in Sect. 4.

2.2.1 Description of the Current Operation

The Allied Chemical Company plant contains the largest privately owned UF_6 production facility in the western world and was designed to convert uranium ore concentrates into UF_6, which is then shipped to DOE gaseous diffusion plants at Paducah, Kentucky, Portsmouth, Ohio, or Oak Ridge, Tennessee, for enrichment of the ^{235}U isotope.[1]

The facility, which uses the fluoride volatility process, has the capacity to convert approximately 1.27×10^7 kg (14,000 short tons) of uranium per year from ore concentrates into UF_6. The ore concentrate feed assays approximately 75% uranium, and the distilled UF_6 product contains less than 300 ppm impurities.

The major site facilities, which include the administration building, the laboratory, the fluorine production facility, the UF_6 manufacturing facility, the waste treatment facilities, and a large area for storage of ore concentrates and UF_6, occupy about 22 ha (54 acres). This developed portion of the site is surrounded by two security fences about 15 m (50 ft) apart. The total site consists of 349 ha (862 acres). An aerial view of the plant is shown in Fig. 2.1; a plot plan of the developed area is shown in Fig. 2.2.

A flow chart of the process used for the conversion of uranium ore concentrate (U_3O_8) to UF_6 is depicted in Fig. 2.3, where the source of effluents and emissions from the various process steps and the pollution abatement systems are also shown. These pollution abatement systems are discussed more fully in Sect. 2.2.2. All major plant equipment is of standard chemical plant design and construction.

Following is a description of each of the steps identified in Fig. 2.3 for the production of UF_6.

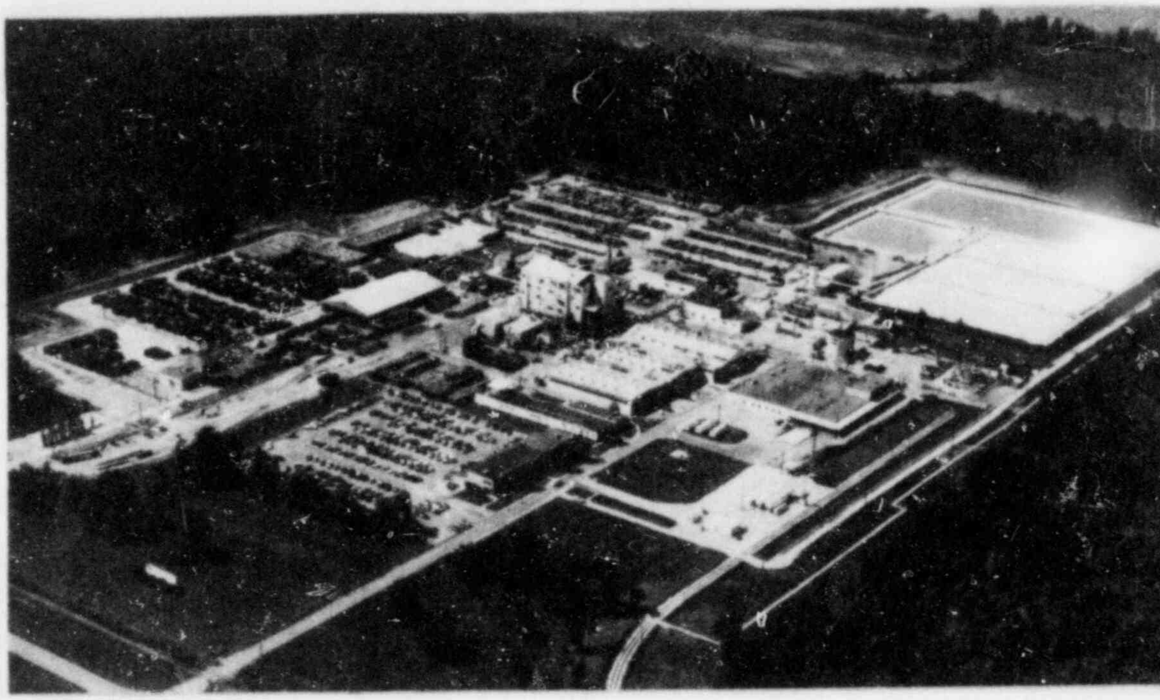

Fig. 2.1. Aerial view of the Allied Chemical Company UF_6 Conversion Plant near Metropolis, Illinois.

2.2.1.1 Sampling and storage

The plant receives uranium ore concentrates (in 55-gal drums) from the uranium mills via rail car or common carrier (truck). The uranium ore storage drums occupy a large area in the southeast corner of the fenced portion of the site. The contents of all drums in each lot are emptied and sampled by the falling-stream method in the Ore Sampling Building to obtain representative analytical samples. Each lot of concentrates is then re-drummed, weighed, and stored until accountability procedures and the uranium and impurity analyses are completed. Off-gas from the sampling building is filtered to remove uranium particulates before venting to the atmosphere. The recovered uranium is processed through the uranium recovery subsystem (Sect. 2.2.1.8). Contaminated wash water is sent to Settling Ponds 3 and 4 (Fig. 2.2) for uranium collection and eventual disposal of liquid waste (Sect. 2.2.2.2).

2.2.1.2 Pretreatment facility

Some ore concentrates and all uranium compounds from the uranium recovery facility (see Fig. 2.3 and Sect. 2.2.2) contain undesirable amounts of contaminants, principally sodium, that must be removed. The pretreatment consists of a four-stage, countercurrent decantation treatment with ammonium sulfate [$(NH_4)_2SO_4$] solution. The uranium solids from this facility discharge into the ore calciner in the ore preparation section. Contaminated ammonium sulfate solution is discharged to settling basins for removal of fine uranium oxide particles before discharge to liquid waste Treatment Ponds 3 and 4. Before venting to the atmosphere, the off-gas from the pretreatment

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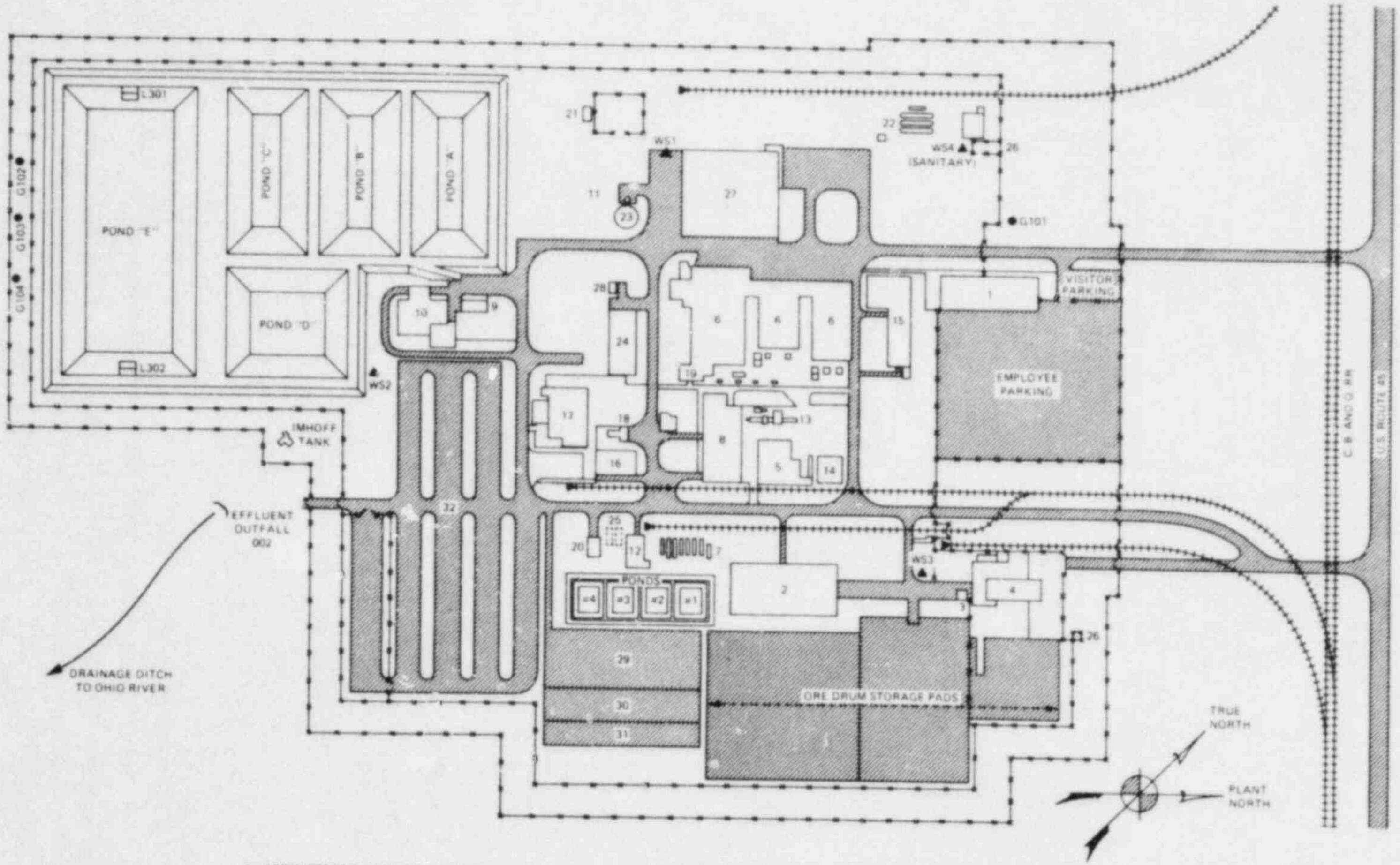

1. ADMINISTRATION SERVICE BUILDING
2. ORE DRUMS STORAGE SHED
3. ORE SCALES
4. ORE SAMPLING BUILDING
5. PRETREATMENT BUILDING
6. FLUORINE BUILDING
7. HF AND NH_3 TANK FARM AREA
8. FEED MATERIAL BUILDING
9. ENVIRONMENTAL PROTECTION FACILITY (EPF)
10. CaF_2 RECOVERY
11. INCINERATOR
12. POND MUDS CALCINER
13. CALCINING FACILITY
14. KOH RECOVERY
15. LABORATORY BUILDING
16. N_2 FACILITY
17. S AND SF_6 FACILITY
18. LIQUID FLUORINE
19. CONTROL ROOM
20. UF_6 CYLINDER WASH BUILDING
21. SUBSTATION AND SWITCH HOUSE
22. LPG STORAGE FACILITIES
23. FIRE PROTECTION WATER STORAGE
24. POWER HOUSE
25. FUEL OIL STORAGE
26. NATURAL GAS METERS
27. SHOP, STORES, OFFICES
28. FLAMMABLE MATERIALS STORAGE
29. OLD MATERIAL AND FILTER FINES STORAGE PAD
30. KOH MUDS STORAGE PAD
31. DRUM STORAGE PAD
32. UF_6 CYLINDER STORAGE AREA

● GROUNDWATER MONITORING WELLS: G101, G102, G103, G104
▲ WATER SUPPLY WELLS: WS1, WS2, WS3, WS4
⊟ POND E UNDERDRAIN SUMPS: L301 AND L302

Fig. 2.2. Plot plan of the Allied Chemical Company UF_6 Conversion Plant.

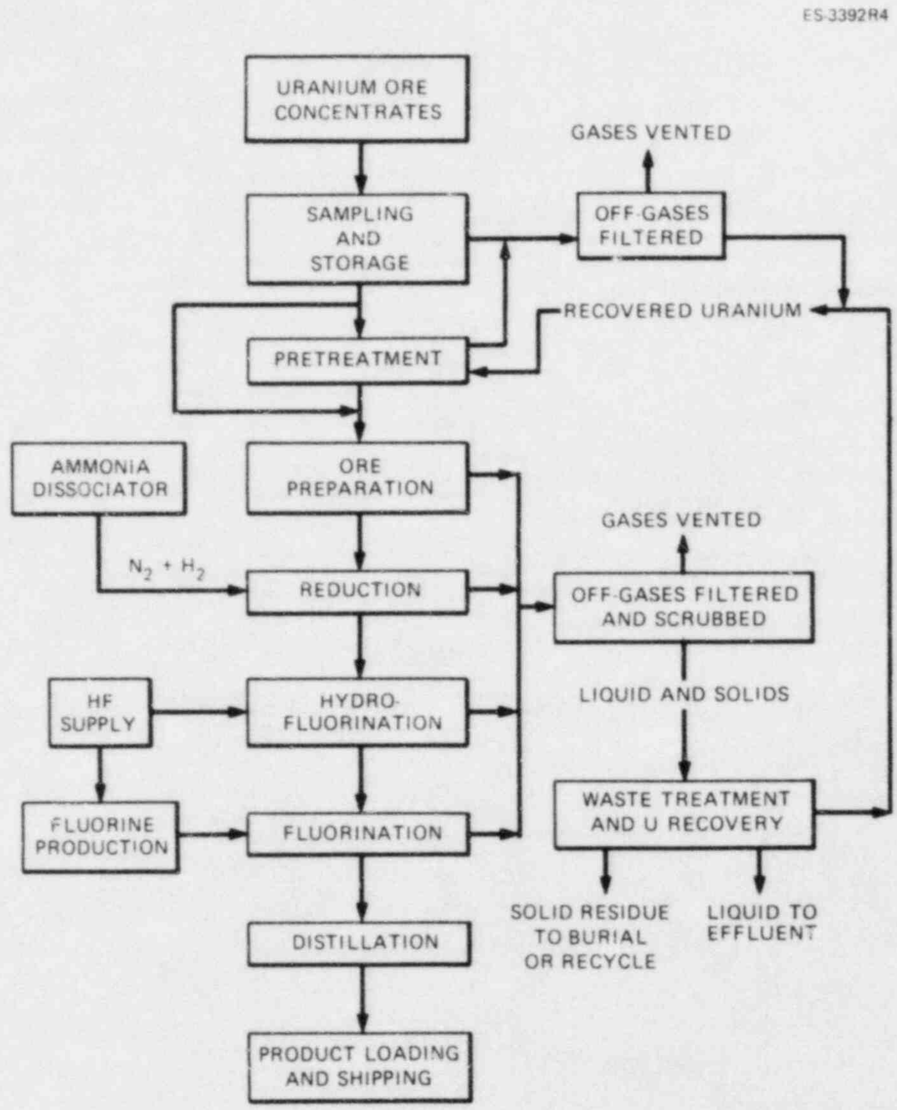

Fig. 2.3. Allied Chemical Company UF_6 Conversion Plant flow chart.

facility is filtered to collect uranium particulates that are processed through the uranium recovery subsystem.

2.2.1.3 Ore preparation

Incoming ore concentrates are charged into the ore preparation 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. Leaving the calciner, the ore concentrates are blended, agglomerated, dried, crushed, and sized to obtain uniform particles. Potentially contaminated, uranium-bearing dusts are collected in dust collectors and processed through the uranium recovery system. Dusts collected in the closed ore preparation equipment are recycled within the system.

2.2.1.4 Reduction

The sized uranium concentrates enter one of two available fluid-bed reactors, termed reductors. In the reductor, the uranium is reduced to the dioxide form using 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. The particulate uranium is recycled to the ore preparation system.

2.2.1.5 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 countercurrent flow of anhydrous HF fluidizing gas converts the uranium dioxide into uranium tetrafluoride (UF_4). The off-gas is filtered to remove particulate UF_4 and scrubbed with water and potassium hydroxide solution to remove HF before being vented to the atmosphere. The UF_4 particulates are recycled to the feed end of this system. The HF scrubber liquors are piped to the Environmental Protection Facility (EPF) for treatment (Sect. 2.2.2).

2.2.1.6 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. The UF_6 is volatilized from the fluorinator. Some residual uranium and nonvolatile 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 to a series of cold traps for UF_6 collection. The uranium-contaminated bed material and filtered uranium particulates are processed through the uranium recovery system.

2.2.1.7 Cold traps

The bulk of UF_6 is condensed in a series of primary cold traps that are operated at approximately −29°C (−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 after liquefaction by heating and 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 (KOH) solution removes fluorides and traces of uranium before release to the atmosphere.

The potassium diuranate precipitated in the off-gas scrubbers is settled from the KOH solution, washed to remove soluble fluoride, and recycled to the pretreatment facility for potassium removal before reentry into the main uranium process flow. Scrubbing solutions are delivered to the EPF for treatment (Sect. 2.2.2).

2.2.1.8 Distillation and product handling

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 retained as UF_6 is vaporized. The UF_6 is condensed and fed as a liquid into product cylinders at one of two possible fill spots. During filling, the cylinder is held horizontally with the valve oriented on the top of the cylinder (at the 12 o'clock position). The low- and high-boiling impurities are condensed, solidified, and disposed of as solid waste.

After filling, each cylinder is lifted by crane and placed on a weigh cart. This movement requires a vertical lift of 8-10 ft, which is the maximum lift during Allied's handling of liquid cylinders. The cylinder then is rotated to put the valve in the 6 o'clock position and is placed in a steam chest. A sample from the cylinder is taken after it is heated for 5-6 h in the chest at about 100°C (212°F) to achieve uniformity of the liquid UF_6. After sampling, the valve is rotated back to the 12 o'clock position and the cylinder is placed on a specially designed transport buggy. A valve protector is installed, and the buggy is pulled outdoors to a temporary storage agea. The cylinders remain outside on the buggies for 4 d or longer to cool and solidify before any further handling. The valve remains in the 12 o'clock position during this cooling time. Once the UF_6 has solidified, the cylinder is lifted off the buggy and placed in a storage cradle until shipped off the site.

2.2.1.9 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). The waste material is dried and packaged for recycle or for 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.

Uranium recovery leach liquors, which are contaminated with fluorides, are sent to the EPF for treatment (Sect. 2.2.2).

2.2.1.10 Cylinder wash facility

Periodically, UF_6 product cylinders must be washed and pressure-tested to ensure 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 is transferred to the uranium recovery facility. The filter residue, which contains daughter products of uranium, principally ^{234}Th and ^{234}Pa, is stored on the site and eventually disposed of at a licensed waste disposal facility.

2.2.1.11 Fluorine production

Fluorine, which is one of the raw materials required for the UF_6 process, is produced on-site by electrolysis using hydrogen fluoride as the source. Most of this material is transferred to the UF_6

operation, and the remainder is used to produce sulfur hexafluoride and liquid fluorine as well as small quantities of antimony pentafluoride and iodine pentafluoride, which are sold commercially.

2.2.1.12 Powerhouse

Process steam for plant operation is provided from three natural-gas-fired boilers with a combined thermal capacity of about 57×10^9 J/h (54×10^6 Btu/h). Liquid petroleum gas and fuel oil (0.2% S) are alternate fuels for this powerhouse. No electricity is generated. The applicant has a permit from the state of Illinois to operate these boilers.[2]

2.2.1.13 Process chemicals and fuels

The annual consumption of the principal chemicals used at the Allied facility is given in Table 2.1. The physical description, hazardous nature, and transportation mode are also indicated in Table 2.1.

The liquid process chemicals (HF, H_2SO_4, KOH, and NH_3) are mostly delivered by rail tank cars and unloaded into fixed tanks in the tank farm area indicated on Fig. 2.2. The HF is stored in three tanks with an estimated maximum site inventory of about 136,000 kg (300,000 lb). The maximum HF tank capacity is 73,400 kg (161,400 lb). The concentrated H_2SO_4 is stored in a tank with a capacity of 125,000 kg (275,000 lb). The site inventory of H_2SO_4 does not normally exceed 45,000 kg (100,000 lb). The anhydrous NH_3 is stored in two tanks, each of 30,000-kg (66,000-lb) capacity. No more than 18,200 kg (40,000 lb) are put into either tank, and the site inventory does not normally exceed 27,300 kg (60,000 lb). The KOH solution (45% concentration) is stored in one tank that can hold 49,500 kg (109,000 lb), but the site inventory normally does not exceed 18,600 kg (41,000 lb). (Ronald Yates, Allied Chemical Company, telephone communication with Norman Hinkle, ORNL, May 25, 1983).

The drums of KHF_2 are stored in or adjacent to the fluorine production building (see Fig. 2.2). This material is melted and piped into the electrolytic cells used for fluorine production. The hydrated, powdered lime is pneumatically transferred from a tank truck to a storage silo in the EPF (Ronald Yates, Allied Chemical Company, telephone communication with Norman Hinkle, ORNL, May 25, 1983).

Table 2.1. Principal chemicals consumed at the Allied Chemical Company UF_6 Conversion Plant.

Commod y	Physical description	Hazardous nature for shipping	Transportation mode and packaging	Average annual consumption	
				10^3 kg	tons
Hydrogen fluoride, HF	Liquid	Corrosive	Rail—tank cars	6000	6600
Potassium bifluoride, KHF_2	Solid, Dry	Not hazardous	Truck—drums	17	19
Sulfuric acid, H_2SO_4	Liquid	Corrosive	Rail or truck—tanks	4350	4800
Lime, hydrated, $Ca(OH)_2$	Solid, dry	Not hazardous	Truck—tank	4350	4800
Potassium hydroxide, KOH	Liquid	Corrosive	Rail—tank car	544	600
Anhydrous ammonia, NH_3	Liquid compressed gas	Nonflamable compressed gas	Rail—tank car	2700	3000

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Since 1980, the Allied facility has used only natural gas at the powerhouse and for direct firing processes such as calcining. Because of conservation efforts, the annual consumption of natural gas has been decreasing. In 1982, the consumption was about 1.1×10^6 m^3 (390×10^6 ft^3), with about 65% used in the powerhouse to produce steam, hot water, compressed air, and compressed nitrogen. The natural gas used at the powerhouse could be replaced with either fuel oil [11,300 m^3 (71,000 bbl)] or liquid petroleum gas (LPG). (Ronald Yates, Allied Chemical Company, telephone communication with Norman Hinkle, ORNL, May 25, 1983).

Liquid chemical wastes from process or laboratory activities that cannot be safely disposed of by dilution in the plant's aqueous effluent are stored in drums on a concrete pad near the laboratory building until it is transported off-site for disposal. (Ronald Yates, Allied Chemical Company, telephone communication with Norman Hinkle, ORNL, May 25, 1983).

The potential for and past incidence of on-site and transportation accidents involving fuel and chemicals are discussed in Sect. 4.3.2.

2.2.2 Waste Confinement and Effluent Controls

2.2.2.1 Gaseous emissions

All areas in the UF_6 process that produce dusts, mists, or fumes containing uranium or other toxic materials are equipped with dust collectors, scrubbers, or ventilation equipment to reduce employee and environmental exposure. A listing of the dust and mist control equipment and rated efficiency of each gaseous cleanup system is presented in Table 2.2.

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 for cleaning workroom air. The total air flow through the process building is sufficient to ensure a complete air changeout approximately once every 5 minutes.

To ensure that there will be little or no entry of contaminated air into the main control room and a process laboratory, these areas have separate air-conditioning systems with a common fresh-air intake located outside and separate from the UF_6 process building. Both areas are maintained under a slight positive pressure.

Currently, 51 individual stacks and exhaust fans associated with the operation of the UF_6 facility could contain significant concentrations of uranium.[1] These exits are sampled continuously at isokinetic flow conditions using 0.6- to 0.8-μm 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 that could have a high loss potential are collected twice per 24 h and counted for alpha radioactivity. If the loss potential is small, the samples are collected once every 24 h. The individual membranes for each sample point are composited for each 24 h and analyzed for uranium content. Uranium emission data is computerized to give losses on a daily, monthly, quarterly, or yearly basis. Table 2.3 indicates the quantities of uranium emitted from the process stacks (identified in Table 2.2) during the past four years (1979-1982) of operaton.[1,2]

Table 2.2. Sources of gaseous emissions from plant processes with identification of type of dust and mist control

Stack No.	Description	Contaminant removed	Primary control	Secondary control	Tertiary control
1-1	Wet oxide dust collector	Particulates	Baghouse (99.9)[a]	Baghouse (99.9)	
1-2	Dry oxide dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
1-3	Drum cleaner dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
1-4	Oxide vacuum cleaner	Particulates	Cyclone (95.9)	Baghouse (95.9)	Baghouse (99.0)
1-7	UF_4 vacuum cleaner	Particulates	Cyclne (80.0)	Baghouse (99.9)	Baghouse (99.9)
1-10	"B" UF_4 dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
1-11	Dry oxide dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
1-12	Ash vacuum cleaner	Particulates	Cyclne (80.0)	Baghouse (99.9)	
1-12	Ash dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
1-13	"A" fluorinator filters	Particulates	Metal filters (>99.9)	Metal filters (>99.9)	
1-13	"A" fluorinator scrubbers	F_2, HF, UF_6	Spray tower (80.0)	Packed tower (99.9)	Coke box (99.0)
1-14	"B" fluorinator filters	System identical to 1-13			
1-14	"B" fluorinator scrubbers	System identical to 1-13			
	"C" fluorinator filters	System identical to 1-13 (may use either "A" or "B" fluorinator scrubber system)			
1-23	"A" top hydrofluorinator filter	Particulates	Carbon filters (>99.9)	Carbon filters (>99.9)	
1-23	"A" top hydrofluorinator scrubber	HF	H_2O venturi jets (88.0)	KOH venturi jets (85.0)	KOH packed tower (99.0)
1-24	"B" top hydrofluorinator filter	System identical to 1-23			
1-24	"B" top hydrofluorinator scrubber	System identical to 1-23			
1-46	"A" UF_4 dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
	Reductor dust filters	Particulates; gases to H_2S incinerator	Metal (99.9) Filters	Metal (99.9) Filters	
1-48	H_2S incinerator stack	H_2S and S	Sulfur condenser	Incinerator (99.0)	
1-54	Drum inverter dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
3-2	Uranium recovery dust collector	Particulates	Baghouse (99.9)		
4-2	Pond mud calciner filter and scrubber	Particulates, HF, SO_2	Baghouse (99.9)	Spray tower (95.0)	
17-1	Sampling plant dust collector	Particulates	Baghouse (99.9)	Baghouse (99.9)	
17-2	Sampling plant vacuum cleaner	Particulates	Baghouse (99.9)	Baghouse (99.9)	

[a]Rated percent efficiency is in parenthesis.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Table 2.4 shows the annual uranium emissions for 1979-1982 from ventilation systems associated with UF_6 conversion facilities.[1,2] From Tables 2.3 and 2.4, the total annual uranium emissions are observed to be fairly uniform with the highest being 412.7 kg, or about 0.14 Ci, in 1979. Up to about one-half of the uranium is lost directly from process equipment (Table 2.3) with the remainder from ventilation systems (Table 2.4).

Essentially all of the stack emissions of uranium are of mixed solubility[1] (Classes D, W, and Y) because of the variety of milling processes used to produce ore concentrates (see Sect. 4.1). In the fluorination and distillation systems, the emissions are primarily highly soluble UO_2F_2 from UF_6 decomposition. The uranium released in the off-gas from the ash dust collector and vacuum cleaner

Table 2.3. Stack height, air flow, and annual uranium emissions for the years 1979–1982 from UF_6 process equipment dust control devices

Stack No.	Description	Discharge direction[a]	Height		Flow		Uranium emission (kg)			
			m	ft	m^3/min	ACFM	1979	1980	1981	1982
1-1	Wet oxide dust collector	V	30	98	143	5,040	29.7	54.4	15.9	12.4
1-2	Dry oxide dust collector	H	32	105	75	2,650	3.8	5.5	15.8	3.5
1-3	Drum cleaner dust collector	V	12	40	122	4,320	2.3	2.1	3.3	8.9
1-4	Oxide vacuum cleaner	H	30	98	12	428	3.0	2.0	1.0	1.7
1-7	UF_4 vacuum cleaner	H	4	12	31	1,078	9.8	5.8	5.5	3.0
1-10	"B" UF_4 dust collector	V	30	98	82	2,889	54.7	50.0	14.8	4.2
1-11	Dry oxide dust collector	V	12	40	167	5,880	4.9	2.6	2.9	0.4
1-12	Ash vacuum cleaner and dust collector	H	26	86	73	2,561	10.4	21.1	9.4	14.5
1-13	"A" fluorination coke box	V	32	105	5	193	51.4	25.8	45.7	58.3
1-14	"B" fluorination coke box	V	32	105	5	193	41.0	30.2	22.7	19.8
1-46	"A" UF_4 dust collector	V	30	98	38	1,338	2.7	3.4	0.2	8.4
1-48	H_2S incinerator stack	V	47	155	184	6,500	0.4	0.4	0.5	1.0
1-54	Drum invertor dust collector	V	6	19	436	15,394	*b*	*b*	0.1	0.4
3-2	U-recovery dust collector	V	12	40	13	462	<0.1	<0.1	<0.1	<0.1
4-2	Pond mud calciner	V	9	29	93	3,296	1.1	0.5	0.4	0.6
17-1	Sampling plant dust collector	V	7	23	214	7,565	0.2	0.5	0.1	1.1
17-2	Sampling plant vacuum cleaner	H	4	13	14	490	*b*	*b*	0.2	0.6
	Total process emissions						215.5	204.4	138.6	138.9

[a]H = horizontal, V = vertical.

[b]Not installed.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

(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, personnel observe and record pressure drops and temperatures of the dust collectors every two hours. Samples from the off-gas scrubbers are also analyzed to identify unusual or unnecessary emissions or potential violations of regulatory limits and to allow operator action to minimize emissions. Additional samples, visual observations, and precautions are taken as necessary to ensure acceptable 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 used to shut down equipment when the concentration of uranium in the exit stack exceeds the established administrative limit for the stack.

The nonradiological emission sources and emission rates[1] are shown in Table 2.5. These emission sources are operated in accordance with their individual air permits which are obtained from the Illinois Environmental Protection Agency. Except for the incineration stack (1-48), emissions are based on stack measurements during operation and scaled to capacity of the equipment. The incinerator stack emissions are routinely measured to determine compliance with permitted SO_2 releases.

Table 2.4. Stack height, air flow, and annual uranium emissions for the years 1979–1982 from ventilation systems associated with UF_6 conversion facilities

Stack No.	Description	Discharge direction[a]	Height		Flow		Uranium emission (kg)			
			m	ft	m^3/min	ACFM	1979	1980	1981	1982
1-15	"A" reductor blower	H	23	75	28	987	1.1	0.6	0.8	1.0
1-16	"B" reductor blower	H	23	75	28	987	41.3	23.1	5.8	4.7
1-17	"A" top hydrofluorinator blower	H	14	45	188	6,630	1.5	1.4	64.2	7.3
1-18	"A" bottom hydrofluorinator blower	H	4	12	188	6,630	0.9	0.3	0.1	0.2
1-19	"B" top hydrofluorinator blower	H	12	38	28	987	14.0	31.0	24.5	6.4
1-20	"B" bottom hydrofluorinator blower	H	14	45	28	987	0.5	0.5	0.5	0.2
1-21	"A" fluorinator blower	H	9	30	120	4,239	0.9	0.6	2.9	14.2
1-22	"B" fluorinator blower	H	9	30	120	4,239	1.7	1.9	1.7	1.4
1-26	Ore prep multifloor exhaust	V	18	60	400	14,145	2.8	1.8	0.0	3.0
1-27	Exhaust fan 1st floor south	H	5	15	651	23,000	5.9	5.3	9.6	6.0
1-28	Exhaust fan 1st floor west	H	5	15	651	23,000	5.1	5.7	7.7	5.3
1-29	Exhaust fan 2nd floor south	H	9	30	651	23,000	0.0	1.1	5.1	3.6
1-30	Exhaust fan 3rd floor south	H	14	45	651	23,000	10.4	9.8	4.9	5.8
1-31	Exhaust fan 3rd floor west	H	14	45	651	23,000	9.8	10.9	7.7	5.3
1-32	Exhaust fan 3rd floor south	H	14	45	651	23,000	3.2	4.9	2.5	5.7
1-33	Exhaust fan 3rd floor north	H	14	45	651	23,000	8.6	12.2	8.1	6.7
1-34	Exhaust fan 4th floor south	H	18	60	651	23,000	6.9	5.8	9.1	5.2
1-35	Exhaust fan 4th floor west	H	18	60	651	23,000	9.6	11.2	11.5	7.5
1-36	Exhaust fan 4th floor south	H	18	60	651	23,000	6.0	10.1	4.1	2.7
1-37	Exhaust fan 5th floor south	H	23	75	651	23,000	8.6	8.4	11.5	7.5
1-38	Exhaust fan 5th floor west	H	23	75	651	23,000	9.1	7.2	10.4	2.7
1-39	Exhaust fan 5th floor south	H	23	75	651	23,000	8.4	10.2	7.9	3.3
1-40	Exhaust fan overhead no. 1	V	27	90	708	25,000	<0.1	*b*	*b*	*b*
1-41	Exhaust fan overhead no. 2	V	27	90	708	25,000	9.9	10.3	*b*	0.4
1-42	Exhaust fan overhead no. 3	V	27	90	708	25,000	4.3	4.6	9.0	1.4
1-43	Exhaust fan overhead no. 4	V	27	90	708	25,000	9.5	15.3	3.7	0
1-45	NH_3 dissociator vent	V	18	60	356	12,580	3.6	6.3	5.0	5.0
1-47	"C" fluorinator blower	H	9	30	120	4,239	1.5	0.7	0.4	0.2
1-49	Distillation multifloor exhaust	V	6	19	787	27,775	0.3	0.2	<0.1	2.3
1-50	"A" reductor off-gas	H	20	67	21	733	10.1	0.3	0.7	0.5
1-51	"B" reductor off-gas	H	20	67	34	1,215	1.6	0.5	3.4	0.7
1-55	Exhaust fan 3rd floor north	H	14	45	242	8,535	*c*	1.5	0.2	0.3
1-56	Exhaust fan distillation 1st floor north	H	7	22	747	26,390	*c*	*c*	3.4	1.2
15-57	Exhaust fan maintenance area 1st floor south	H	3	11	149	5,268	*c*	*c*	*c*	<0.1
	Total ventilation emissions						197.1	203.7	226.5	117.8

[a]H = horizontal, V = vertical.

[b]Removed from service.

[c]Not installed.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

2.2.2.2 Liquid effluents

All liquid wastes from the facility are discharged through the main effluent line (Outfall 002) into a natural drainage ditch, which empties into the Ohio River (Fig. 2.2). The current wastewater disposition methods are shown in Fig. 2.4.

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

Table 2.5. Engineering estimates of nonradiological emissions from plant stacks in kilograms per hour

Stack No.	Description	Fluoride	Fluoride as HF	H_2S	Hydrocarbons	SO_2	NH_3
1-1	Wet oxide dust collector			0.6	0.8		
1-13	"A" fluorination scrubbers		0.0006				
1-14	"B" fluorination scrubbers		0.0006				
1-23	"A" top hydrofluorinator scrubber			0.0005			
1-24	"B" top hydrofluorinator scrubber			0.0005			
1-48	Incinerator stack					9.3	
2-9, 2-10, 2-11	Sodium removal unit						1.77
4-1	Calciner combustion gas flue	0.9					
4-2	Calciner exhaust scrubber vent	0.8					
5-1	KOH scrubber vent	0.3					
5-1B	No. 2P KOH scrubber—5KA expansion	0.1					
5-2	H_2 scrubber vent	0.3					
5-2B	No. 1P H_2 scrubber	0.04					
6-1	KOH scrubber vent	0.3					
8-3	IF_5 scrubber vent		0.007				
8-4	SbF_5 scrubber vent		0.3				
8-5	IF_5 fume vent scrubber	0.0009					
14-1	KOH scrubber	0.3					
14-2	H_2 scrubber	0.03					
14-3	Melt tank scrubber	0.005					
7-1, 7-2, 7-3	Powerhouse					0.05	

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.
Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

composition of the waste. Ponds 1 and 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 EPF. Settling Ponds 3 and 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, which does not contain significant fluoride.

The pH of Settling Ponds 3 and 4 is maintained slightly basic to minimize dissolved uranium loss. Experience indicates that about 90% of the uranium loss from these ponds is soluble uranium. As the effluent leaves these ponds, the flow rate is measured, and a 24-h composite sample is taken. The pH and uranium content of the composite sample is analyzed. The average flow from these two ponds is about 40 gpm. The effluent from Ponds 3 and 4 is then mixed with the other acceptable facility effluents before discharge to the Ohio River.

The solids in each of Ponds 1-4 are removed when the available "freeboard" is reduced to about 60 cm (2 ft). Whenever 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 layed 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.

The HF water scrubber liquors are routed directly to the EPF for HF neutralization. The uranium content of this stream averages less than 5-ppm uranium. Uranium recovery leach liquors are

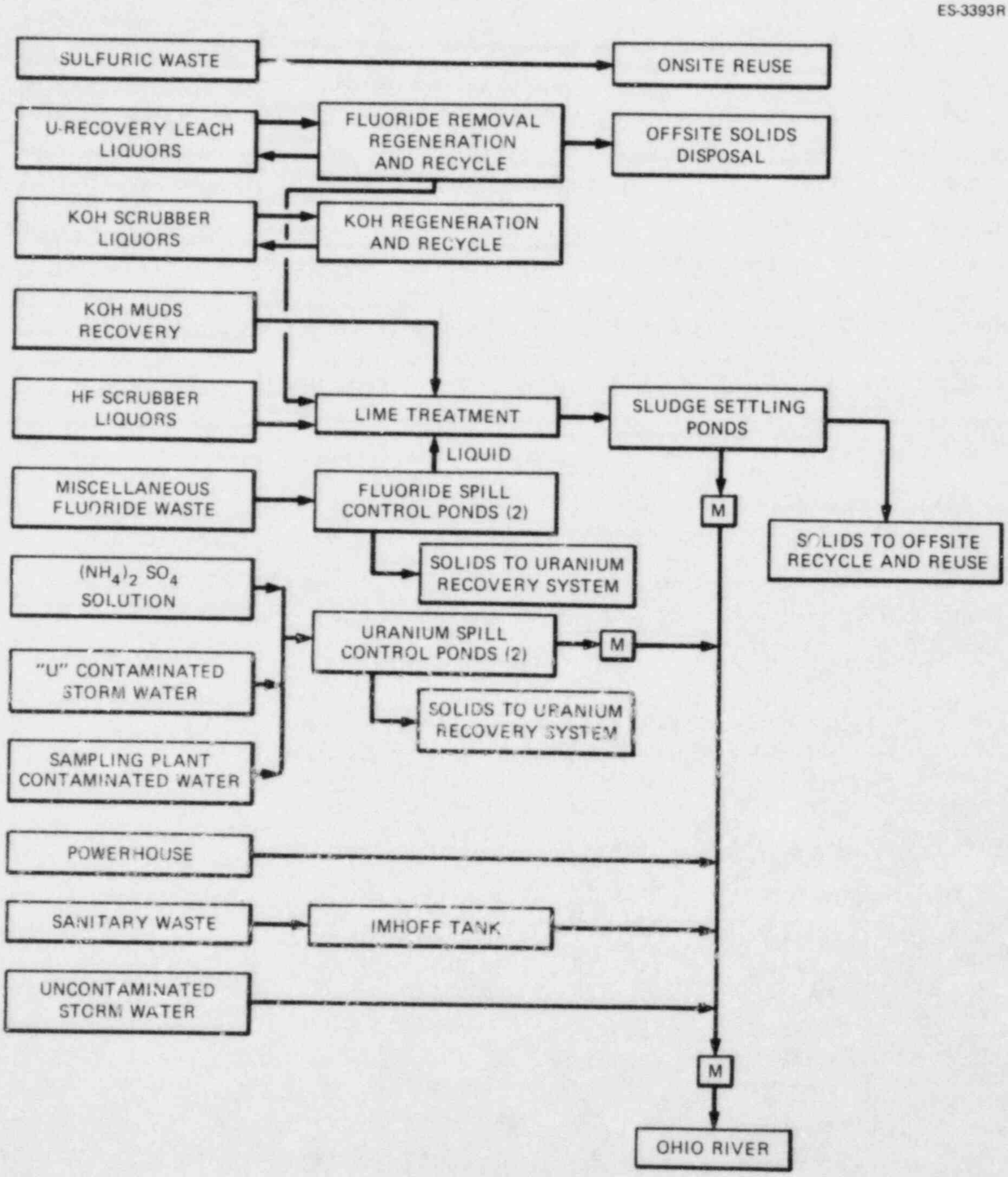

Fig. 2.4. Current wastewater and solid waste disposition. M = monitoring station.

recycled for additional leaching. When fluoride concentrations in these liquors exceed operating specifications, they are withdrawn and pumped to the EPF for fluoride removal.

In the EPF, calcium hydroxide is used to precipitate fluorides as insoluble calcium fluoride (CaF_2). The precipitated CaF_2 is separated in settling basins (Ponds A to F in Fig. 2.2). The effluent from the EPF plant and the settling basins has a pH of about 12 and is automatically adjusted to a pH of about 8 using H_2SO_4. This stream is combined with treated sanitary waste, uncontaminated cooling water, and the effluent from the uranium settling ponds before discharge into the Ohio River.

Before release at Outfall 002, the plant effluent is continuously sampled, and the composite sample is analyzed daily for uranium. Administrative controls are used 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 that routine concentrations rarely exceed 2% of the release limit. In the event of a major spill that could significantly increase effluent water concentrations of uranium, additional controls, such as diking and neutralization, are used to minimize the environmental impact.

Suspended and dissolved solids, pH, and fluoride, are monitored in accordance with the National Pollutant Discharge Elimination System (NPDES) permit (Appendix B). The daily samples of the main effluent are composited into a monthly sample that is analyzed for numerous impurities.

The annual average releases of radioactivity at Outfall 002 for the years 1979-1982 are shown in Table 2.6. The annual average flow and nonradiological analyses of the liquid effluent are shown in Table 2.7.

Table 2.6. Annual average release of radioactivity in liquids released from Outfall 002 at Allied Chemical Company UF_6 Conversion Plant

Description	1979	1980	1981	1982
Gross alpha, pCi/L[a]	300	240	200	130
Gross beta, pCi/L	320	170	270	200
Total uranium				
ppm	0.74	0.46	0.46	0.34
pCi/L	500	310	310	230
^{226}Ra, pCi/L				
Soluble	0.72	0.71	0.7	1.3
Insoluble	0.31	0.22	0.1	1.9
^{230}Th, pCi/L				
Soluble	4.2	1.7	1.4	1.9
Insoluble	8.7	12	4	5.9

[a]One pCi/L = 10^{-9} μCi/mL.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982..

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 2.7. Annual average flow, pH, and nonradiological analysis of Allied Chemical Company UF_6 Conversion Plant liquid effluent at Outfall 002 for the years 1979–1982 (mg/L except where indicated)

	1979	1980	1981	1982
Flow, m^3/d	13,800	16,600	15,900	16,500
pH[a]	7.4	7.3	7.4	7.4
Total dissolved solids[a]	791	705	754	725
Total suspended solids[a]	2.5	1.5	1.6	1.5
Chloride	38	38.5	36.9	39.8
Chromium (+6)	<0.003	<0.003	0.003	0.003
Chromium (+3)	0.015	0.008	0.008	0.012
Fluoride[a]	5.7	4.[illegible]	4.8	6.5
Iron	0.18	0.12	0.13	0.1
Molybdenum	0.11	0.07	0.10	0.12
Nickel	0.015	0.015	0.013	0.19
Phosphate	0.78	0.34	0.62	0.56
Sulfate	317	276	321	273
Vanadium	0.12	0.09	0.11	0.16

[a]Monitoring required by NPDES permit.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

The applicant's data[1,2] indicate that the monthly (or quarterly) averages do not deviate significantly from the annual averages. The radioactivity in the plant liquid effluent represents only a small percentage (less than 5%) of any of the established limits for release of radioactivity to unrestricted areas (10 CFR Part 20).

The concentrations of nonradiological contaminants discharged in the plant effluent do not exceed recognized wastewater-quality standards. Fluoride, the principal 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 (Appendix B) 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 or annual averages, the applicant found no excursions of the permit in 1981. There were five pH excursions during 1980 with the maximum time being 80 min and the minimum excursion time 25 min. During 1979 there were five excursions including two fluoride excursions of 24-h each of 15.5 ppm F^- and 18.9 ppm F^-, one for pH alone, one involving pH and suspended solids, and one for suspended solids alone.[1] These brief excursions of the permit limits would not be expected to produce any environmental impact on the Ohio River because the 0.2 m^3/s of effluent discharged into the river is insignificant compared to the average flow of the Ohio River of 7,505 m^3/s, and only 0.05% of the river's lowest flow on record (425 m^3/s). Under these conditions, the contaminants discharged would not be detectable after mixing with the river and should have no significant environmental impact.

2.2.2.3 Solid wastes

The solid waste streams of the UF_6 conversion facility can be classified as follows:

1. Uranium-bearing particulates filtered from process off-gas and building ventilation are recycled as feed material.
2. Uranium-bearing particulates precipitated from wastewater streams are processed to recover the uranium for recycle as feed material. Remaining solids, which may contain about 0.03 μCi/g of radioactive elements (uranium, radium, and thorium), are dried, packaged, and subsequently shipped to a licensed off-site facility for disposal.[1] About 100 kg (220 lb) of the solid wastes (principally insoluble CaF_2) are generated for each short ton of UF_6 produced. Thus, about 1.4×10^6 kg (1540 tons) of radioactive process waste containing a maximum of 42 Ci must be shipped to licensed disposal facilities each year.
3. The routine wastes, consisting of contaminated filters, papers, floor sweeping compounds, cleaning rags, and assorted contaminated trash are compacted for a volume reduction of more than 50% and are packaged in drums for shipment to a licensed waste disposal site. About 1000 drums are shipped each year.
4. Contaminated process equipment and piping removed from service are decontaminated, when possible, to recover uranium values. This material is compacted for volume reduction before shipment to a licensed disposal site. Noncontaminated scrap metal is sold to various scrap metal dealers. Thorough radiation monitoring is done to ensure that the residual radioactivity level is below applicable NRC guidelines.
5. Wastewater streams containing little or no uranium are processed in the EPF. Since the dominant impurity in the combined waste streams is fluoride, the EPF process uses calcium hydroxide to precipitate fluorides as insoluble calcium fluoride (CaF_2) which is separated in Settling Ponds A-E (Fig. 2.2). The synthetic CaF_2 containing 200-300 ppm of uranium is recovered from the settling ponds and transported to an Allied Chemical HF production plant in Louisiana. The synthetic CaF_2 is blended in a 1/10 to 1/20 ratio with natural CaF_2 and reacted with concentrated sulfuric acid (H_2SO_4) for routine HF production. The calcium sulfate ($CaSO_4$) solid residue with impurities, which includes about 13 to 21 ppm of uranium, is deposited on the plant site in Louisiana under conditions of a state permit.[2]

2.3 DECOMMISSIONING

At the end of its operating life, the plant will be decontaminated to levels such that the plant buildings and grounds can be released for unrestricted use. By letter dated August 14, 1978, the applicant submitted a decommissioning plan, cost estimate, and a commitment that funds will be made available for the decontamination effort. The major guidelines embodied in the plan are as follows:

1. Current radiological limits and decontamination technology are to be used.
2. All buildings are to be cleaned to levels established for unrestricted use.
3. All process and ancillary equipment in controlled areas is to be cleaned to the extent practicable, packaged, and buried in a licensed disposal facility.

4. Any contaminated underground piping is to be removed, cleaned to the extent practicable, packaged, and transported to a licensed disposal facility for burial. The ground surrounding such piping is also to be surveyed and removed for disposal if contaminated beyond established limits.
5. Material that is decontaminated to an acceptable level for unrestricted use would be sold to scrap dealers.
6. All decontamination activities are designed to maximize recovery of uranium.
7. Packaging, transportation, and disposal charges are to be calculated using information from existing licensed low-level waste disposal facilities.

The NRC reviewed this decommissioning plan for the Allied Chemical Company UF_6 Conversion Plant and concluded that the plan was reasonable and adequate. On January 31, 1980, NRC issued Amendment No. 3 to include the decommissioning plan and financial commitments as part of Condition 17 of the current license.

2.4 MATERIAL CONTROL AND ACCOUNTABILITY

Because there is no enriched uranium on the Allied Chemical Company site, material control and safeguard requirements set forth in 10 CFR Parts 70 and 73 are not applicable to the UF_6 conversion operations. The applicant maintains detailed records of raw materials use and UF_6 production and shipment as a matter of prudent economical operation and maintains control of all operations including waste handling to ensure the health and safety of the employees and the public.

2.5 STAFF EVALUATION OF THE PROPOSED ACTION AND ALTERNATIVES

The staff believes that the material processing at the Allied facility is performed in a manner that protects the public and the environment from unusual or adverse impact. The methods of waste confinement and effluent controls result in releases of wastes that meet all applicable state and federal standards (Sects. 2.2 and 4.1). The environmental impact of continued operation is expected to be acceptable providing that the following conditions are added to the license.

1. The applicant will be required to investigate why the uranium content of recent (1979-1982) samples of soil and vegetation from both on-site and off-site locations is considerably higher than the content determined during the 1968-1973 period and to propose what, if any, corrective action is necessary by Allied to stop this increasing trend (Sects. 4.1.2 and 4.1.3).
2. The applicant will be required to take samples and perform uranium and fluoride analyses of bottom sediments from several (at least two) locations along the effluent drainage ditch from Outfall 002 (Sects. 4.1.2 and 4.1.3).
3. The applicant will be required to install additional monitoring devices to measure gamma dose rates at appropriate off-site locations such as the nearest residences to the northeast and the hotel to the east of the fenced plant area (Sects. 4.1.2.1 and 4.1.3). The method used to measure gamma dose rates should provide sufficient accuracy to demonstrate compliance with 40 CFR Part 190.

REFERENCES FOR SECTION 2

1. Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.
2. Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

3. THE AFFECTED ENVIRONMENT

3.1 SITE DESCRIPTION

The Allied Chemical Company UF_6 Conversion Plant is located on a 349-ha (862.3-acre) tract of land in Massac County at the southern tip of Illinois along the north bank of the Ohio River (Fig. 3.1). The site perimeter is formed by U.S. Highway 45 and the right-of-way for the Chicago, Burlington, and Quincy Railroad to the north, the Ohio River to the south and east, and an industrial coal blending plant to the west. A short segment of the eastern boundary of the site is contiguous with the Metropolis city limits.

Plant operations are conducted in a fenced-in, restricted area covering 22 ha (54 acres) in the north central portion of the site,[1] about 3 km (1.8 miles) from the center of Metropolis (Fig. 3.1). This restricted area is situated on an alluvial terrace some 18 m (60 ft) above the floodplain of the Ohio River. The terrace surface is generally level except where intermittent streams or drainageways have cut channels. Immediately southwest of the terrace a 300-m (1000-ft) floodplain terrace extends to the bank of the Ohio River.

3.2 CLIMATOLOGY AND METEOROLOGY

3.2.1 Climatology

The climate of the site area is characteristic of the humid continental zone, but more typical of western Kentucky than of Illinois, and slightly influenced by the Ohio River. The average annual temperature is 14°C (58°F), with normal average temperatures ranging from 25.6°C (78°F) in July to 1.5°C (35°F) in January.[2] The temperature range is smaller than observed in nearby areas of Illinois to the north. Temperatures of 38°C (100°F) or higher and −18°C (0°F) or lower occur with frequencies of less than once in five years.[1]

The normal precipitation for the site is 114 to 117 cm (45 to 46 in.) per year. The winter and spring months have slightly more rainfall than does the period July through October.[3] The average winter has only occasional light snows; the seasonal average snowfall is 25 cm (10 in.)

3.2.2 Winds, Tornados, and Storms

The area has a long-period average of 53 thunderstorm days per year, but the number of damaging winds and hail storms is not large. The maximum 5-min wind velocity recorded for the site area is 101 km/h (63 mph). The entire Southern Illinois and Western Kentucky area has a 45-year tornado frequency rate of 2.5 tornadoes per year.[1] According to methods for estimating tornado occurrence presented by Thom,[4] the probability of a tornado actually striking the site is 1.9×10^{-3} per year (based on the above frequency), with a recurrence interval of 515 years.

3.2.3 Meteorology

A four-year (1960–1964) annual summary of wind speed, direction, and stability categories from the Paducah, Kentucky, weather station has been used to determine dispersion and dilution factors. These data, which include the wind direction-speed-stability frequency information are shown in Tables A.6 and A.7 in Appendix A.

ES-6071

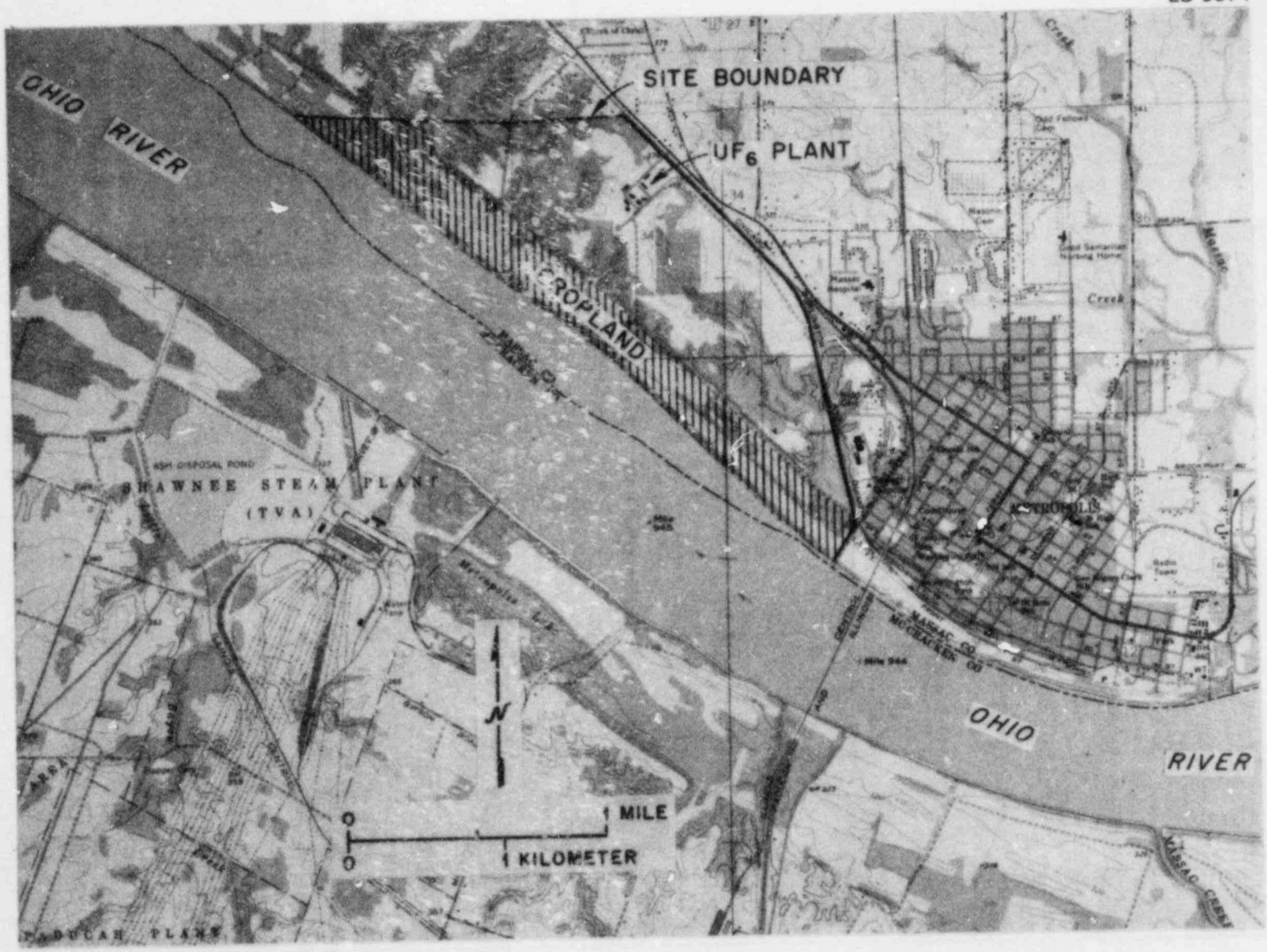

Fig. 3.1. Site of Allied Chemical Company UF_6 Conversion Plant near Metropolis, Illinois. Source: U.S. Geological Survey, Joppa and Metropolis Quadrangle, 1967.

Meteorological dispersion factors (annual χ/Q values) are estimated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence.[5,6] The annual average χ/Q value in 16 sectors up to a distance of 80 km (50 miles) from the site are given in Table A.5 of Appendix A. An average annual mixing height[7] of 1000 m is used in this report.

3.2.4 Air Quality

The state of Illinois has adopted air quality standards (Table 3.1) that are very similar to the National Ambient Air Quality Standards.

Table 3.1. Ambient air quality standards for Illinois

Pollutant	Time criteria	Concentration standard ($\mu g/m^3$)	
		Primary	Secondary
SO_2	3-h maximum[a]		1,300
	24-h maximum[a]	365	
	Annual arithmetic mean	80	
TSP[b]	24-h maximum[a]	260	150
	Annual geometric mean	75	60
NO_x	Annual arithmetic mean	100	100
CO	8-h maximum[a]	10,000	10,000
	1-h maximum[a]	40,000	40,000
Ozone	1-h maximum[a]	235	

[a]The concentration standard for this time criteria is not to be exceeded more than once per year.

[b]Total suspended particulates.

The most likely areas that would be affected by atmospheric pollution from the applicant's UF_6 production facility are Massac County (Illinois) and McCracken County (Kentucky) (Fig. 3.2).

The air quality of these counties is adversely affected by the pollution from the urbanized Paducah area and by two coal-fired electric generation facilities: the Shawnee Steam Plant (1750 MWe) across the Ohio River from Allied's facility and the Joppa Steam Electric Plant (about 1100 MWe) near Joppa, Illinois, about 10 km (6.2 miles) to the west-northwest.

Considering the small size of the Allied on-site power plant (equivalent to about 5-MWe capacity) compared to the utility steam plants, and its exclusive use of gaseous fuels or low-sulfur fuel oil, the staff does not expect the applicant's power plant operation to have a noticeable effect on the regional air quality.

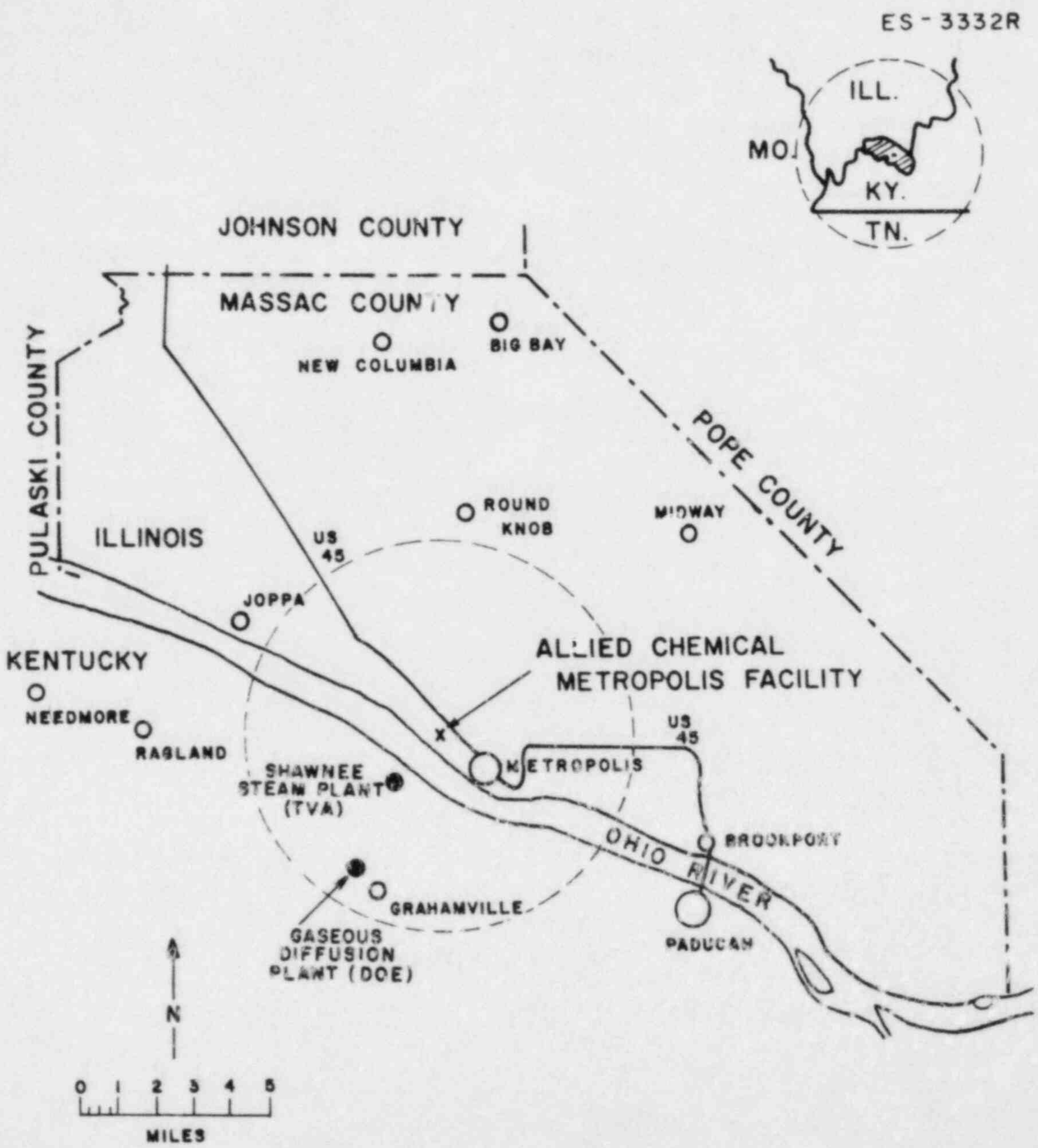

Fig. 3.2. Location of Allied Chemical Company UF_6 Conversion Plant at Metropolis with an indication of the nearby communities and major industrial employers.

3.3 DEMOGRAPHY AND SOCIOECONOMIC PROFILE

The plant site is located in a predominantly agricultural area of low average population density with widely scattered villages and small cities in Massac County, Illinois, and across the river in McCracken County, Kentucky (Fig. 3.2). Massac County has a population of about 14,000 with about 7,000 residing in the adjacent town of Metropolis. McCracken County has about 61,000 residents with 33,000 residing in the city of Paducah, which is 16 km (10 miles) southeast of the site. The 1980 population within 80 km (50 miles) of the plant is given in Table 3.2 for

Table 3.2. Incremental 1980 population within 80 km (50 miles) of the Allied Chemical Company UF_6 Conversion Plant at Metropolis, Illinois

Direction	Distance (miles)									
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	18	0	0	202	0	208	938	2,054	6,199	10,831
NNE	42	20	80	0	228	199	536	741	12,277	12,121
NE	21	0	147	125	18	158	1,121	3,026	2,112	4,018
ENE	12	160	33	0	26	377	575	2,570	4,796	5,602
E	54	0	283	0	65	556	653	2,934	5,069	8,313
ESE	24	2,329	0	0	99	1,068	4,020	7,876	2,923	1,712
SE	0	0	1,716	1,069	400	15,862	28,052	7,050	11,418	6,539
SSE	0	0	1,208	299	0	3,196	6,254	8,037	11,459	19,602
S	0	0	0	461	55	1,251	1,701	4,834	7,065	9,625
SSW	0	0	146	113	0	1,021	1,801	2,756	3,895	5,693
SW	0	0	120	214	97	417	2,011	3,323	1,783	5,603
WSW	0	19	0	0	96	576	2,750	9,382	6,758	16,078
W	0	0	57	0	96	348	1,324	4,791	2,903	21,211
WNW	0	71	55	0	187	302	1,133	3,136	3,356	33,682
NW	18	0	50	163	9	397	1,534	1,923	10,938	28,595
NNW	12	87	130	0	8	157	2,515	3,117	15,428	40,749
Total	201	2,686	4,025	2,646	1,384	26,093	56,918	67,550	108,379	229,974

each of 160 segments defined by 16 radial (compass) directions and ten radial distances [1.6, 3.2, 4.8, 8.1, 16.1, 32.2, 48.3, 64.4, and 80.5 km (1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 miles)]. The 1980 population in each circular zone (annulus) is also shown in Table 3.2. The cumulative 1980 population for each radial zone up to 80 km (50 miles) of the plant is given in Table 3.3. The total population within 80 km (50 miles) of the site is 499,659.

The nearest residence is located on the east side of U.S. Highway 45, about 421 m (1380 ft) from the Feed Materials Building. There are 13 other permanent residences in the near-site area ranging out to a distance of approximately 762 m (2500 ft) from the Feed Materials Building. Within the immediate vicinity, there are no off-site facilities that would present significant evacuation problems in the event of an on-site accidental release of hazardous material.

The Allied Chemical UF_6 Conversion Plant currently has 466 employees.[8] Most of the management personnel reside in the Paducah area, but the skilled craftsmen and operators generally live in or near Metropolis. The plant employment is not a significant fraction of the employment in Massac and McCracken counties. For example, the Paducah Gaseous Diffusion Plant west of Paducah (Fig. 3.2) is the largest employer in the area with about 1400 employees. Based on an employment/population ratio of 0.37,[9] employment at the Allied Chemical facility accounts for about 1.7% of the estimated 28,000 employment in the two-county area.

3.4 LAND

3.4.1 Site Area

Before being purchased by Allied Chemical about 25 years ago, much of the site was used for agriculture. Today the majority of the site consists of second-growth hardwood forest. About

Table 3.3. Cumulative 1980 population within 80 km (50 miles) of the Allied Chemical Company UF_6 Conversion Plant at Metropolis, Illinois

Direction	Distance (miles)									
	0-1	0-2	0-3	0-4	0-5	0-10	0-20	0-30	0-40	0-50
N	18	18	18	220	220	428	1,366	3,420	9,619	20,450
NNE	42	62	142	142	370	569	1,105	1,846	14,123	26,244
NE	21	21	168	293	311	469	1,590	4,616	6,728	10,746
ENE	12	172	205	205	231	608	1,183	3,753	8,549	14,151
E	54	54	337	337	402	958	1,611	4,545	9,614	17,927
ESE	24	2,353	2,353	2,353	2,452	3,520	7,540	15,416	18,339	20,051
SE	0	0	1,716	2,785	3,185	19,047	47,099	54,149	65,567	72,106
SSE	0	0	1,208	1,507	1,507	4,703	10,957	18,994	30,453	50,055
S	0	0	0	461	516	1,767	3,468	8,302	15,367	24,992
SSW	0	0	146	259	259	1,280	3,081	5,837	9,732	15,425
SW	0	0	120	334	431	848	2,859	6,182	7,965	13,568
WSW	0	19	19	19	115	691	3,441	12,823	19,581	35,659
W	0	0	57	57	153	501	1,825	6,616	9,519	30,730
WNW	0	71	126	126	313	615	1,748	4,884	8,240	41,922
NW	18	18	68	231	240	637	2,171	4,094	15,032	43,627
NNW	12	99	229	229	237	394	2,909	6,026	21,454	26,203
Total	201	2,787	6,912	9,558	10,942	37,035	93,953	161,503	269,882	499,856

80 ha (200 acres) of the property along the Ohio River are still used for grain production through a lease agreement with a local farmer (Fig. 3.1). There are no plans to increase the existing agricultural area or to harvest the marketable timber on the site.[8] A transmission line traverses the Allied property about half-way between the Ohio River and the southwestern border of the fenced area. The transmission line corridor is maintained in grasses and low-growing shrubs.

Major facilities in the 22-ha (54-acre) restricted area include the administration building, the laboratory, the fluorine production facility, the UF_6 manufacturing facility, the wastewater ponds and treatment plant, and a UF_6 cylinder storage area (Fig. 2.2). These facilities are surrounded by inner- and outer-perimeter security fences, about 15 m (50 ft) apart. Although the grounds are well-landscaped, large quantities of scrap metal are being accumulated to the south and east of the plant between the two fences. Only the six-story UF_6 production facility and the administration building are prominently visible from U.S. Highway 45 northeast of the plant structures.

3.4.2 Adjacent Area

Agriculture has been important in the general region of the Allied Chemical UF_6 facility throughout its recorded history. In 1978, approximately 72% of the land in Massac County was used for agricultural purposes.[10] The remaining lands were occupied by woodlands, idle farms, or urban areas. Farm income is derived about equally from sale of crops and sale of livestock, poultry, and their products. Important livestock in the area are hogs and cattle, and the major cash crops are soybeans, corn, and wheat.[10]

In the vicinity of the Allied plant, much of the floodplain along the Ohio River is cultivated. The nearest off-site cultivated fields and pasturelands downwind of the prevailing wind direction are located a few hundred meters northeast of the Allied property across U.S. Highway 45.

Major nearby industrial developments include the Tennessee Valley Authority Shawnee Steam Plant and the Paducah Gaseous Diffusion Plant (uranium enrichment facility) located immediately across the river, and an American Electric Power Company coal blending plant located immediately northwest of the Allied plant site. A coal-fired power plant operated by Electrical Energy, Inc., is located about 9.5 km (6 miles) northwest of Allied on the north side of the Ohio River.

There are two state natural areas within an 8-km (5-mile) radius of the Allied plant. About 5.5 km (3.5 miles) northwest of the Allied plant is the Mermet Lake Conservation Area, which contains the Mermet Swamp Nature Preserve. This conservation area is under the jurisdiction of the Illinois Department of Conservation. The West Kentucky Wildlife Management Area is across the river, 3.2 km (2 miles) southwest of the Allied plant and adjacent to the Paducah Gaseous Diffusion Plant.

3.4.3 Historic Significance

A review of the *Federal Register*[11,12] reveals that two historic sites are located in the immediate vicinity of the Allied site: (1) the Elijah P. Curtis House, located in Metropolis and (2) Fort Massac, located in Fort Massac State Park which occupies about 0.6 km (1 mile) of riverbank along the Ohio about 0.6 km (1 mile) upriver from the Allied plant. Operation of the Allied facility should not affect use of these historic sites nor have an impact on the recreational use of the state park.

3.4.4 Floodplains and Wetlands

The Allied plant is situated on an alluvial terrace about 26 m (85 ft) above the Ohio River. Immediately southwest of the terrace, a 300-m (1000-ft) wide floodplain extends to the bank of the Ohio River (Fig. 3.1). Although flooding of the Ohio River occurs annually, floodwaters have never reached the plant site. The 1937 floodwaters reached an elevation of 104 m (342 ft).[1] The probable elevation of the 100-year flood in the area is about 103 m (340 ft).[13] Because elevation at the Allied site is 114 m (375 ft), the chance of the facility being affected by floodwaters is extremely remote. The applicant does not use any of the floodplain for its industrial activity. Thus, there would be no impact on the floodplain from operation of the plant.

Although there are no pools of water, small wetland habitats are located along the drainageway channel used to discharge plant effluents into the Ohio River (Fig. 2.2, outfall 002).

3.5 HYDROLOGY

3.5.1 Surface Water

There are no natural surface waters within the site boundaries. Natural drainageways on the site carry surface runoff in a southerly direction into the Ohio River. One drainageway is used to discharge effluents from the site into the Ohio River.

The Ohio River borders the Allied property on the southwest and is about 914 m (3000 ft) wide with a normal pool elevation of 88 m (290 ft) above mean sea level River flow is regulated by flood control structures, the nearest being Lock and Dam No. 52 at Brookport, Illinois, about 11 km (7 miles) upstream from the site.

State-discharge records have been maintained at Metropolis, Illinois (Illinois Central Railroad Bridge), since 1928. The maximum discharge of the Ohio River was 50,410 m^3/s (1,780,000 cfs) on February 1, 1937, and the minimum discharge of 425 m^3/s (15,000 cfs) occurred on July 30, 1930. Average discharge is 7,505 m^3/s (265,000 cfs).

The NPDES permit for the plant was issued on May 16, 1975; it became effective on June 15, 1975, and would have expired on May 31, 1980. Pending approval of Allied's renewal application, the existing permit has been extended (Appendix B). Requirements of the NPDES permit for discharges from the Allied plant into the Ohio River and the annual average for these parameters in 1982 are shown in Table 3.4 (also see Table 2.7). In a few instances, the NPDES limits were slightly exceeded, but these excursions would not be expected to produce any significant impact on the Ohio River (Sect. 2.2.2.2). The average annual values and monthly values for these contaminants are also below recognized wastewater-quality standards. The main contaminant of concern is fluoride, and the maximum monthly values (highest 15 mg/L in August 1982) did not exceed the state of Illinois recommended discharge limit.

Table 3.4. Requirements of the NPDES permit and annual average values for 1982 at the Allied plant outfall to the Ohio River

	NPDES requirements	Outfall (annual average)
pH	6.0-9.0	7.4
Fluoride, mg/L	15.0	6.5
Solids (total dissolved), mg/L	3500	725
Solids (suspended), mg/L	15.0	1.5

Source: Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

The average discharge rate for the plant effluent during the last three years was 0.18 m^3/s (6.3 cfs), which is trivial compared with the average discharge rate of 7,505 m^3/s (265,000 cfs) for the Ohio River (Sect. 2.2.2.2). Under these conditions, the discharged contaminants (Tables 2.6 and 2.7) would not be detectable after mixing with the river and should have no significant environmental impact. This expectation is confirmed by the data which show the upstream concentrations to be about the same as downstream (Sects. 4.1.2.4 and 4.1.4.1).

3.5.2 Groundwater

An adequate supply of groundwater is present in the surficial deposits up to 30-m (100-ft) deep to satisfy individual residential or farm use but not to satisfy industrial requirements or municipal water service systems. The principal source of groundwater for industrial, utility, and municipal water systems is the highly fractured and cavernous Mississippian limestone that underlies the area at depths greater than 60 m (200 ft).[1]

The water supply for the Allied Chemical plant is pumped from four wells identified as supply wells 1-3 and the sanitary well on Fig. 2.2. The total capacity of these wells is in excess of 17 m^3/min (4500 gpm). This is significantly more than normal plant use reflected by the 11.5 m^3/min (3000 gpm) average discharge from Outfall 002 in 1980 (Table 2.7).

A three-day pumping test on well No. 2 resulted in drawdowns of less than 0.6 m (2 ft) in the other on-site wells. Because other industrial and municipal wells in the area are at distant off-site locations, the staff does not expect them to be affected by the Allied plant groundwater use.

The Illinois Department of Public Health has established a quarterly sampling program of the plant potable water supply from the sanitary well to assure compliance with state drinking water standards for the safety of the plant employees and visitors.[1]

3.6 SOILS, GEOLOGY, AND SEISMICITY

3.6.1 Soils

Soils in the immediate vicinity of the UF_6 conversion facility generally consist of silty loam and silty clay loam to depths of 18 to 30 m (60 to 100 ft). These soils developed under forest vegetation from the original loess, a fine silty material transported by wind and deposited on land. These soils are characterized by their very low permeability and poor drainage.

The soils in the bottom land along the Ohio River were developed primarily from outwash or alluvium from under forest vegetation. Runoff from higher elevation on or near the plant site or siltation during river flooding contributes to the bottom land soil development.

3.6.2 Geology

Beneath the Quaternary surficial materials is the Tertiary and Cretaceous gravels, sands, and clays that may extend to more than 60 m (200 ft) deep. This material is supported by the older Mississipian undifferentiated carbonate (limestone) rocks that extend to more than 150 m (500 ft) deep. Except for sand and gravel, no mineral resources are known to exist on the site.

Structurally, the area is part of both the Mississippi Embayment syncline and the Illinois Basin. The older rocks of Mississippian age form the southern part of the Illinois Basin and dip toward the north and northeast. The younger rocks of Cretaceous and Tertiary age are on the east side of the Embayment syncline and dip toward the southeast.

3.6.3 Seismicity

A number of faults are found about 40 to 48 km (25 to 30 miles) east and west of the site, generally trending northeast-southwest toward New Madrid, Missouri.[14] Most faulting occurred millions of years ago. However, according to Ross, "earthquake activity in the upper part of the Mississippi Embayment suggests that this system of faults is still active."[14]

The only major earthquakes in historic times in this area were the New Madrid earthquakes of 1811-1812, centered about 60 miles southwest of the plant site. These earthquakes are generally recognized as the strongest in the recorded history of eastern North America. According to Nuttli, the intensity of the New Madrid earthquake (December 16, 1811) was X to XI in the epicentral region and between VIII and IX at Metropolis.[15]

Seismologists are unable to predict with any accuracy the recurrence rates for major earthquakes such as the New Madrid event. However, experience indicates that a major earthquake along the New Madrid front zone is capable of causing extensive damage in the Metropolis area. The Allied Chemical plant could sustain significant damage in such an earthquake, potentially leading to off-site environmental impacts like those discussed (Sect. 4.3.2) for other major accidents.

3.7 BIOTA

The biotic resources of the site have never been surveyed. The information presented here is based on literature concerning the regional biota and observations made by the staff during a site visit.

3.7.1 Terrestrial

The natural vegetation in the vicinity of the Allied site is characteristic of oak-hickory and southern mixed hardwood forests.[16] Consequently, even though much of the site was used for agriculture before the UF_6 facility was built, the majority of the area today consists of second-growth upland stands of oak (*Quercus* spp.) and hickory (*Carya* spp.). Characteristic pioneer tree species associated with these areas include persimmon (*Diospyros virginiana*), sassafras (*Sassafras albidum*), and black locust (*Robinia pseudoacacia*).[17] About 80 ha (200 acres) of the site along the Ohio River are still used for grain production through a lease agreement with a local farmer (Fig. 3.1). This cropland uses most of the floodplain, but it is interspersed with wooded drainage areas.

Vegetation along the river is subject to periodic inundation. Species such as cottonwood (*Populus deltoides* and *P. heterophyla*) and a variety of willows (*Salix* spp.) occur predominately adjacent to the water. Species such as box elder (*Acer negundo*), American beech (*Fagus grandifolia*), sweet gum (*Liquidambar styraciflua*), and sycamore (*Plantenus occidentalus*) are more predominant farther away from the river in areas subject to less frequent flooding.

Vegetation of the transmission line corridor on the site (Sect. 3.4.1) is maintained in grasses and low-growing shrubs. Characteristic species include brome grass (*Bromus tectorum*), broom sedge (*Andropogon virginicus*), bluegrass (*Poa pratensis*), goldenrod (*Solidago* spp.), sumac (*Rhus* spp.), and blackberry (*Rubus allegheniensis*).[17]

Within the 16 southern-most counties of the state, 32 species of amphibians are known to occur, 48 species of reptiles, 50 species of mammals, and 283 species of birds.[18] Fauna in the vicinity of the site is probably more diverse than in the rest of the state because the ranges of many animals characteristic of the Gulf Coastal Plain extend into the valleys of the Mississippi River and its tributary, the Ohio. This is especially true of many species of amphibians and reptiles characteristic of lowland swampy environments.[19] The Allied plant is near the edge of the Mississippi flyway, and a large number of migrating waterfowl use the nearby wetlands of the Ohio, Mississippi, and Cache rivers.[20] Also, southern Illinois is the wintering grounds for an estimated 300,000 Canada geese (*Branta canadensis*), which is the majority of Canada geese in the Mississippi flyway.[20]

Animal species occurring on the Allied site should be those typical of old fields and second-growth forests in Illinois. Common birds and mammals associated with open habitat such as the transmission line corridor and the cultivated fields include bobwhite quail (*Colinus virginianus*), mourning dove (*Zenaidura macroura*), horned lark (*Eremophila alpestris*), woodchuck (*Marmota monax*), deer mouse (*Peromyscus maniculatus*), and the eastern cottontail (*Sylvilagus floridanus*). Birds and mammals that could occur on forested land include the cardinal (*Richmondena cardinalis*), titmice and chickadees (*Parus* spp.), woodpeckers, eastern gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), opossum (*Didelphis marsupialis*), and white-tailed deer (*Odocoileus virginianus*).

Shorebirds such as plovers and sandpipers use the banks and sandbars of the Ohio River, although the sandbars near the Allied site are under water much of the year and are therefore not suitable nesting habitat. Other animals associated with the riverine habitat include muskrats (*Ondatra zibethica*), raccoon (*Procyon lotor*), and a variety of species of turtles, water snakes, salamanders, and frogs.

3.7.2 Aquatic

This discussion includes a summary of information available from general studies on the Ohio River and data in the literature on the biota of large, turbid rivers in temperate climates.

There are few major studies on the biota of the Ohio River; investigations that characterized all major biological groups at a given location are those done for previous environmental impact analyses. A recent draft environmental statement on proposed dredging operations in the Ohio River between river miles 438 and 981 (Allied Chemical is located at about Ohio river mile 950) summarizes much of the available biological information, and information from this document[21] is largely used as the basis for the following statements.

As in most large rivers, diatoms are generally the dominant algal plankton component in the Ohio River.[22] Common genera include Melorisra, Synedra, and Fragilaria. Maximum development occurs in the spring and fall, similar to the classic diatom pulses for lentic waters.[23,24] Green algae probably constitute the next most abundant group in the phytoplankton.[25] Most of the green algae are Chlorococcalean forms, including genera such as Scenedesmus, Pediastrum, and Antistrodesmus. A smaller, but sometimes conspicuous assemblage of flagellates often occurs, with species of Euglena, Mallomonas, and Trachelomonas predominating. Large developments of blue-green algae (particularly Anacystis and Aphanezomenon) sometimes occur in large rivers, particularly in artificial reservoirs receiving large inputs of nutrient materials.[24,26]

Phytoplankton densities are greatly affected by alterations of the flow regime and by changes in the turbidity of the water. Low flows in the warmer months generally allow for the development of larger standing crops of blue-greens from increased retention times and warmer temperatures. Higher turbidity reduces the depth to which light can penetrate and, hence, the volume of water that will support an actively photosynthesizing algal population. Highest cell densities are generally associated with blue-green developments; surface standing crops in the Ohio River can apparently reach 100,000 cells per milliliter in some instances.[27]

Because of generally high turbidity, fluctuating water levels, and often poor substrate conditions, periphyton development in the Ohio River is minimal.[21] In areas in which conditions are favorable, large standing crops can develop from the generally high nutrient levels. Hynes[22] lists the following genera as common benthic forms in large rivers: Synedra, Nitzchia, Navicula, Diatoma, and Surirella.

Macrophyte growth is not extensive in the river, due largely to high turbidity, fluctuating water levels, and shifting bottom topography. Sheltered embayments may support dense stands of rushes, cattails, and the like, but such areas represent only a small percentage of the river's littoral areas.[21]

Zooplankton in the Ohio River, as in most large, turbid rivers, consists largely of rotifers.[22,28] Mean densities of 200 to 300 organisms per liter have been recorded for several locations. Peak populations around Louisville usually develop from late spring to early winter and densities are depressed by increased flows and turbidity.[21] Pooled areas behind dams have greater populations of crustaceans (a group largely favoring lentic conditions) than do flowing areas.[22]

Common rotifer genera in larger rivers include Kerarella, Polyarthra, Asplanchna, and Brachionus; common crustacean genera are Cyclops and Bosmina.[22]

Benthic macroinvertebrate populations are not well developed in the Ohio River, possible due to the paucity of suitable substrates, high turbidity, and an often unfavorable chemical environment (low bottom redox potentials, toxic materials sorbed to the sediments).[21] Chironomid larvae and tubificids often dominate the community (in terms of numbers), and the the asiatic clam (*Corbicula manilensis*) is also often found in large quantities. Other common organisms include *Chaoborus* spp. and various snails and leeches. In rocky areas, diversity is increased in *Hydra* spp., and crayfish have been found.[21]

The character of the Ohio River Basin has changed greatly in the last 100 years after the construction of many locks and dams and the degradation of the water quality by industrial and municipal discharges. A once common gamefish, the walleye, is rare, and today nongame fish (e.g., carp, freshwater drum) and forage fish (e.g., emerald shiner and gizzard shad) predominate. The large-scale damming of the river has decreased the habitats of many fish by creating more lentic conditions and has hindered the migration of others such as the walleye. Changes in water quality have affected fish directly (e.g., toxins) as well as indirectly through the alteration of food sources.

Conditions in the river today are quite favorable for the abundant forage fish that feed largely on detritus, plant material (allochthonous and autochthonous), and benthic invertebrates. The emerald shiner is the most common forage species found, although it does not constitute a large percentage of the total biomass.[21] In numbers and weight, the gizzard shad appears to represent a very significant proportion of the total fish population.

Nongame fish such as carp commonly thrive in highly turbid, poor-quality waters, often when no other fish can. The abundance of allochthonous organic material in the river likewise provides these bottom feeders with a large food supply. By weight, these fish dominate all other types by a wide margin.

Although commercial fishing has largely been abandoned on the Ohio River, sport fishing is still fairly popular. Commonly caught species include channel catfish, white bass, and bluegill.[21]

3.7.3 Threatened and Endangered Species

3.7.3.1 Terrestrial

No federally listed threatened or endangered plant species occur in Illinois (50 CFR Parts 17.11 and 17.12).

Federally listed threatened or endangered animals whose ranges include southern Illinois are the bald eagle (*Haliaeetus leucocephalus*), American peregrine falcon (*Falco peregrinus anatum*), Bachman's warbler (*Vermivora bachmanii*), gray bat (*Myotis grisescens*), and Indiana bat (*M. sodalis*) (50 CFR Parts 17.11 and 17.12). The staff knows of no reports of these species being observed on or near the Allied site. A few bald eagles, however, winter near Mermet Lake, about 5.5 km (3.5 miles) northwest of the Allied facility, and at other sites along the Mississippi and Ohio rivers in southern Illinois. Also, the bald eagle currently nests in both Williamson and Alexander counties, about 65 km (40 miles) from the Allied site (M. Sweet, Illinois Department of Conservation, Springfield, personal communication to L. D. Voorhees, ORNL, May 11, 1983). It is unlikely that these individuals would occur near the Allied site.

Peregrine falcons are known to occur only as migrants in the state of Illinois. Each year during migration, peregrines are sighted along the Illinois and Mississippi rivers.[29] They might occur near the site as very rare migrant or vagrant individuals.

Bachman's warblers have not been seen in several years and may be extinct. However, the river swamp forest of southeastern Missouri, northeastern Arkansas, and western Kentucky represent potential breeding habitat.[30] Because of the history of land use on the site and the site's present habitat conditions (Sect. 3.7.1), it is very unlikely that these warblers occur on the site.

Both the gray bat and Indiana bat occur in southern Illinois. The gray bat, however, is associated with limestone caves and is known only from Pike and Hardin counties.[29] The geographic range of the Indiana bat is also associated with major cavernous limestone areas.[30] The male is closely associated with limestone caves throughout the year, whereas the summer distribution of maternity colonies prefer streamside forest. No Indiana bats are known to winter in Massac County. (M. Sweet, Illinois Department of Conservation, Springfield, personal communication to L. D. Voorhees, ORNL, May 11, 1983). Further, with farming occurring on much of the floodplain in the vicinity of the Allied site (Sects. 3.4.1 and 3.4.2), it is unlikely that the Indiana bat would occur in this area.

3.7.3.2 Aquatic

There are no known threatened or endangered fish species in the Ohio River near the Allied Chemical site.[28] Endangered clams that potentially occur in the Ohio River near the facility are the pearly mussels (*Lampsilis higginsi), L. urbiculata, Epioblasma sampsoni,* and *E. torulosa.*[31]

3.8 RADIOLOGICAL CHARACTERISTICS (BACKGROUND)

The radiological background characteristics presented in this section were developed from selected data and published reports.

3.8.1 Total-body Dose Rate

The total-body dose rate for the population in the vicinity of Metropolis, Illinois, is approximately 106 millirem per year.[32] This dose rate includes 42 millirem/year from cosmic rays, 45.6 millirem/year from terrestrial sources, and 18 millirem/year from internal emitters.

3.8.2 Soil, Vegetation, Sediment and Water Background

The background uranium activity in the soil and vegetation as determined by preoperational sampling was 0.6 ppm and 0.28 ppm, respectively. For surface water, the background uranium concentration was found to be 0.009 ppm.[33]

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4. ENVIRONMENTAL CONSEQUENCES OF PROPOSED LICENSE RENEWAL

4.1 MONITORING PROGRAMS AND MITIGATORY MEASURES

A comprehensive effluent and environmental monitoring program is conducted by the applicant to demonstrate compliance with appropriate environmental protection standards and to provide, where possible, "site-specific" data which would preclude the need to use conservative assumptions in the environmental modeling of radiation exposure data.[1] The on-site and off-site monitoring programs are shown in Tables 4.1 and 4.2, respectively, and are discussed in detail below along with results obtained in recent years.[1,2]

Table 4.1. On-site environmental monitoring program

Sample medium	Number of stations	Collection frequency	Sample type	Type of analysis
Air particulates[a]	6	Weekly	Continuous	Uranium, ^{226}Ra, ^{230}Th, fluorides
Soil	6	Semiannually	Grab	Uranium, fluorides
Vegetation	6	Semiannually	Grab	Uranium, fluorides
Ambient radiation	5	Quarterly	Continuous	Gamma
Surface water[b]	1	Daily	Continuous	Uranium, gross alpha, gross beta, ^{226}Ra, ^{230}Th
		Six times/week	Grab	pH
		Twice/week	Grab	suspended solids, dissolved solids, fluorides other chemicals
Groundwater	4	Quarterly	Grab	Fluorides, gross alpha, gross beta, ^{226}Ra
		Semiannually	Grab	pH, specific conductance, total organic carbon, total organic halogen
		Annually	Grab	Chloride, iron, phenols, manganese, sodium, sulfate

[a]Currently, 51 plant stack emissions are also sampled continuously for uranium.

[b]Plant effluent stream.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Table 4.2. Off-site environmental monitoring program

Sample medium	Number of stations	Collection frequency	Sample type	Type of analysis
Air particulates[a]	2	Weekly	Continuous	Uranium, ^{226}Ra, ^{230}Th, fluorides
Soil	7	Semiannually	Grab	Uranium, fluorides
Vegetation	7	Semianually	Grab	Uranium, fluorides
Ambient radiation	1	Quarterly	Continuous	Gamma
Surface water	7	Semiannually	Grab	Uranium, fluorides
Bottom sediment	7	Semiannually	Grab	Uranium, fluorides

[a]Air samples at the nearest residence are also analyzed for particle size and solubility (see text).

Source: Allied Chemical Company, "Allied Chemical Appication for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

4.1.1 Effluent Monitoring Program

4.1.1.1 Radiological

A radiological monitoring program for atmospheric and liquid effluents has been in effect for the UF_6 Conversion Plant for many years. At present, there are 51 stacks and exhaust fans releasing uranium compounds to the environment from normal operation of the plant (see Sect. 2.2.2.1). The quantities of uranium emitted from the process stacks during 1979-1982 are shown in Tables 2.3 and 2.4.

All liquid wastes from the plant are discharged through the main effluent line (Outfall 002, Fig. 2.2) via natural drainage which travels about 600 m (2000 ft) across Allied property before it enters the Ohio River. The natural drainage course also carries runoff during periods of heavy precipitation. This effluent is continuously sampled, and the composite sample is analyzed daily for uranium. The daily samples are composited monthly and analyzed for uranium, gross alpha, and gross beta. Quarterly composites of the monthly samples are analyzed for ^{226}Ra and ^{230}Th. Results of analyses indicating radiological concentrations in the plant effluents during the last four years of operation are shown in Table 2.6. The maximum annual concentration for ^{234}U was 1.5×10^{-7} $\mu Ci/mL$. This value represents 0.5% of the limit (3×10^{-5} $\mu Ci/mL$ for ^{234}U) in unrestricted waters (10 CFR Part 20). Soluble ^{226}Ra has the most restrictive limit (30 pCi/L or 3×10^{-8} $\mu Ci/mL$) of the radionuclides appearing in the plant effluents. The maximum annual average value found for soluble ^{226}Ra is only 1.3 pCi/L, or 4.3% of the limit.

Underdrains, consisting of perforated pipes placed in shallow, gravel-filled channels, are installed beneath the linings of Ponds 1 through 4. Any liquids collecting in the underdrains for Ponds 1 and 2 are returned without analysis to the ponds. Liquids from the underdrains of Ponds 3 and 4 are piped to a storm sewer and eventually are monitored and discharged through Outfall 002 as part of the main plant effluent.

Three groundwater monitoring wells (G-102, G-103, and G-104) have been installed along the southwestern edge of calcium fluoride Pond E (see Fig. 2.2) for the detection of potential groundwater contamination from the calcium fluoride ponds. An additional well (G-101) was installed in the northern portion of the site to serve as a control station for groundwater monitoring. The level of the water in these wells ranged from 16 to 19.5 m (52 to 64 ft) below the surface. The four wells were sampled quarterly beginning with July 1982 for gross alpha, gross beta, and ^{226}Ra to comply with monitoring requirements of the Resource Conservation and Recovery Act. Monitoring results from the four wells show that concentrations of each of these parameters are below EPA drinking water standards.

4.1.1.2 Nonradiological

Periodic sampling of SO_2 emissions from the powerplant and incinerator stacks is performed to check on the compliance of these emissions with the conditions of the state and federal operating permits. These emissions are indicated in Table 2.5. This table also provides the nominal emission of pollutants from other sources within the plant.

The nonradioactive pollutants in the composite samples of the effluent from Outfall 002 are also analyzed. The annual average concentration of principal pollutants for the years 1979-1982 is given in Table 2.7. Generally, the pollutant concentrations are within the limits prescribed in the NPDES permit (Appendix B), except for a few slight exceedances for fluoride (see Sect. 2.2.2.2).

The calcium fluoride settling Ponds A through E are provided with a leak-detection system beneath a rubber lining.[2] This system consists of perforated polyethylene pipes (underdrains) which drain into a sump located at the ends of the ponds. The system of pipes is divided into zones to facilitate the location of any leak that might occur. A leak would be detected by the presence of liquid in a sump. The sumps of each pond are included in a weekly inspection schedule. When a leak is detected, use of the pond is discontinued until the calcium fluoride sludge can be removed and the lining repaired.

The four groundwater monitoring wells are also sampled for a wide variety of chemical contaminants to satisfy requirements of the Resource Conservation and Recovery Act. No significant differences in the chemical analysis of the four wells were observed.[2] Future monitoring for the groundwater wells will be as indicated in Table 4.1.

4.1.2 Environmental Monitoring Program

4.1.2.1 Radiological

On-site

Air monitoring. The on-site environmental air survey program consists of taking continuous air samples at four points along the restricted area fence line and at two points near the site boundary in the direction of the prevailing winds (see Fig. 4.1). The sample filters are changed weekly and analyzed for uranium. Additionally, a quarterly composite of the weekly samples is analyzed for ^{226}Ra and ^{230}Th. Monitoring results for uranium are summarized in Table 4.3 (1979-1982) and for radium and thorium in Table 4.4 (1980-1982). These results satisfy the criteria for acceptable impact established by the NRC in Conditions 1, 4, and 5 of Amendment No. 4 (Mar. 24, 1980) to the current license.

Soil and vegetation monitoring. Environmental samples of soil and vegetation are collected semiannually. The six on-site sampling stations are at the same locations as the air samplers (Fig. 4.1). Each sample is analyzed for uranium.

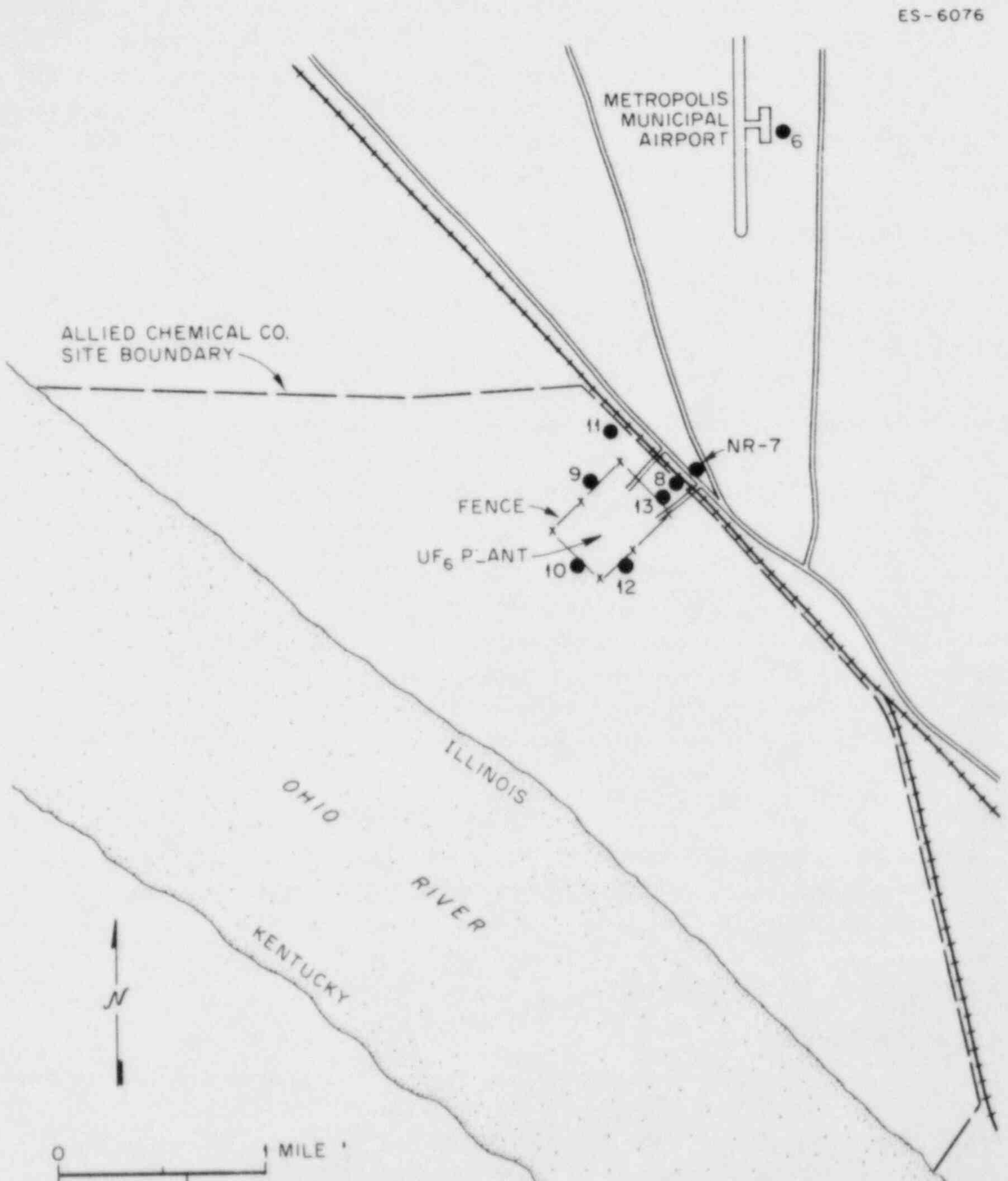

Fig. 4.1. Location of on-site sampling stations and the nearest resident (NR) and Metropolis Municipal Airport sampling stations.

Table 4.3 Environmental air monitoring for uranium at on-site locations, at the Metropolis Municipal Airport, and at the nearest residence

Sampling station	Annual average (μCi/cc)			
	1979	1980	1981	1982
On restricted fence line[a]				
No. 9	3.1×10^{-14}	1.5×10^{-14}	1.0×10^{-14}	1.4×10^{-14}
No. 10	3.3×10^{-14}	4.0×10^{-14}	2.5×10^{-14}	3.0×10^{-14}
No. 12	3.5×10^{-14}	3.7×10^{-14}	2.6×10^{-14}	2.2×10^{-14}
No. 13	3.1×10^{-14}	4.4×10^{-14}	3.4×10^{-14}	2.8×10^{-14}
On-site near property boundary[b]				
No. 8	2.2×10^{-14}	2.1×10^{-14}	1.4×10^{-14}	1.3×10^{-14}
No. 11	2.8×10^{-14}	2.9×10^{-14}	1.6×10^{-14}	1.5×10^{-14}
Off-site near airport[c]				
No. 6	2.2×10^{-15}	3.5×10^{-15}	2.5×10^{-15}	1.9×10^{-15}
Nearest residence[d]				
No. NR-7		2.1×10^{-14}	1.6×10^{-14}	1.1×10^{-14}

[a]Station Nos. 9, 10, 12, and 13 are located on the restricted area fence line: No.9—236 m (775 ft) NNW of UF_6 building; No. 10—219 m (720 ft) SW of UF_6 building; No. 12—180 m (590 ft) SSE of UF_6 building; No. 13—230 m (755 ft) NE of UF_6 building.

[b]Nos. 8 and 11 are located on-site near nearest property boundary: No. 8—315 m (1035 ft) NE of UF_6 building; No. 11—378 m (1240 ft) N of UF_6 building.

[c]No. 6 is located off-site—1615 m (5300 ft) NNE (Metropolis Airport).

[d]No. 7 is located off-site—421 m (1380 ft) NE of feed materials building.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982 [Table 4.1(C)].

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Tables 4.5 and 4.6 show the results of the soil and vegetation analyses during 1979-1982. The on-site uranium concentration in the soil averaged about 12 ppm during the four-year period. This is twenty times the average value found in preoperational surveys (Sect. 3.8.2) and more than twice the average of 5 ppm determined for the period 1968-1973. However, when converted to pCi/g of soil, the annual average uranium concentrations in Table 4.5 are less than the NRC criteria of 35 pCi/g of soil for release of a site for unrestricted use.[3]

The on-site concentrations of uranium in vegetation have averaged 14.5 ppm during the years 1979-1982. This is almost fifty times the preoperational value (Sect. 3.8.2) and twelve times the average concentration determined for the period 1968-1973.[4]

Although there is not a consistent trend in the annual uranium concentrations for the on-site soil and vegetation samples since 1979, the staff is concerned about the upward trend for the longer period since 1968. The staff will therefore require the applicant to investigate the reason for the increasing uranium concentrations in the environment and to evaluate the implications (Sect. 4.1.3).

No soil or vegetation samples are taken in or along the effluent discharge ditch between Outfall 002 and the Ohio River. Slight elevations of uranium in the bottom sediment where the ditch empties into the river (discussed in this section under "Off-site—Aqueous monitoring")

Table 4.4. Environmental air monitoring for ^{226}Ra and ^{230}Th at on-site locations, at the Metropolis Municipal Airport, and at the nearest residence

Sampling station	Annual average (μCi/cc)					
	1980		1981		1982	
	^{226}Ra	^{230}Th	^{226}Ra	^{230}Th	^{226}Ra	^{230}Th
On restricted fence line[a]						
No. 9	9.9×10^{-17}	7.0×10^{-16}	7.3×10^{-17}	5.9×10^{-16}	9.2×10^{-17}	1.1×10^{-15}
No. 10	1.9×10^{-16}	4.9×10^{-15}	4.7×10^{-16}	5.5×10^{-15}	2.8×10^{-16}	6.2×10^{-15}
No. 12	2.5×10^{-16}	3.7×10^{-15}	1.6×10^{-16}	7.8×10^{-15}	1.2×10^{-16}	2.4×10^{-15}
No. 13	2.1×10^{-16}	3.7×10^{-15}	1.6×10^{-16}	1.9×10^{-15}	7.5×10^{-17}	2.4×10^{-15}
On-site near property boundary[b]						
No. 8	9.7×10^{-17}	2.2×10^{-15}	1.0×10^{-16}	8.4×10^{-16}	1.1×10^{-16}	1.1×10^{-15}
No. 11	1.2×10^{-16}	9.1×10^{-16}	5.7×10^{-17}	7.0×10^{-16}	7.1×10^{-17}	1.1×10^{-16}
Off-site near airport[c]						
No. 6	4.9×10^{-17}	3.2×10^{-16}	9.1×10^{-17}	4.6×10^{-16}	5.6×10^{-17}	5.0×10^{-16}
Nearest residence[d]						
No. NR-7	3.1×10^{-17}	4.1×10^{-16}	4.0×10^{-17}	6.0×10^{-16}	1.3×10^{-16}	3.4×10^{-16}

[a]Station Nos. 9, 10, 12, and 13 are located on the restricted area fence line: No. 9—236 m (775 ft) NNW of UF_6 building; No. 10—219 m (720 ft) SW of UF_6 building; No. 12—180 m (590 ft) SSE of UF_6 building; No. 13—230 m (755 ft) NE of UF_6 building.

[b]Nos. 8 and 11 are located on-site near nearest property boundary: No. 8—315 m (1035 ft) NE of UF_6 building; No. 11—378 m (1240 ft) N of UF_6 building.

[c]No. 6 is located off-site—1615 m (5300 ft) NNE (Metropolis Airport).

[d]No. 7 is located off-site—421 m (1380 ft) NE of feed materials building.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982 [Table 4.1(C)].

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.5 On-site environmental soil samples

Location	Sampling station	Uranium (ppm)			
		1979	1980	1981	1982
Northeast of feeds building	No. 8	5.2	8.2	9.7	7.8
West of feeds building	No. 9	4.8	0.5	8.0	8.0
South of feeds building	No. 10	10.9	0.7	24.0	13.8
North of feeds building	No. 11	3.8	1.8	5.4	6.6
East of feeds building	No. 12	24.0	84.0	14.0	5.5
Northeast of feeds building	No. 13	9.0	7.7	6.5	11.0
On-site average		9.6	17.1	11.2	8.8

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.6. On-site environmental vegetation samples

Location	Sampling Station	Uranium (ppm)			
		1979	1980	1981	1982
Northeast of feeds building	No. 8	13.1	9.0	11.6	7.0
West of feeds building	No. 9	11.7	5.1	12.9	12.8
South of feeds building	No. 10	7.1	9.2	29.0	13.3
North of feeds building	No. 11	8.0	5.7	10.7	9.3
East of feeds building	No. 12	20.0	23.4	36.6	18.8
Northeast of feeds building	No. 13	21.8	17.4	22.6	10.7
On-site average		13.6	11.6	20.6	12.0

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

indicate that uranium may have settled and accumulated in the drainage ditch during past operation. Because this may inhibit future decommissioning and release of the site for unrestricted use, the staff will require sampling along the effluent discharge ditch to evaluate the current extent of contamination, if any (Sect. 4.1.3).

External gamma monitoring. Environmental thermoluminescence dosimetry results reported by Allied are shown in Table 4.7. Environmental thermoluminescent dosimeter (TLD) badges are located on the restricted area fence on each side of the plant. One TLD badge is also located at the northeastern boundary of the plant site. The badges are exchanged quarterly for analysis by a vendor laboratory.

Table 4.7 Environmental TLD radiation monitoring results

Location	Dose rate (millirem/year)			
	1979	1980	1981	1982
North fence	306	318	244	244
East fence	1354	1415	1512	1698
South fence	558	568	616	629
West fence	137	155	124	130
North boundary	151	176	130	154
Metropolis Airport	111	132	92	108

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

The maximum annual average external gamma dose rate consistently occurs toward the southeast of the facility at what Allied calls the "east fence" sample site. A major contributor to this high dose is a large ore concentrate storage area located inside the fence in this area. The maximum for a single year (1982) is about 1700 millirem, and the average for the four-year period is about 1500 millirem/year. If an individual were continuously present at the southeast fence for seven consecutive days, he or she could receive a dose of 33 millirem. This dose is 33% of the radiation level allowed by 10 CFR Part 20.105 in unrestricted areas. It is extremely unlikely that anyone would ever be near the southeast fence for any significant time. The land beyond the southeast fence is owned and controlled by Allied as far as 1.6 km (1 mile) away in a southeasterly direction. As shown in Figs. 2.1 and 2.3, this property is densely wooded and has low, if any, occupancy. Allied's property does not extend as far to the east, and the nearest dwelling in this direction is a private hotel about 600 m (2000 ft) from the southeast fence. The nearest residence to the ore concentrate storage area is located approximately 300 m (1000 ft) to the northeast. This residence is also roughly 400 m (1300 ft) from the Feed Materials Building and other potential sources of direct radiation on the Allied site. The TLD badge at the north site boundary, which is approximately 90 m (300 ft) from the residence, shows a four-year average of about 150 millirem/year. This measure, which is approximately 40 millirem/year higher than the background measured at the Metropolis Airport, suggests that the dose rate at the residence may also be above background. To determine the direct radiation levels at the residence and to ensure compliance with 40 CFR Part 190 (which limits off-site doses to a real person to 25 millirem/year), Allied will be required to measure direct gamma radiation on the resident's property. Allied will also be required to measure direct gamma radiation at other nearby locations, such as the residence where the air sampling station is located and at the hotel to the east.

Off-site

Air monitoring. The off-site environmental air survey program includes one sampler (No. 6) located approximately 1.6 km (1 mile) downwind of the feed material building at the Metropolis Airport (see Figs. 4.1 and 4.2). The sampler is changed weekly and analyzed for uranium. Additionally, a quarterly composite of the weekly samples is analyzed for ^{226}Ra and ^{230}Th.

A second sampler (No. NR-7) is located at the nearest residence downwind from the plant about 420 m (1380 ft) NE of the feed material building (Fig. 4.1). In addition to the above schedule of analysis for uranium, ^{226}Ra, and ^{230}Th, the samples from this station are also analyzed each week for the activity median aerodynamic diameter (AMAD) of the aerosol distribution. Each quarter, simulated lung fluid solubility tests are also run to determine the simulated biological half-life of the uranium collected. Tests have been attempted to determine the solubility of ^{230}Th; however, Allied has indicated that this procedure was not feasible. Therefore, ^{230}Th is assumed to be 100% solubility class Y in accordance with recommendations of ICRP Publication 30 for thorium oxides. Similarly, the ^{226}Ra is assumed to be 100% class W in accordance with ICRP recommendations. The "site-specific" data from the nearest residence is used to determine the radiation exposure of the resident. A summary of the monitoring results obtained during a 2.5-year period (July 1980-December 1982) is shown in Table 4.8.

Soil and vegetation monitoring. Off-site environmental soil and vegetation samples are collected semiannually and analyzed for uranium. Seven locations, covering a radius of about 13 km (8 miles)

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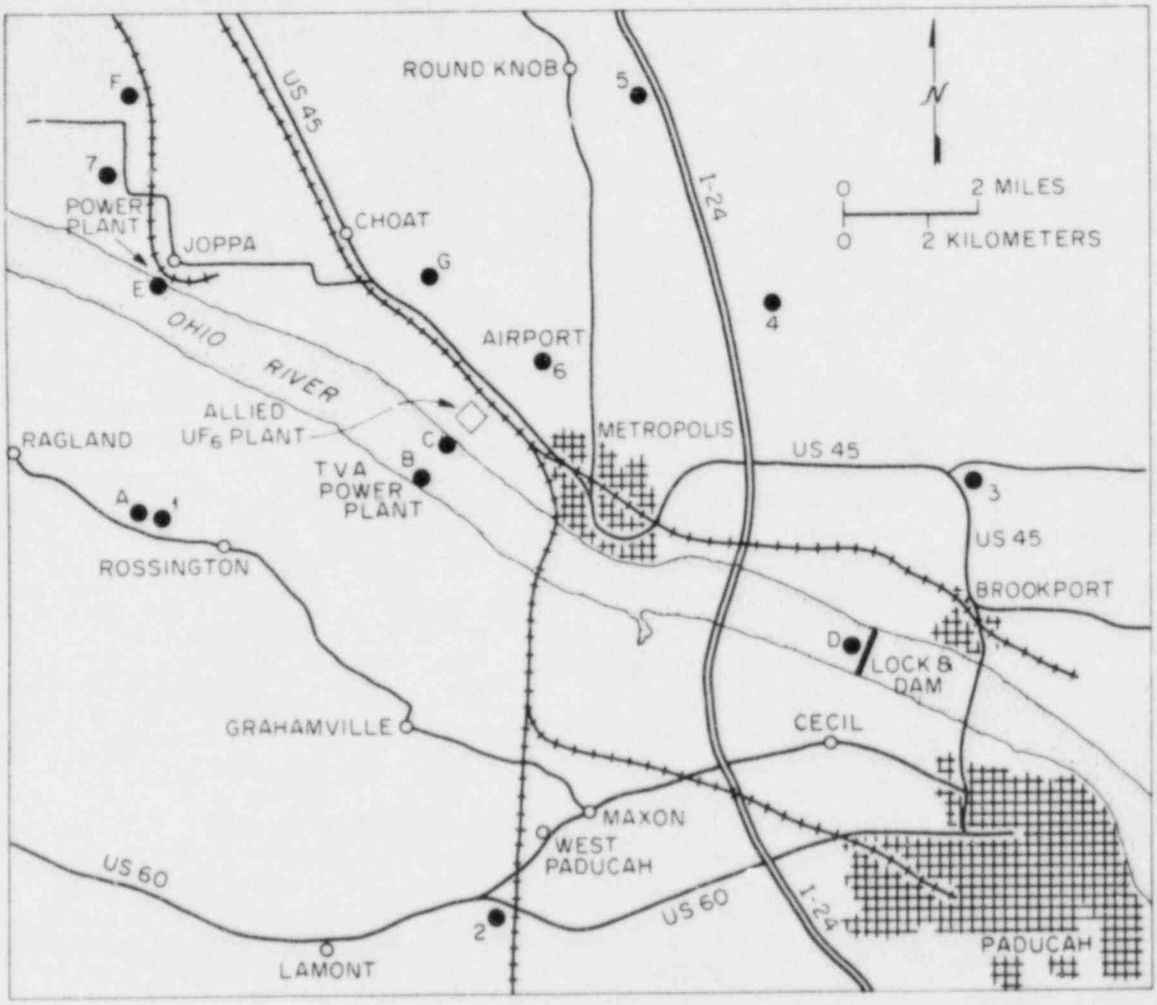

Fig. 4.2. Location of off-site sampling stations.

in the surrounding areas of Illinois and Kentucky, are sampled (see Figs. 4.1 and 4.2). The annual average concentrations in the soil and vegetation for the past four years are shown in Tables 4.9 and 4.10.

The average annual concentration in the off-site soil sample locations during this recent four-year period was 1.7 ppm, with a highest one-year average of 2.8 ppm (Table 4.9). For the period 1968-1973, the average soil concentration at the same sites was determined to be 1.1 ppm with a maximum semiannual average of 2.5 ppm.[3] The average annual concentration in vegetation at the off-site locations during the 1979-1982 period was 3.1 ppm, with a highest one-year average of 8.8 ppm (Table 4.10). For the 1968-1973 period, the average vegetation concentration at the same sites was determined to be 0.33 ppm, with a maximum semiannual average of 0.7 ppm.[3] These results indicate an upward trend in the concentration of uranium in both the soil and vegetation at the off-site locations when compared with the preoperational averages (Sect. 3.8.2),

Table 4.8. A summary of the average radionuclide concentration as a function of solubility class at the nearest residence in prevailing wind direction (420 m or 1380 ft NE of the Feed Material Building) for the period July 1980 through December 1982

Radionuclide[b]	Concentration in sample (μCi/cc)[a]		
	Class D	Class W	Class Y
^{226}Ra	*c*	4.5×10^{-17}	*c*
^{230}Th	*c*	*c*	4.5×10^{-16}
^{234}U	4.3×10^{-15}	2.3×10^{-15}	1.1×10^{-15}
^{235}U	2.0×10^{-16}	1.1×10^{-16}	4.9×10^{-17}
^{238}U	4.3×10^{-15}	2.3×10^{-15}	1.1×10^{-15}

[a]Annual average concentration of solubility class.

[b]Particle size: 3.4 μm.

[c]For dose calculations, it is assumed that ^{226}Ra is 100% class W and ^{230}Th is 100% Class Y.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.9 Average annual concentration of uranium in off-site environmental soil samples for the years 1979–1982

Location	Sampling station	Uranium (ppm)			
		1979	1980	1981	1982
Lamb Farm	No.1	5.1	0.50	1.2	1.2
Brubaker Farm	No.2	2.1	0.62	1.1	0.80
Texaco Station	No.3	2.9	0.76	0.87	1.1
Illinois Power Equipment Station	No.4	3.1	0.58	1.1	1.0
Reineking Property	No.5	2.5	0.57	1.1	0.89
Metropolis Airport	No.6	2.3	0.92	9.9	1.2
Maple Grove School	No.7	1.3	0.47	1.0	0.93
Annual average		2.8	0.63	2.3	1.0

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.10. Average annual concentration of uranium in off-site environmental vegetation samples for the years 1979–1982

Location	Sampling station	Uranium (ppm)			
		1979	1980	1981	1982
Lamb Farm	No. 1	1.9	3.3	11.1	6.5
Brubaker Farm	No. 2	2.0	4.1	10.5	3.7
Texaco Station	No. 3	3.0	4.7	11.0	4.4
Illinois Power Equipment Station	No. 4	2.9	4.4	9.5	3.0
Reineking Property	No. 5	1.7	3.1	6.5	3.0
Metropolis Airport	No. 6	2.2	3.3	5.9	6.2
Maple Grove School	No. 7	3.5	3.1	7.3	5.3
Annual average		2.5	3.7	8.8	4.6

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

as was also indicated above for the on-site sampling. Thus, the staff will require the applicant to investigate the reason for the increasing uranium concentrations and to evaluate the implications (see Sect. 4.1.3).

External gamma monitoring. One off-site environmental TLD badge is located at the Metropolis Airport to measure area external gamma exposure levels. The badge is changed quarterly for analysis. The annual average exposure rates for the years 1979-1982 are shown in Table 4.7. The average annual level of 110 millirem/year essentially represents natural background for the area.

Aqueous monitoring. Environmental water and bottom sediment samples are taken semiannually from four locations on the Ohio River and at three area lakes and ponds (see Fig. 4.2). The results of surface water and bottom sediment analysis for uranium are shown in Tables 4.11 and 4.12 for the years 1979-1982.

The average annual uranium concentration in the river upstream of the plant discharge (Station D at Brookport Dam) was 0.028 ppm while approximately 8 km (5 miles) downstream at Joppa, Illinois (nearest downstream municipality which could but does not use the river water for drinking purposes), the annual average uranium concentration over the last four years was only 0.019 ppm. The highest value is near the plant outflow to the Ohio River, where the average uranium concentration is about 0.05 ppm. All of these values are less than 0.1% of the standard for unrestricted waters (10 CFR Part 20). However, the recent four-year average uranium concentrations in surface water are significantly greater than observed during the 1968-1973 period,[4] except for the plant site outflow sample. Because of the rapid exchange of water in the Ohio River, these increased uranium concentrations at Stations B, D, and E cannot be explained by uranium releases from either the Allied facility or the nearby Paducah Gaseous Diffusion Plant and

Table 4.11. Average annual concentrations of uranium in off-site environmental surface water samples for the years 1979–1982

Location	Sampling station	Uranium (ppm)[a]			
		1979	1980	1981	1982
Lamb Farm	A	1.7×10^{-2}	7.6×10^{-2}	9.0×10^{-3}	2.5×10^{-3}
TVA[b]	B	1.1×10^{-2}	7.0×10^{-3}	9.0×10^{-3}	1.5×10^{-2}
Plant site—outflow[c]	C	5.0×10^{-2}	1.1×10^{-1}	3.1×10^{-2}	2.5×10^{-2}
Brookport Dam[d]	D	1.1×10^{-2}	8.8×10^{-2}	9.0×10^{-3}	4.5×10^{-3}
Joppa Power Plant[e]	E	1.8×10^{-2}	4.1×10^{-2}	1.3×10^{-2}	3.0×10^{-3}
Lindsay Lake	F	5.0×10^{-3}	3.6×10^{-2}	1.0×10^{-2}	3.5×10^{-3}
Oak Glenn Lake	G	2.0×10^{-2}	1.0×10^{-3}	7.0×10^{-3}	1.0×10^{-3}

[a]One ppm is equivalent to 6.77×10^{-7} μCi/mL for uranium.

[b]Ohio River, opposite the plant outflow.

[c]Ohio River, near the plant outflow.

[d]Ohio River, 7 miles upstream from plant.

[e]Ohio River, 5 miles downstream, at Joppa, Ill.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.12. Average annual concentration of uranium in off-site environmental bottom sediment samples for the years 1979–1982

Location	Sampling station	Uranium (ppm)[a]			
		1979	1980	1981	1982
Lamb Farm	A	1.3	1.5	3.1	1.0
TVA[b]	B	1.8	0.9	1.7	1.1
Plant site—outflow[c]	C	3.6	34.4	2.7	2.0
Brookport Dam[d]	D	2.7	1.3	0.9	1.1
Joppa Power Plant[e]	E	15.5	1.2	1.4	1.2
Lindsay Lake	F	1.3	1.7	1.3	1.5
Oak Glenn Lake	G	2.1	1.7	0.9	1.0

[a]One ppm is equivalent to 6.77×10^{-7} μCi/mL for uranium.

[b]Ohio River, opposite the plant outflow.

[c]Ohio River, near the plant outflow.

[d]Ohio River, 7 miles upstream from plant.

[e]Ohio River, 5 miles downstream, at Joppa, Ill.

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

may indicate increased uranium releases from upstream sources. The staff will require the applicant to conduct an investigation (see Sect. 4.1.3) to resolve the concerns about the apparent upward trend in uranium concentrations in the environment near the Allied facility.

The analysis of the bottom sediment indicated that there is a very slight increase in the concentration of uranium in the river sediment at the point of effluent discharge (Station C). With the exception of a questionable sample taken in the spring of 1979 from the sediment downstream of the effluent (at Joppa Power Plant, Station E), the uranium concentrations upstream and downstream from the site do not differ significantly. Generally, the uranium concentrations in the sediment samples are similar to the results found in the 1968-1973 period.[4]

4.1.2.2 Nonradiological

On-site

Aqueous monitoring. The daily samples of the main effluent from Outfall 002 are composited into a monthly sample that is analyzed for many contaminants (Table 2.7). Compliance with the NPDES permit is determined from six weekly grab samples for pH, and twice-weekly analyses of 24-h composite samples for fluoride and suspended and dissolved solids. As discussed in Sect. 3.5.1, the discharged liquid waste is in compliance with the NPDES permit requirements. Wells G101 to G104 are analyzed periodically (Table 4.1) to detect possible changes in groundwater quality resulting from leakage from Ponds A-E or other plant sources. In addition, the underdrains of Ponds A-E are routinely inspected for water that would be present if the pond linings leaked.

Air monitoring. The environmental air monitoring program consists of taking continuous air samples at the on-site locations identified in Fig. 4.1 and at the Metropolis Municipal Airport and analyzing the samples for fluoride on a weekly basis. The average annual fluoride concentrations in the air are shown in Table 4.13. The maximum annual and monthly values, which occur near the south fence, may be influenced by airborne dust or mist from the adjacent CaF_2 settling ponds in addition to HF losses from the UF_6 conversion facility. The second highest fluoride concentrations occur at the north and east fences, which are in the path of the dominant wind direction for the potential HF releases from the main processing building.

The state of Illinois does not have an ambient air quality standard for fluoride. However, the state of Kentucky has established a standard that limits ambient concentrations of fluoride in air to a maximum monthly average of 1 ppb as HF, which is equivalent to 0.76 $\mu g\ F^-/m^3$. During the years 1979-1982, the maximum monthly average fluoride concentration at the applicant's continuous air sampling stations never exceeded the Kentucky standard. Because the ambient fluoride concentrations on the site are very low and the fluorides are emitted from several ill-defined sources, the staff does not believe that monitoring of the emissions would be useful.

Soil and vegetation monitoring. Fluoride concentrations are also determined in soil and vegetation samples collected semiannually at the six on-site locations shown in Fig. 4.1. The annual average results for the soil sampling are shown in Table 4.14 and for the vegetation sampling in Table 4.15. The fluoride concentrations in the on-site soil and vegetation samples are higher than observed at off-site locations (given below) as a result of fluoride losses (HF or CaF_2) from plant operations. The fluoride concentration in the vegetation samples is higher than the level generally

Table 4.13. Annual average fluoride concentrations in air samples at the site and at the Metropolis Airport for the years 1979–1982

Sampling station[a]	Annual average fluoride concentration, $\mu g\ F^-/m^3$			
	1979	1980	1981	1982
No. 6	0.008	0.013	0.011	0.011
No. 8	0.053	0.064	0.050	0.047
No. 9	0.099	0.086	0.050	0.087
No. 10	0.287	0.386	0.149	0.256
No. 11	0.075	0.104	0.040	0.065
No. 12	0.169	0.163	0.099	0.078
No. 13	0.146	0.145	0.160	0.103

[a]Station Nos. 9, 10, 12, and 13 are located on the restricted area fence line: No. 9—236 m (775 ft) NNW of UF_6 building; No. 10—219 m (720 ft) SW of UF_6 building; No. 12—180 m (590 ft) SSE of UF_6 building; No. 13—230 m (755 ft) NE of UF_6 building.

Nos. 8 and 11 are located on-site near nearest property boundary: No. 8—315 m (1035 ft) NE of UF_6 building; No. 11—378 m (1240 ft) N of UF_6 building.

No. 6 is located off-site—1615 m (5300 ft) NNE (Metropolis Airport).

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

accepted for domestic grazing animals, but there are no domestic animals kept on the site. However, the staff will require that fluoride monitoring be continued at the site.

Surveys of the on-site ecological communities have not been conducted. Because no construction activities are currently planned, no land or habitat will be significantly impacted by continued operations under a renewed license. If new activities are proposed that require an expansion of the industrial areas, the applicant will be required to survey the affected habitat and evaluate the construction impact.

No sediment samples are taken from the effluent discharge ditch for fluoride analysis, but high fluoride concentrations found in the Ohio River sediment at the plant outflow (discussed in this section under "Off-site—Aqueous monitoring") indicate that fluoride may also be accumulated in the ditch sediments. This accumulation could potentially result in complications during plant decommissioning. To characterize the fluoride content of these sediments and thereby provide a better understanding for their proper disposal at the end of plant life, the staff will require sampling and analyses for fluoride in the sediments of the drainage ditch (see Sect. 4.1.3).

Off-site

Aqueous monitoring. Water and mud samples are taken semiannually from four locations on the Ohio River and at three area lakes and ponds (Fig. 4.2) and analyzed for fluoride content.

Table 4.14. Annual average concentrations of fluoride in on-site soil samples for the years 1979–1982

Sampling station[a]	Annual average fluoride concentration, ppm			
	1979	1980	1981	1982
No. 8	6.8	23.6	18.1	38.7
No. 9	4.0	19.4	18.1	33.9
No. 10	13.7	73.5	74.8	69.0
No. 11	2.7	11.4	13.9	21.1
No. 12	181	175.2	66.0	20.2
No. 13	20	63.6	71.1	125.1
Average	38.2	61.2	43.7	51.4

[a]Station Nos. 9, 10, 12, and 13 are located on the restricted area fence line: No. 9—236 m (775 ft) NNW of UF_6 building; No. 10—219 m (720 ft) SW of UF_6 building; No. 12—180 m (590 ft) SSE of UF_6 building; No. 13—230 m (755 ft) NE of UF_6 building.

Nos. 8 and 11 are located on-site near nearest property boundary: No. 8—315 m (1035 ft) NE of UF_6 buildng; No. 11—378 m (1240 ft) N of UF_6 building.

No. 6 is located off-site—1615 m (5300 ft) NNE (Metropolis Airport).

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Environmental water samples collected from the Ohio River show that the plant is not contributing significant fluoride to the ambient river concentration (Table 4.16). During the last four years of plant operation, the ambient river concentration of fluoride upstream of the plant discharge averaged 0.26 mg/L. Downstream concentrations at Joppa, Illinois, also averaged 0.26 mg/L. Joppa is the nearest downstream municipality which could but does not use river water for drinking purposes. The state of Kentucky limits fluoride in drinking water (401 KAR 5:031) at the point of withdrawal to 1 mg/L.

Analyses of mud samples (bottom sediment) for fluoride show that there is considerable deposition in river sediment at the point of effluent discharge into the river, and fluoride concentrations in sediment are slightly higher downstream than at the upstream location (Table 4.17).

The fluoride concentrations in the sediments of small lakes (Stations A, F, and G in Table 4.17) are very similar to baseline concentrations in the off-site soil samples (given below) and are probably related to normal erosion. However, the higher fluoride concentrations detected in the Ohio River (Stations B and D) are possible indicators of fluoride losses from upstream industrial activity and agricultural runoff. There are no established standards for fluoride in stream sediments.

Table 4.15. Annual average concentrations of fluoride in on-site vegetation samples for the years 1979–1982

Sampling station[a]	Annual average fluoride concentration, ppm			
	1979	1980	1981	1982
No. 8	5.7	67.1	118.5	55.5
No. 9	4.7	43.1	18.5	154.0
No. 10	6.4	53.3	55.1	209
No. 11	6.5	101.4	49.1	92.0
No. 12	10.8	53.7	99.3	114.7
No. 13	29.3	336.4	275	127.7
Average	11.5	109.2	102.7	117.1

[a]Station Nos. 9, 10, 12, and 13 are located on the restricted area fence line: No. 9—236 m (775 ft) NNW of UF_6 building; No. 10—219 m (720 ft) SW UF_6 building; No. 12—180 m (590 ft) SSE of UF_6 building; No. 13—230 m (755 ft) NE of UF_6 building.

Nos. 8 and 11 are located on-site near nearest property boundary: No. 8—315 m (1035 ft) NE of UF_6 building; No. 11—378 m (1240 ft) N of UF_6 building.

No. 6 is located off-site—1615 m (5300 ft) NNE (Metropolis Airport).

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.16. Annual average fluoride content (ppm) of surface water samples taken in the region of the Allied Chemical Company plant

Location	Sampling station	1979	1980	1981	1982
Lamb Farm	A	0.18	0.28	0.18	0.15
TVA	B[a]	0.44	0.33	0.12	0.31
Plant site—outflow	C[b]	0.74	2.62	0.42	0.50
Brookport Dam	D[c]	0.10	0.42	0.14	0.23
Joppa Power Plant	E[d]	0.15	0.38	0.14	0.25
Lindsay Lake	F	0.14	0.34	0.15	0.53
Oak Glenn Lake	G	1.98	0.10	0.17	0.16

[a]Ohio River, opposite the plant outflow.

[b]Ohio River, near the plant outflow.

[c]Ohio River, 7 miles upstream from plant.

[d]Ohio River, 5 miles downstream, at Joppa, Ill.

Source: Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.17. Annual average fluoride content (ppm) of mud samples taken in the region of the Allied Chemical Company plant

Location	Sampling station	1979	1980	1981	1982
Lamb Farm	A	2.5	9.25	10.6	10.5
TVA	B[a]	8.5	23.2	34.9	51.5
Plant site-overflow	C[b]	18.5	3762	103.2	137.5
Brookport Dam	D[c]	23.8	34.9	20.1	46.8
Joppa Power Plant	E[d]	33.8	76.1	88.3	109.5
Lindsay Lake	F	2.8	8.3	4.2	8.2
Oak Glenn Lake	G	2.5	8.0	3.1	24.7

[a]Ohio River, opposite the plant outflow.

[b]Ohio River, near the plant outflow.

[c]Ohio River, 7 miles upstream from plant.

[d]Ohio River, 5 miles downstream, at Joppa, Ill.

Source: Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Soil and vegetation monitoring. Soil and vegetation samples are collected semiannually at the off-site locations identified in Fig. 4.2 and analyzed for fluoride content. The annual average concentrations for the years 1979-1982 are shown in Tables 4.18 and 4.19 for soil and vegetation, respectively. On the basis of these results, there appears to be a slight upward trend in fluoride content of soil or vegetation at these off-site sampling locations. However, similar ranges of fluoride concentrations were observed in both soil and vegetation samples analyzed in the years 1968-1973. Thus, a long-term change in fluoride concentrations is not indicated for the off-site locations, but fluoride sampling should continue.

4.1.3 Mitigating Measures

The radiological monitoring programs that have been established for the Allied facility at Metropolis are needed to measure the impacts of plant emissions and effluents on the environment during normal plant operations or following an accident situation. The analysis in Sect. 4.2.5 does not indicate any serious radiological impact on nearby residents or the regional population. However, the staff is concerned about an upward trend in the uranium concentrations in off-site soil and vegetation samples (Sect. 4.1.2.1) because of the potential for radiological exposure through the ingestion pathway. The applicant has not provided an explanation for the increasing uranium concentrations. The applicant's monitoring data do not provide any pattern to show that these uranium concentrations result from operation of the UF_6 conversion facility. The staff's review of existing documentation[5,6] indicates that the nearby Paducah Gaseous Diffusion Plant currently does not significantly contribute to uranium deposition in the area. Some of the applicant's data indicate that the upward trend in uranium concentrations in the environment may result from sources outside the immediate area. It is also possible that changes in sampling technique and/or analytical procedures introduced a discontinuity in some of the monitoring results. Therefore, the staff will require the applicant to investigate the cause of the upward trend in uranium concentrations in on- and off-site soil and vegetation and to propose what, if any, corrective action by Allied is necessary to stop the trend.

Table 4.18. Annual average concentrations of fluoride in off-site soil samples for the years 1979–1982

Location	Sampling station	Annual average fluoride concentration, ppm			
		1979	1980	1981	1982
Lamb Farm	No. 1	<2.5	11.0	6.9	12.6
Brubaker Farm	No. 2	<2.5	7.6	4.6	7.7
Texaco Station	No. 3	3.7	54.6	6.9	17.7
Illinois Power Equipment Station	No. 4	3.3	8.4	3.8	9.0
Reineking Property	No. 5	2.9	10.3	7.6	15.4
Metropolis Airport	No. 6	<2.5	5.4	6.5	10.7
Maple Grove School	No. 7	<2.5	7.3	4.4	10.3
Annual Average		2.8	15.0	5.9	12.0

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

Table 4.19. Annual average concentrations of fluoride in off-site vegetation samples for the years 1979–1982

Location	Sampling station	Annual average fluoride concentration, ppm			
		1979	1980	1981	1982
Lamb Farm	No. 1	<4	9.1	7.3	15.2
Brubaker Farm	No. 2	<4	13.6	7.5	8.2
Texaco Station	No. 3	<4	8.6	7.2	8.7
Illinois Power	No. 4	<4	16.2	6.0	8.4
Reineking Property	No. 5	<4	5.3	5.8	6.4
Metropolis Airport	No. 6	<4	13.4	6.9	8.5
Maple Grove School	No. 7	5	8.9	7.4	6.6
Annual average		<4	10.7	6.9	8.9

Source: Allied Chemical Company, "Allied Chemical Application for Renewal of Source Material License SUB-526, Docket 40-3392, UF_6 Conversion Plant," Metropolis, Ill., July 1982.

Allied Chemical Company, "Responses to NRC Site Visit Information Requests," May 27, 1983.

There is a potential to accumulate uranium in the soil of the liquid effluent drainage ditch. Such an accumulation could require removal of the sediments during decommissioning and disposal under prescribed conditions. To characterize the radiological nature of the sediments and enable better planning for their future disposal, the staff will require the applicant to expand the existing monitoring program to include sampling for uranium in the soil (or sediment) at several locations (at least two) along the drainage ditch.

As discussed in Sect. 4.1.2.1, results from environmental TLD badges suggest that direct radiation at nearby residences may be elevated above background. Direct gamma radiation is currently not monitored at these locations. To ensure compliance with 40 CFR Part 190, Allied will be required to measure direct gamma dose rates at appropriate off-site locations, such as the nearest residences to the northeast and the hotel to the east.

The nonradiological program shows that aqueous effluents from the Allied Chemical site are within NPDES limits. Therefore, the current monitoring program at the Allied facility for aqueous effluents is adequate. Because no significant impacts on aquatic life are likely to result from routine operation (Sect. 4.2.4.2), no mitigation associated with the proposed action is necessary.

Because no significant nonradiological impact to the terrestrial environment is expected to occur during the license renewal period (Sect. 4.2.4.1), no mitigation associated with the proposed action is currently necessary. Generally, the terrestrial monitoring program is considered adequate to identify the impacts of plant operation and should be continued. However, the fluoride concentration in the sediment at the effluent outflow to the Ohio River (Station C, Table 4.17) indicates that fluoride may also be accumulating in the sediments in the effluent drainage ditch. As discussed above for uranium, fluoride in the ditch sediments may require their removal and disposal under prescribed conditions at the end of the plant life. Fluoride analyses would help to characterize the sediments and ensure their proper disposal during decommissioning. Therefore, the staff will require the applicant to include sampling for fluoride in the sediment at several (at least two) locations along the drainage ditch.

4.2 DIRECT EFFECTS AND THEIR SIGNIFICANCE

4.2.1 Air Quality

Normal operation of Allied's UF_6 Conversion Plant is not expected to have any significant off-site effect on nonradiological air quality parameters. Elevated fluoride concentrations have been detected in air samples on the plant site as a result of HF emissions from the UF_6 production building. These fluoride concentrations, which are less than the air quality standard set by the state of Kentucky (Sect. 4.1.2.2), will be even less at off-site residences.

There may also be noticeable off-site odors because of the storage and use of several other volatile acids and solvents, but concentrations of noxious gases are not expected to be harmful to nearby residents.

4.2.2 Land Use

Operation of the Allied plant has had no adverse effects on land use in the past, and there are no plans to expand the facility. Therefore, no additional impacts on land use, historical sites, or floodplains and wetlands will result from license renewal. Any proposal to expand the fenced area of the facility during the license renewal period will necessitate an environmental evaluation of land use impacts (see Sect. 1.2).

4.2.3 Water

Direct effects on surface waters are minimized by the requirements of the NPDES permit as specified by the Illinois Environmental Protection Agency. Allied Chemical is in compliance with these requirements (Sects. 3.5.1 and 4.1.2).

4.2.4 Ecological

4.2.4.1 Terrestrial

Before construction of the UF_6 facility, much of the site was used for farming. With the exception of an 80-ha (200-acre) plot of land along the Ohio River currently used for grain production and the 22 ha (54 acres) used for plant operations, most of the 349-ha (862-acre) site has reverted to second-growth hardwood forest. This change in land use has probably had a beneficial effect on the wildlife in the area by providing food and cover for a variety of species. Because no major expansion of existing facilities is planned, there will be no construction-related impacts. However, any proposed expansion of the fenced area during the license renewal period will require additional evaluation of terrestrial impacts. No soil erosion or excessive noise caused by traffic or plant operation was noted during the staff's visit to the site. No threatened or endangered species are known to frequent the area (Sect. 3.7.3), and none should be affected by continued plant operation.

The primary potential for impact on terrestrial biota from operation of the Allied facility is associated with release of gaseous effluents, including HF, SO_2, and NH_3. The effects of these effluents on terrestrial biota were evaluated and presented in detail in the EIA prepared by the staff for license renewal in 1977.[7] It was concluded that operation of the facility would result in no adverse impact on terrestrial biota or people near the Allied plant.[7] The present application for renewal of the license involves no increase in scope of the current authorization (Sect. 1.2). Furthermore, fluoride ion (F^-) concentrations in air, soil, and vegetation resulting from HF emissions have been consistently below those which may result in adverse effects. Therefore, no impacts to terrestrial biota are expected from continued operation of the facility. Because fluoride adversely affects vegetation at relatively low ambient concentrations and accumulation of relatively high fluoride concentrations by forage crops are potentially hazardous to livestock,[8] the staff requires that the monitoring of fluoride in air, soil, and vegetation be continued (Sect. 4.1.2).

The staff has analyzed the applicant's fluoride monitoring program and results[1,2] in relation to distance, direction, and meteorological conditions. A review of the last four years of data does not show any potentially damaging concentrations of fluoride as a result of plant airborne releases. Although the range of values at all sampling stations is relatively small, the highest concentrations of fluoride in vegetation off-site are located at sample stations 1, 2, 4, and 6 (Fig. 4.2). This pattern of results is generally consistent with the meteorological conditions of the site and vicinity (Sect. 3.2.3). Based on disperson coefficients (χ/Q) calculated by the staff, the maximum concentration of airborne pollutants is expected to occur at about 1200 to 1600 m (0.75 to

1 mile) north-northeast of the facility. Although no significant concentration of fluorides has been found in this area in recent years, the applicant will continue to monitor the fluoride in the air at sample site No. 6, located about 1900 m (1.2 miles) north-northeast of the facility. On the basis of this evaluation of the applicant's monitoring results, the staff does not find it necessary to alter the location of the existing fluoride monitoring sites. If the applicant would propose to increase the scope of operations at the facility resulting in greater releases of HF, an environmental impact evaluation of potential fluoride increases in air, soil, and vegetation would be required.

4.2.4.2 Aquatic

No construction-related impacts are considered because the plant is currently operating and no major expansion of facilities is planned at this time. If expansion of the plant or its operations is proposed during the licensing period, an evaluation of environmental impacts on aquatic biota would be required.

The discharge ditch does not normally contain flowing water from sources other than the plant outfall. Therefore, it is not considered to represent aquatic habitat in this appraisal. The quantity of water discharged from Allied's facility [0.18 m^3/s (6.3 cfs)] is insignificant compared with the average flow of the Ohio River [7,363 m^3/s (260,000 cfs)]. Moreover, this discharge constitutes only about 0.02% of the river's lowest flow on record of 425 m^3/s (150,000 cfs). Under such conditions, the contaminants discharged would not be detectable with current methods of analysis after moderate mixing in the river. In addition, fluoride levels measured above and below the outfall are almost identical (Table 4.16). Finally, no waste heat is discharged in the liquid effluent.

Although the Ohio River is a highly turbid system, periodic additions of sediments from the discharge ditch probably have some detrimental influence on the biota in a restricted area. Thus, benthic macroinvertebrate communities of the predominantly sandy substrates along the shore could be modified, phytoplankton production could be reduced by decreased light penetration, and zooplankton could be affected by the reduced phytoplankton production.

In considering these factors, the staff concludes that the impact of the Allied facility is likely confined to the effluent mixing zone, which constitutes a very small area of the Ohio River, at the discharge point. Very few, if any, organisms are expected to show acutely toxic reactions, because of the relatively low levels of chemical releases and the rapid dilution of the effluent with river water. Any chronically toxic effects would likewise be minimal because of dilution. Some siltation may occur in a restricted area, largely due to sediment loading of the discharge ditch by runoff water. However, the river sediments are probably disturbed during flood events, and the pollutants from the plant effluent are not expected to build up to a serious level at the discharge point.

Except for a small area comprising the effluent mixing zone, the staff concludes that the operation of the Allied facility has had no significant impacts on any aquatic environments.

4.2.5 Radiological Impacts

The radiological impacts of the Allied UF_6 Conversion Plant were assessed by calculating the maximum dose to the individual living at the nearest residence and to the local population living within an 80-km (50-mile) radius of the plant site.

Except where specified, the term "dose" as referred to in this report is actually a 50-year dose commitment for all internal exposures—that is, the total dose to the reference organ that will accrue from one year of intake of radionuclides during the remaining lifetime (50 years) of the individual. It was assumed that the individual spends 80% of his time at the reference location and that none of the food consumed is produced at the site because there is no vegetable garden. The dose reflects the annual release of radionuclides from the combined effluents. Where possible, site-specific data are used for estimating dose.

4.2.5.1 Doses from airborne releases

Emissions from building exhaust stacks are monitored continuously, and the average annual release rates for uranium (in kilograms) over the period 1979 through 1982 are shown in Tables 2.3 and 2.4. These release rates are used to estimate the dose to the local population [within an 80-km (50-mile) radius of the plant site]. The estimated release rates for the uranium isotopes and for ^{226}Ra and ^{230}Th (not routinely monitored), lung clearance (solubility) classes, and particle size shown in Table 4.20 are based on measurements made at the site of the nearest residence[1,2] (Sect. 4.1.2).

Table 4.20. Estimated annual average release of radionuclides in the stack effluents of the Allied Chemical Company UF_6 Conversion Plant

Radionuclide[a]	Release rate (μCi/year)[b]		
	Class D	Class W	Class Y
^{226}Ra		6.7×10^2	
^{230}Th			6.6×10^3
^{234}U	6.3×10^4	3.4×10^4	1.6×10^4
^{235}U	3.1×10^3	1.7×10^3	7.5×10^2
^{238}U	6.3×10^4	3.4×10^4	1.6×10^4

[a]Releases of natural uranium were measured between 1979 and 1982.

[b]Release rates in terms of lung clearance classes (solubility) were estimated from radionuclide analysis at the nearest residence. Releases of ^{226}Ra and ^{230}Th were not measured in the stack effluents but were estimated on the basis of data obtained at the nearest residence.

The nearest residence is about 422 m (1380 ft) NE of the release stacks. At this point, a continuous air sampler monitors the concentration of radionuclides in the air. In addition, the AMAD of the aerosol distribution is analyzed.[2] Simulated lung fluid solubility tests are also run to determine the respiratory clearance class (D, W, or Y) for uranium.[9] This determination is based on the lung model for inhaled particles proposed by the task group of the International Commission on Radiological Protection.[10,11] As previously mentioned in Sect. 4.1.2.1, the ^{230}Th is assumed to be 100% solubility class Y and the ^{226}Ra is assumed to be 100% class W in accordance with recommendations in ICRP Publication 30. The "site-specific" data for the nearest residence are shown in Table 4.8 and are used to determine the dose to the maximum exposed individual.

Population doses were estimated using the AIRDOS-EPA computer code.[12] The methodology is designed to estimate (1) the rates of deposition on ground surfaces; (2) ground surface contaminations; (3) intake rates via inhalation of air and ingestion of meat, milk, and vegetables; and (4) radiation doses to man from the airborne releases of radionuclides. The highest estimated doses to the individual residing nearby and to the population living within an 80-km (50-mile) radius of the site can be calculated with the code.

Meteorological dispersion factors, χ/Q, were estimated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence.[13,14] The χ/Q values are summarized in Appendix A. Because the actual concentrations of radionuclides in air are obtained by measurement at the site of the maximum-exposed individual, the meteorological dispersion and dilution values are used only to determine the concentration of airborne radionuclides to which the local population is exposed.

Radionuclide concentrations in meat, milk, and vegetables consumed by man are estimated by coupling the output of the atmospheric transport models with NRC Regulatory Guide 1.109.[15] Since on-site meteorological measurements are not made, the average windspeed data for each directional segment and for each stability class are based on weather station data collected during the years 1960-1964 at nearby Paducah, Kentucky. Other parameters used in the dose calculations are given in Appendix A.

Dose to the maximally exposed individual

The 50-year dose commitments to the maximally exposed individual living at the nearest residence (422 m NE of the plant site) from the UF_6 conversion plant airborne effluents are shown in Table 4.21. The total-body dose of 0.6 millirem resulted almost entirely from the inhalation (99%) pathway. Most of the total-body dose was due to the ^{238}U (43%) and ^{234}U (49%) released (see Table 4.22).

The highest organ dose of 6.4 millirem was to the bone and resulted about equally from the ^{234}U (49%) and ^{238}U (44%), primarily via the inhalation pathway. The dose to the lungs of about 4.7 millirem was due almost entirely from the inhalation of ^{234}U (50%) and ^{238}U (47%).

The total-body and organ doses are well below 500 millirem/year to the total body, gonads, and bone marrow; 3000 millirem/year to the bone; and 1500 millirem/year to the other organs (designated in or derived from NRC regulations in 10 CFR Part 20). When the doses are compared to the Environmental Protection Agency (EPA) standards for the uranium fuel cycle facilities (40 CFR Part 190), the total-body dose is only about 2% of the limit of 25 millirem/year. The highest organ dose of 6.4 millirem to the bone is about 25% of the applicable EPA standard of 25 millirem/year while the lung dose of 4.7 millirem is about 20% of the standard. As mentioned in Sect. 4.2.5, based on information from the applicant, the nearest residents do not produce any of the food they consume at the point of the reference location and, thus, ingestion pathway was not considered a valid exposure pathway. The total doses which would result from producing all of their food locally are shown in footnote *d* of Table 4.21. Additionally, in order to estimate the doses as realistically as possible, it was assumed that the

Table 4.21. Fifty-year dose commitments[a] to the maximum exposed individual at the nearest residence[b] from the airborne effluents of the Allied Chemical Company UF_6 Conversion Plant

Pathway	Dose (millirem)			
	Total body	Bone	Lungs	Kidney
Immersion in air	2.0×10^{-7}	2.7×10^{-7}	1.9×10^{-7}	1.8×10^{-7}
Exposure to surface	4.9×10^{-3}	6.5×10^{-3}	4.0×10^{-3}	4.1×10^{-3}
Inhalation[c]	6.2×10^{-1}	6.4	4.7	1.3
Ingestion[d]				
Total	6.2×10^{-1}	6.4	4.7	1.3

[a]Fifty-year dose commitment from the intake of radionuclides resulting from one year of plant operation.

[b]Nearest residence is approximately 422 m NE of the plant site.

[c]Based on an inhalation rate of 8000 m^3/year.

[d]Since the resident did not have a garden nor produce milk or beef at this site, the ingestion pathway was not considered valid, and the dose was not included. Had the ingestion dose (based on the assumption that all food consumed is produced at the reference location) been included, the total dose would be as follows: total body, 1.9 millirem; bone, 21.6 millirem; lungs, 4.8 millirem; and kidney, 4.5 millirem. The ingestion doses are based on maximum intake rates for adults of 280 kg/year of vegetables, 310 L/year of milk, and 110 kg/year of meat (NRC Regulatory Guide 1.109).

Table 4.22. Major contributions (in percent) to dose to the nearest resident from the airborne effluents of the Allied Chemical Company UF_6 Conversion Plant

Radionuclide	Percentage contribution to dose			
	Total body	Bone	Lungs	Kidney
^{226}Ra	1.3	1.3	0.2	<0.1
^{230}Th	4.4	3.24	1.6	<0.1
^{234}U	48.8	49.1	50.3	51.9
^{235}U	2.3	2.3	0.9	2.2
^{238}U	43.2	44.0	47.0	45.9

residence time of the maximum exposed individual at the reference location was 80%. Where site-specific information was not available, assumptions that would tend to maximize the dose were used in the calculations.

If the parameters for these calculations of exposure to the nearest resident change during the license renewal period, the NRC shall be informed and the applicant will provide revised calculations.

In the staff's analysis for the issuance of Amendment No. 4 to the current license, it was concluded that the nearby DOE Paducah Gaseous Diffusion Plant (PGDP) might contribute about

14% of the total environmental uranium concentrations in the air at the nearest resident to the Allied facility and about 7% of the radiological dose to the lung of the resident.[5] However, since then, the UF_6 conversion facility at the DOE plant has been shut down, and uranium emissions in 1979 were only about 0.02 Ci (ref. 6) as compared to about 0.9 Ci used in the staff's earlier analysis. With this reduction in uranium emissions and the fact that the average alpha activity in samples taken north and east of the PGDP in 1979 was about 4×10^{-15} μCi/mL (4×10^{-6} pCi/L), which is less than the concentrations near the Allied facility, the staff believes that the PGDP does not now measurably contribute to the radioactivity near the Allied facility. The staff had also previously concluded that TVA's Shawnee Steam Plant across the river from the Allied site contributed less than 1% of the alpha activity at the nearest residence.[5]

As indicated in Sect. 4.1, upward trends in the uranium concentrations in water, sediment, soil, and vegetation samples at on-site and off-site locations are cause for some concern. Based on the findings in the preceding paragraph, the staff does not expect that the environmental monitoring data obtained near the Allied facility is significantly complicated by radioactive emissions from the PGDP or the Shawnee Plant. Nevertheless, enough information is not presently available to attribute solely to Allied the observed increases in uranium concentrations in the environment [sometimes at locations as great as 8 km (5 miles) from the Allied facility]. Additional monitoring will, therefore, be required to assist in the evaluation of the past monitoring results (Sect. 4.1).

Doses to the population within 80 km of the plant site

The 1980 population within an 80-km (50-mile) radius of the plant site is shown in Tables 3.2 and 3.3. Almost 500,000 persons live within this area. The population dose commitments from the routine annual releases of radionuclides (Table 4.20) are shown in Table 4.23. The total-body dose of 7.6 man-rem is only about 0.014% of the population dose of 5.3×10^4 man-rem resulting from the natural background radiation dose rate of 106 millirem/year.

Table 4.23. Fifty-year dose commitments[a] from the airborne effluents to the population[b] living within 80 km of the Allied Chemical Company UF_6 Conversion Plant

Pathway	Dose (man-rem)			
	Total body	Bone	Lungs	Kidney
Immersion in air	4.9×10^{-7}	6.6×10^{-7}	4.3×10^{-7}	4.5×10^{-7}
Exposure to surface	5.5×10^{-2}	6.9×10^{-2}	4.3×10^{-2}	4.6×10^{-2}
Inhalation[c]	1.4	1.5×10^{1}	3.0	1.1×10^{1}
Ingestion[d]	6.1	8.2×10^{1}	1.7×10^{1}	2.0×10^{-1}
Total	7.6	9.7×10^{1}	2.0×10^{1}	1.1×10^{1}

[a]Fifty-year dose commitment from the intake of radionuclides resulting from one year of plant operation.

[b]Based on the 1980 population of 500,000 persons.

[c]Based on an inhalation rate of 8000 m^3/year.

[d]Based on an average intake rate for adults of 103 kg/year of vegetables, 110 L/year of milk, and 95 kg/year of meat (NRC Regulatory Guide 1.109).

4.2.5.2 Doses from aqueous releases

The methodology used for calculating the 50-year dose commitments to man from the release of radionuclides to the aquatic environment is described in detail in ref. 16. Three exposure pathways are considered in dose determination: water ingestion, fish ingestion, and submersion in water (swimming). Internal and external dose conversion factors are discussed in Appendix A. The dietary intake rates are found in Regulatory Guide 1.109 (Appendix A, Table A.3). The release rates and concentrations of radionuclides after mixing with the Ohio River below the plant discharge are shown in Table 4.24.

Table 4.24. Annual average radionuclide release rate[a] in the Allied Chemical Company plant liquid effluents and concentrations of radionuclides in the Ohio River[b] near the plant site

Radionuclides	Release rates[c] (μCi/year)	Concentration in the Ohio River ($\mu Ci/cm^3$)
^{226}Ra	4.22×10^3	1.8×10^{-14}
^{230}Th	2.80×10^4	1.2×10^{-13}
^{234}U	9.29×10^5	3.9×10^{-12}
^{235}U	4.25×10^4	1.8×10^{-13}
^{238}U	9.23×10^5	3.9×10^{-12}

[a]Based on annual release rates for the years 1979-1982 in Allied Chemical Company, "Application for Renewal of Source Material License UF_6 Conversion Plant, SUB-526, Docket 40-3392," Metropolis, Ill., July 1982; and in Allied Chemical Company "Responses to NRC Site Visit Information Requests," May 27, 1983.

[b]Annual average flow at the plant site is 2.37×10^{17} cm^3/year.

[c]Average discharge rate of effluent is 5.63×10^{12} cm^3/year.

Dose to the maximally exposed individual

The 50-year dose commitments for individuals exposed to various aquatic pathways associated with the Ohio River are shown in Table 4.25. Of the total-body dose of only 0.004 millirem, 76% is due to the ingestion of water. Most of the doses were due to ^{234}U (50%) and ^{238}U (47%).

All of the estimated doses are so low as to be quite insignificant in contributing to the individual dose calculation. They are well below 500 millirem/year to the total body, gonads, and bone marrow; 3000 millirem/year to the bone; and 1500 millirem/year to the other organs (designated in or derived from NRC regulations in 10 CFR Part 20). Similarly, the doses are small fractions of the EPA standard of 25 millirem/year to the total body, 75 millirem/year to the thyroid, and 25 millirem/year to the other organs (40 CFR Part 190). The highest organ dose of 0.06 millirem to

Table 4.25. Maximum 50-year dose commitment from the use of the Ohio River near the liquid effluent discharge of the Allied Chemical Company UF_6 Conversion Plant[a]

Pathway	Dose (millirem)			
	Total body	Bone	Lungs	Kidney
Submersion in water[b]	2.9×10^{-8}	3.9×10^{-8}	2.6×10^{-8}	2.4×10^{-8}
Consumption of fish[c]	9.5×10^{-4}	1.3×10^{-2}	3.4×10^{-5}	2.7×10^{-3}
Consumption of water[d]	3.2×10^{-3}	4.3×10^{-2}	9.8×10^{-5}	9.2×10^{-3}
Total	4.2×10^{-3}	5.6×10^{-2}	1.3×10^{-4}	1.2×10^{-2}

[a]Assumes full mixing of the effluent discharge with the river.
[b]Assumes swimming in the water 1% of the year.
[c]Assumes intake of 21 kg/year of fish.
[d]Assumes intake of 730 L/year of drinking water.

the bone is about 0.24% of the EPA standard. Additionally, the total-body dose of 0.004 millirem is only 0.004% of the natural background dose (106 millirem/year) to an individual living in the Metropolis area.

Population dose commitments from liquid effluents

The nearest municipality downstream from the plant effluent discharge point which uses the Ohio River water as a source of drinking water is Cairo, Illinois. The city, located approximately 47 km (29 miles) downstream of the Allied plant, has a current population of 5900. If the concentration of radionuclides in the river shown in Table 4.24 (thus ignoring any further downstream dilution) is used, the total-body dose commitment to the population of Cairo is only about 0.025 man-rem. This population dose is a very small percentage of the comparable dose of 625 man-rem from natural background sources and thus would not noticeably add to the normal background dose.

4.3 INDIRECT EFFECTS AND THEIR SIGNIFICANCE

4.3.1 Socioeconomic Effects

As discussed in Sect. 3.3, employment at the Allied facility is not a major factor in the economy of the Metropolis, Illinois, and Paducah, Kentucky, area. Neither continued operation nor discontinuance would have a significant impact on socioeconomic conditions.

4.3.2 The Potential Effects of Accidents

The applicant has identified and analyzed a spectrum of accidents from probable minor events to unlikely major accidents. The "Metropolis Works Radiological Contingency Plan," which describes procedures for minimizing and mitigating the potential impact of radiological accidents, was approved by the NRC on March 24, 1982.

Because the most likely radiological accident with potential off-site consequences also results in a general hydrogen fluoride release, the plan is also applicable to nonradiological toxic gaseous release accidents.

4.3.2.1 Plant accidents involving radioactive materials

Minor accidents involving radioactive material

All incoming uranium concentrate (nominally U_3O_8) is received in 0.2-m^3 (55-gal) drums. This sandlike material is sampled and weighed for inventory in a falling stream sampling system (excess sodium, if present, is removed in a countercurrent slurry system), reduced with ammonia, and hydrofluoronated to UF_4 (greensalt) solid (see Sect. 2.2.1). There is a possibility of spillage of low-specific-activity solids in these processing steps or from drummed concentrate during in-plant transport. No off-site consequences would be expected. Such spills are promptly collected and the affected area decontaminated.

Accidents with potential off-site consequences

The UF_4 is then fluorinated to UF_6 which may exist as a vapor, as a solid vapor mixture (e.g., in cold traps), or as a liquid-vapor mixture (e.g., in a cold-trap on its heating cycle, in still feed tanks, in distillation columns, or in a product-cooling cylinder). Throughout the rest of the processing, until the final product cylinder has cooled to below 56°C (133°F) where the vapor pressure is one atmosphere, a release of UF_6 vapor will occur if a breach of containment occurs. The magnitude of release depends on temperature and inventory, and the rate of release depends on defect size and location.

The staff has reviewed normal inventory of all process vessels in the applicant's plant and finds that only the still feed tanks (10 tons) approach the size of a nominal 14-ton product cylinder. However, the potential for loss of UF_6 from the still feed tanks is much less than from the product cylinders because of their construction, fixed location, and isolation using block valves. Therefore, the staff chose to evaluate the potential consequences of accidents involving hot [93°C (200°F)] product cylinders.

Although a large UF_6 release from a cylinder at the Allied facility is unlikely, such an accident conceivably can occur. At least two such accidents have been recorded: one in 1977 at a French facility[17] and another in 1978 at the gaseous diffusion plant in Portsmouth, Ohio.[18] The applicant's operating procedures (Sect. 2.2.1.8) make the catastrophic breach of a liquid UF_6 cylinder very unlikely; however, if such a rupture ever occurred, it would most likely happen inside the Feed Materials Building where all sampling, weighing, and vertical lifting take place. A cylinder could rupture if dropped during this indoor handling. The cylinders are not moved outside until positioned on specially designed transport buggies. Once outside, the cylinders remain on the buggies, without any further handling, until the UF_6 has cooled and solidified. The most plausible accident scenario resulting in a rupture while outside would be that of a passing vehicle striking a liquid cylinder on the outdoor storage pad. This potential outdoor release could result in severe off-site exposures, and its consequences are described in detail below. An indoor release is expected to result in smaller off-site impacts and, because a calculation of exposures resulting from such a release would be highly speculative and uncertain, its consequences are described in more general terms.

For the outdoor release assessment, the staff chose a scenario similar to the accident that occurred at the gaseous diffusion plant in Portsmouth, Ohio. That incident involved the rupture of a filled liquid 14-ton cylinder in an outdoor storage area. The accident was caused by the failure of a straddle carrier, which allowed the cylinder to drop about 20 to 25 cm (8 to 10 in.) and rupture below the liquid level. As a result, approximately 9500 kg of UF_6 (equivalent to 6400 kg of natural uranium) were released in less than 5 min. On the basis of the amount of UF_6 remaining in the cylinder afterwards and the quantities of uranium either recovered or released via a drainage ditch, it was estimated that about 4800 kg of uranium was dispersed in the air. A release of this magnitude could be expected at Allied if a liquid cylinder in the outdoor storage area was struck and ruptured by a passing vehicle.

To conservatively assess the effects of such a release at Allied, the accident is assumed to occur under adverse meteorological conditions including an F type of atmospheric stability and a light wind blowing at 1 m/s. With a ground-level release and a dilution effect caused by building wake turbulence, the χ/Q at the nearest residence in the predominant wind direction (about 420 m away) is 1×10^{-3} s/m^3. According to meteorological data collected at the Metropolis Airport, the wind blows in this direction about 14% of the time. If these atmospheric conditions were all in effect at the time of release, uranium and HF could move downwind in a narrow, unwavering plume. The plume would be a dense white cloud which would be highly visible at the nearest residence during the day. The average concentrations of uranium and HF as the plume passes through this location would be 1.6×10^4 mg/m^3 and 5.3×10^3 mg/m^3, respectively. Because HF is a corrosive vapor that causes severe respiratory discomfort, a person would naturally try to escape from the plume if at all possible; however, if someone could not escape, exposure to these high concentrations for even a short period might cause a fatality. For HF, the level recognized to be dangerous to life for brief exposures is 40 mg/m^3 (ref. 19), and exposure to 100 mg/m^3 of HF for 1 min is considered epidemiologically significant.[20] Thus, exposure to the calculated HF concentration at the nearest residence for less than 1 min could be fatal. Exposures to the plume for less than a minute could also result in a fatal uranium intake of 160 mg.[21]

For the indoor release scenario, it is postulated that a filled liquid UF_6 cylinder is dropped and ruptured during crane transfer from the loading station to the weigh cart. This transfer is made in a room estimated by Allied to have a volume of 3400 m^3 with several openings to the main building. Over a period of minutes, depending on defect size, a large volume of liquid UF_6 would escape from the cylinder with some portion flashing to vapor. Forced ventilation is shut off at the time of cylinder rupture according to emergency planning procedures, and plant operations are generally conducted with the doors closed. Therefore, most of the gas released from the accident is expected to be initially contained indoors and principally in the loading room. This UF_6 gas, which could be extremely dense, will mix and react with available water vapor, forming HF gas and particulate UO_2F_2. Under typical indoor air conditions, such as a temperature of 20°C (68°F) and 50% relative humidity (8.8 g/m^3 of water vapor), relatively small amounts of water vapor would probably limit this reaction, and much of the gas is expected to remain UF_6. The HF and UF_6 gases and some of the particulate UO_2F_2 will begin to seep outdoors and/or spread from the cylinder-loading room into other parts of the main building. Additional quantities of UO_2F_2 and HF will be formed as the UF_6 reacts with water vapor in the rest of the building and with moisture entering the building by natural air exchange. The portion of spilled liquid UF_6 that did not vaporize would cool and solidify on the floor.

Because of the containment provided by the building, the staff believes that most plausible indoor releases would result in smaller off-site exposures than the outdoor accident described above. With forced ventilation shut off, building air exchange to the outside environment will occur slowly with a complete air changeout possibly requiring hours, depending on atmospheric conditions and how well the plant is closed up. During this time, most of the UO_2F_2 would deposit on the floors and other surfaces inside the building. Some of the UF_6 gas will condense, forming an airborne particulate which will also settle indoors. Nevertheless, some of the UF_6 and UO_2F_2 and most of the HF would escape outside, but the cloud would exit the building through many different openings. It is highly unlikely that the wind direction, wind speed, and atmospheric stability would remain constant during this slow, diffuse release. Consequently, UO_2F_2 and HF would be expected to pass through a larger downwind area but in much less concentration than the narrow, unwavering plume resulting from the postulated outdoor accident.

It must be emphasized that the probability of such accidents is very low and that the hazards and risks of a large UF_6 spill at Allied are not uncommon to the operation of other large chemical plants. This plant has been converting uranium to UF_6 since 1958, except for a period from 1964 to 1968. Allied has only experienced one substantial UF_6 spill, and it occurred in 1968 when 43 kg of liquid UF_6 leaked indoors as a result of a valve falure in the distillation section. No off-site impact was detected. Nevertheless, history has shown that massive releases can and do occur. The potential consequences of such a release outside at Allied are clearly unacceptable and the off-site impacts of a comparable indoor release, although less, are not well defined. Therefore, the NRC will closely examine Allied's handling of liquid UF_6 cylinders as well as their ability to mitigate off-site consequences of a large UF_6 spill.

Conditions for handling liquid cylinders will then be incorporated by amendment into Allied's renewed license in order to further reduce the likelihood of such a release.

4.3.2.2 Plant accidents involving nonradioactive material

The plant consumes relatively large quantities of chemicals annually (Table 2.1). Potassium bifluoride and hydrated lime have no hazard connotations, and laboratory chemicals (not listed in Table 2.1) are bought and used in small quantities which provide no off-site risks.

Sulfuric acid and potassium hydroxide are corrosive liquids which, if spilled, can cause on-site problems until neutralized and cleaned up. There is no potential for such spills causing off-site consequences.

Both hydrogen and anhydrous ammonia stored on-site as liquids can be classified as hazardous as well as fluorine gas produced on-site to convert UF_4 to UF_6. The potential consequences of accidents with these materials is discussed below.

HF

Anhydrous HF is a colorless corrosive liquid widely used in industrial processes. Its boiling point of 19.4°C (67°F) makes any plant release at ambient conditions below this temperature of negligible consequence off-site. At Metropolis, HF is stored in three tanks, two of 144,000-lb capacity and one of 132,000-lb capacity. Incoming HF is transferred from railroad tank cars into these tanks using pressurized nitrogen at 35 psig. The storage tanks are bermed to contain moderate spills. In the opinion of the staff, no catastrophic failure of tankage or tank cars can be expected. Leaking valves or transfer line failure are postulated to be the worst credible accident. If such an accident occurred at 26.7°C (80°F), 6% of the HF released would flash to vapor. To approach the potential consequences of the UF_6 accident, the release rate would have to be over 163 kg (360 lb)/min or about 0.17 m^3 (45 gal) per minute. This rate is not possible through the valves or transfer line at 35 psig, so the postulated UF_6 accident is also the worst HF release accident.

Four criteria have been selected to gauge the environmental effects of accidental releases of HF. These are as follows:

1. air concentrations not exceeding 0.25 mg/m^3 (0.3 ppm), which is in the range where exposures of the order of 1 h can cause damage to vegetation;[22]
2. concentrations up to 2 mg/m^3 (2.5 ppm), which is the threshold limit value for an 8-h work day recommended by the American Conference of Governmental Hygienists;[23]
3. concentrations up to 7 mg/m^3 (8.5 ppm), which is the emergency exposure limit for 60 min recommended by the National Academy of Sciences;[24] and
4. concentrations not exceeding 40 mg/m^3 (50 ppm), which is extremely dangerous for even very short exposures.[19]

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, 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 1 min intolerable. For this reason, it is unlikely that persons able to escape would remain in the toxic cloud for any length of time.

As previously mentioned (Sect. 4.3.2.1), an HF concentration of 5.3×10^3 mg/m^3 was calculated at the distance of the nearest residence, and an individual exposed to this and much smaller concentrations will make every effort to flee. Even at low concentrations, the UO_2F_2 forms a dense white cloud, and avoidance is possible. The effective plume width is about 40 m (127 ft), so only tens of seconds are required for escape; however, a nonambulatory individual would be at severe health risk.

In addition to risk to individuals, several hundred acres might suffer varying degrees of damage to replaceable vegetation.

The staff emphasizes that, while credible, the accident described above is extremely unlikely in view of the precautions used in UF_6 transfer and mitigation measures available to interrupt release after initiation. The total release may be only a fraction of that postulated.

NH_3

Ammonia is a colorless gas easily liquified under pressure. Its boiling point of −33.4°C (−28°F) makes it much more volatile than HF. It is widely used in industry, and hundreds of thousands of tons are used annually as fertilizer. It is transferred to and stored on-site in a manner similar to that described above for HF.

The staff has chosen for analysis an accident involving leaking valves or transfer line breakage since no catastrophic tankage failure appears credible.

For comparative purposes, the staff has used the same accident conditions needed to make the HF leak comparable to the UF_6 release case. For NH_3, about 20% flashes to vapor so the release rate becomes about 50 kg (110 lb) per minute or about 0.05 m^3 (14 gal) per minute.

At the nearest residence, the corresponding concentration becomes about 200 mg/m^3 of NH_3.

The exposure criteria utilized to assess the impact are as follow:

- 13.8 mg/m^3 (20 ppm)—first perceptible odor (threshold limit value for NH_3 = 25 ppm),
- 27.6 mg/m^3 (40 ppm)—a few individuals may suffer slight eye irritation,
- 69 mg/m^3 (100 ppm)—noticeable irritation of eyes and nasal passages after a few minutes of exposure,
- 276 mg/m^3 (400 ppm)—severe irritation of the throat, nasal passages, and upper respiratory tract, and
- 1173 mg/m^3 (700 ppm)—severe eye irritation, no permanent effect if the exposure is limited to less than one-half hour.

This accident would result in discomfort to an individual at the nearest residence but would cause no permanent damage.

Fluorine

Fluorine is a pale yellow corrosive gas which reacts with practically all organic and inorganic substances. It is produced in the plant by electrolysis of potassium hydrogen fluoride, and the process inventory is very small as it reacts with UF_4 to produce UF_6 in the fluorinator. Should an equipment leak occur, production can be stopped by switching off the electrolysis current. It has a characteristic pungent odor detectable as low as 20 ppb, so leaks are easily detectable.

Approximately one shipment is made from the plant per year in a DOT SP1479 cylinder by sole-use truck. The potential off-site effects of fluorine production are small compared to previously discussed materials.

4.3.2.3 Transportation accidents

Incoming raw materials

Incoming anydrous 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 2.1 lists the inbound chemicals along with a brief description of the material, mode of transport, and approximate frequency of shipments.

The commodities shipped to Allied Chemical 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 employed 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 is 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. On the basis of 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, on the basis of statistics for maximum production at this UF_6 facility, one might expect one serious accident affecting an ammonia car every 1000 years and for a hydrofluoric acid car every 126 years. These 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 DOT-approved 0.2-m^3 (55-gal) drums.

Containers and vehicles are properly labeled and placarded in accordance with DOT regulations. An accident severe enough to rupture one of the 0.2-m^3 (55-gal) drums would result in little, if any, dispersion of the material because of the high density and low solubility. Any spilled material would be picked up and re-drummed with little significant impact upon the environment.

Outgoing shipments

The UF_6 product is packaged in steel cylinders with capacities of 9.1 or 12.7 net metric tons (10 or 14 net tons) (refer to quality assurance program in Chap. 7 of the license renewal application[1]). After the cylinders are filled with UF_6 in liquid form, the product is allowed to cool and solidify for a minimum of 4 d before shipment. The shipments are normally made by sole-use vehicle. When loaded, the containers are inspected to ensure 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 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 transportation accidents have occurred. 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. 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 DOT. 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, as much as possible, 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. Thus, these shipments represent an insignificant impact on the environment and the public safety.

Radioactive wastes are generated at the plant during routine operations. These wastes are dry solids which are packaged into 0.2-m^3 (55-gal) drums. Approximately 75 truckload shipments are made annually to an NRC-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 low-specific-activity 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.

4.3.2.4 Conclusions

The conclusion of the staff is that, while potentially hazardous chemicals are received and used in the operation of the Metropolis plant, the risks of accidents are no greater than in many other industrial operations. Operational safety is emphasized and is borne out by the applicant's previous operating history.

4.3.3 Possible Conflicts Between the Proposed Action and the Objectives of Federal, Regional, State, and Local Plans and Policies

At this time, the staff is not aware of any conflict between the proposed action and the objectives of federal, regional, state (Illinois), or local plans, policies, or controls for the action proposed as long as proper agencies are contacted, proper applications are submitted, and proper monitoring and mitigatory measures are taken to protect the environment and public health and safety.

4.3.4 Effects on Urban Quality, Historical and Cultural Resources, and Society

The environmental effects of the proposed license renewal action as discussed above are considered to be insignificant. The facility has not affected historical or cultural resources. The short-term social effects during operation are and will be minimal, and there will be minimal effects after decommissioning and reclamation because the site then will be required to meet federal standards for unrestricted use.

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Appendix A

METHODOLOGY AND ASSUMPTIONS FOR CALCULATING RADIATION DOSE COMMITMENTS FROM THE RELEASE OF RADIONUCLIDES

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METHODOLOGY AND ASSUMPTIONS FOR CALCULATING RADIATION DOSE COMMITMENTS FROM THE RELEASE OF RADIONUCLIDES

A.1 METHODOLOGY AND ASSUMPTIONS FOR AIRBORNE RELEASES

A.1.1 Methodology

The radiation dose commitments resulting from the atmospheric releases of radionuclides are calculated using the AIRDOS-EPA computer code.[1] The methodology is designed to estimate the radionuclide concentrations in air; rates of deposition on ground surfaces; ground-surface concentrations; intake rates via inhalation of air and ingestion of meat, milk, and fresh vegetables; and radiation doses to man from the airborne releases of radionuclides.

With the code, the highest estimated dose to an individual in the area and the doses to the population living within an 80-km radius of the plant site can be calculated. The doses may be summarized by radionuclide, exposure mode, or significant organ of the body. However, in this assessment for the Allied facility, site-specific data obtained from the nearest resident property are used to calculate the highest dose to an individual.

Many of the basic incremental parameters used in AIRDOS-EPA are conservative; that is, values are chosen to maximize intake by man. Many factors that would reduce the radiation dose, such as shielding provided by dwellings and time spent away from the reference location, are not considered. For the population dose calculations in this assessment, it is assumed that an individual lives outdoors at the reference location 100% of the time. Moreover, in estimating the doses to individuals via ingestion of vegetables, beef, and milk, all of the food consumed by the individual is assumed to be produced at the reference location specified in the calculation. Thus, the population dose estimates calculated by these methods are likely to be higher than the doses that would actually occur.

Meteorological dispersion factors, χ/Q, were estimated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence.[2,3] Radionuclide concentrations in meat, milk, and vegetables consumed by man are estimated by coupling the output of the atmospheric transport models with the NRC Regulatory Guide 1.109, "Terrestrial Food Chain Models."[4] The models are described in ORNL/TM-6100.[5]

A.1.2 Radiation exposure pathways and dose conversion factors

Environmental transport links the source of release to the receptor by numerous exposure pathways. Figure A.1 is a diagram of the most important pathways that result in the exposure of man to radioactivity released to the environment. The resulting radiation exposures may be either external or internal. External exposures occur when the radiation source is outside the irradiated body, and internal exposures are those from radioactive materials within the irradiated body.

Factors for converting the radiation exposures to estimates of dose are calculated using the latest dosimetric criteria of the International Commission on Radiological Protection (ICRP) and other recognized authorities.

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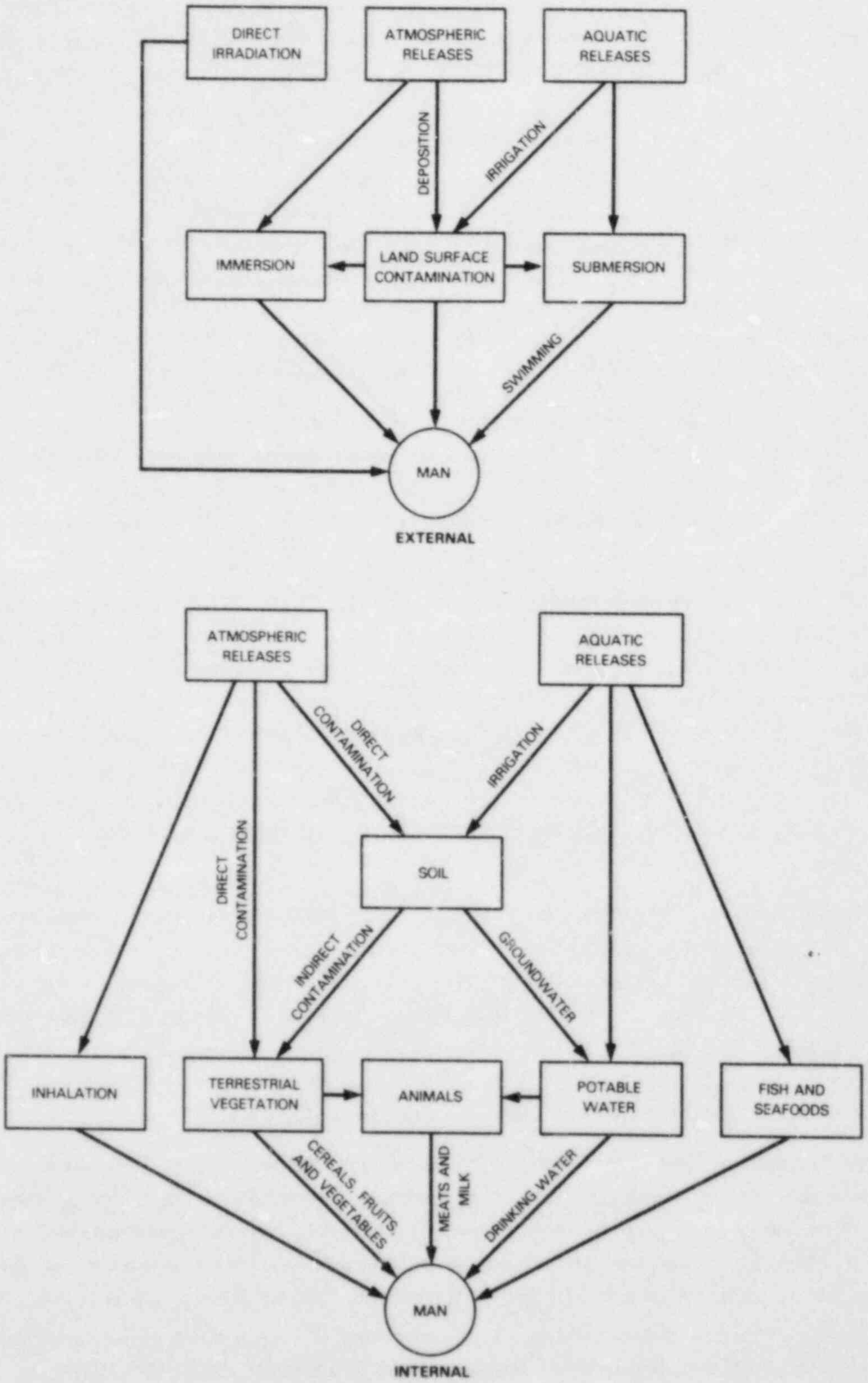

Fig. A.1. Pathways for exposure to man from releases of radioactive effluents.

External dose conversion factors. Releases of radioactive gases and particulates to the atmosphere may result in external doses by exposure to and/or immersion in the plume and by exposure to contaminated land surfaces. The dose conversion factors are summarized by Kocher in ORNL/NUREG-79,[6] and those used in this report are shown in Table A.1.

Internal dose conversion factors. Factors for converting internal radiation exposure to estimates of dose have been computed based on recent models[7-9] and are summarized by Dunning et al. in ORNL/NUREG/TM-190/V3.[10] The dose conversion factors used in this report are presented in Tables A.2 and A.3. These factors are input data into the AIRDOS-EPA computer code, which is used to calculate the dose from inhaled and ingested radionuclides.

A.1.3 Radiation dose to the individual

Internal exposure continues as long as radioactive material remains in the body, which may be longer than the duration of the individual's residence in the contaminated environment. The best estimates of the internal dose resulting from an intake are obtained by integrating over the

Table A.1. Dose conversion factors to major contributor to the external exposure pathways

Radionuclide	Organ			
	Total body	Bone	Kidney	Lungs
	Exposure to ground surfaces (millirem/year per $\mu Ci/cm^2$)			
^{226}Ra	6.8×10^3	9.2×10^3	5.8×10^3	6.2×10^3
^{230}Th	7.8×10^2	6.6×10^2	3.3×10^2	3.8×10^2
^{234}U	7.1×10^2	3.0×10^2	1.0×10^2	1.7×10^2
^{235}U	1.5×10^5	2.1×10^5	1.3×10^5	1.4×10^5
^{238}U	5.7×10^2	2.1×10^2	5.9×10^1	1.2×10^2
	Immersion in air (millirem/year per $\mu Ci/cm^3$)			
^{226}Ra	3.1×10^7	4.1×10^7	2.6×10^7	2.8×10^7
^{230}Th	1.7×10^6	2.4×10^6	1.3×10^6	1.4×10^6
^{234}U	6.8×10^5	7.1×10^5	3.7×10^5	4.1×10^5
^{235}U	6.8×10^8	9.4×10^8	5.9×10^8	6.3×10^8
^{238}U	4.6×10^5	4.5×10^5	2.2×10^5	2.5×10^5
	Submersion in water (millirem/year per $\mu Ci/cm^3$)			
^{226}Ra	6.8×10^4	9.2×10^4	5.9×10^4	6.3×10^4
^{230}Th	4.1×10^3	5.7×10^3	3.1×10^3	3.3×10^3
^{234}U	1.7×10^3	1.7×10^3	8.9×10^2	9.8×10^2
^{235}U	1.5×10^6	2.1×10^6	1.3×10^6	1.4×10^6
^{238}U	1.1×10^3	1.1×10^3	5.3×10^2	6.1×10^2

Source: D. C. Kocher, *Dose-Rate Conversion Factors for External Exposure to Photons and Electrons*, ORNL/NUREG-79, Oak Ridge National Laboratory, August 1981.

Table A.2. Dose conversion factors[a] for inhalation pathway—AMAD-3 μm

Radionuclide	Committed dose equivalent (rem/μCi)			
	Total body	Bone	Kidney	Lungs
		Class D		
^{234}U	6.35	8.63×10^{1}	1.90×10^{1}	5.28×10^{-1}
^{235}U	5.92	1.00×10^{2}	1.70×10^{1}	6.18×10^{-1}
^{238}U	5.65	7.67×10^{1}	1.69×10^{1}	4.64×10^{-1}
		Class W		
^{226}Ra	4.99	5.80×10^{1}	7.8×10^{-1}	2.98×10^{1}
^{230}Th	5.88×10^{1}	7.91×10^{2}	2.90	2.90×10^{1}
^{234}U	3.40	4.0×10^{1}	8.83	2.96×10^{1}
^{235}U	2.20	3.0×10^{1}	5.18	2.79×10^{1}
^{238}U	3.02	3.56×10^{1}	7.85	2.61×10^{1}
		Class Y		
^{230}Th	2.15×10^{1}	1.8×10^{2}	6.99×10^{-1}	2.71×10^{1}
^{234}U	8.41	4.74	1.07	2.76×10^{2}
^{235}U	7.82	6.0	1.03	5.22×10^{1}
^{238}U	7.69	4.23	9.50×10^{-1}	2.61×10^{2}

[a]Based on information from R. E. Sullivan et al., *Estimates of Health Risk from Exposure to Radionuclide Pollutants,* ORNL/TM-7745, November 1981, and International Commission on Radiological Protection, "Limits for Intakes of Radionuclides by Workers," ICRP Publication 30, Part 1, *Annals of the ICRP,* Vol. 3, No. 4 (1979).

Table A.3. Dose conversion factors for ingestion pathway

Radionuclide	Committed dose equivalent (rem/μCi)			
	Total body	Bone	Kidney	Lungs
		Classes D and W		
^{226}Ra	3.4	4.3×10^{1}	5.9×10^{-1}	5.90×10^{-1}
^{234}U	5.8×10^{-1}	7.8	1.7	1.7×10^{-2}
^{235}U	5.2×10^{-1}	7.1	1.5	1.6×10^{-2}
^{238}U	5.1×10^{-1}	7.0	1.5	1.5×10^{-2}
		Class Y		
^{230}Th	9.2×10^{-2}	1.2	4.3×10^{-3}	4.6×10^{-3}
^{234}U	2.4×10^{-2}	3.1×10^{-1}	6.7×10^{-2}	6.9×10^{-4}
^{235}U	2.2×10^{-2}	2.8×10^{-1}	6.1×10^{-2}	7.4×10^{-4}
^{238}U	2.1×10^{-2}	2.8×10^{-1}	6.0×10^{-2}	6.1×10^{-4}

Source: I. G. Eve, "A Review of the Physiology of the Gastrointestinal Tract in Relation to Radiation Doses from Radioactive Materials," *Health Phys.* **12**: 131-62 (1966).

remaining lifetime of the exposed individual; such estimates are called "dose commitments." The remaining lifetime is assumed to be 50 years for an adult.

External doses are assumed to be annual doses. The dose rate above the contaminated land surface is estimated for a height of 1 m. Following the initial deposition of radionuclides, the potential for exposure of man may persist, depending on the influence of environmental redistribution, long after the plume leaves the area. Concentrations of radionuclides at the point of deposition normally are reduced by infiltration of radionuclides into the soil, by loss of soil particles due to erosion, and by transport in surface water and in groundwater. When the effects of these processes cannot be quantified, a conservative estimate of dose due to external exposure to contaminated surface is obtained by assuming that the radionuclide concentrations are diminished by radioactive decay only.

The dose is estimated, using site-specific information where available, for individuals at the nearest residence. The intake parameters used for individual dose determination are shown in Table A.4.

Table A.4. Intake parameters (adult)[a] used in lieu of site-specific data

Pathway	Maximum exposed individual	Average exposed individual[b]
Vegetables, kg/year	281[c]	190
Milk, L/year	310	110
Meat, kg/year	110	95
Drinking water, L/year	730	370
Fish, kg/year	21	6.9
Inhalation, m^3/year	8000	8000

[a]From NRC Regulatory Guide 1.109.
[b]Used for calculating population doses.
[c]This value includes leafy vegetables.

A.1.4 Radiation dose to the population

The total dose received by the exposed population is estimated by the summation of individual dose estimates within the population. The area within the 80-km (50-mile) radius of the site is divided into 16 sectors (22.5° each) and into a number of annuli. The average dose for an individual in each division is estimated, that estimate multiplied by the number of persons in the division, and the resulting products are summed across the entire area. The unit used to express the population dose is man-rem. For this report, the population dose estimates are calculated for a population composed entirely of adults. The parameters used for calculating population doses are shown in Table A.4.

A.2 METHODOLOGY AND ASSUMPTIONS FOR AQUEOUS RELEASES

The methodology used for calculating the 50-year dose commitments to man from the release of radionuclides to an aquatic environment is described in detail in ORNL-4992.[11] Bioaccumulation factors for radionuclides in freshwater and some sample problems can be found in ref. 10. AQUAMAN is a computer code[12] that can also be used for calculating similar dose commitments from exposures to aquatic pathways.

Three exposure pathways are considered in dose determination: water ingestion, fish ingestion, and submersion in water (swimming). The internal dose conversion factors for converting exposure to dose are discussed in Sect. A.1.2, and the factors are shown in Table A.2. The external dose conversion factors are shown in Table A.1. Intake parameters are shown in Table A.4.

A.3 ATMOSPHERIC DISPERSION

The atmospheric dispersion model used in estimating the atmospheric transport to the terrestrial environment is discussed in detail in NRC Regulatory Guide 1.111 (Rev. 1). Where site-specific monitoring data of radionuclide air concentrations are not available, the meteorological χ/Q values are used in conjunction with dry deposition velocities and scavenging coefficients to estimate air concentrations and steady-state ground concentrations for particulate release. The atmospheric dispersion model estimates the concentration of radionuclides in air at ground surfaces as a function of distance and direction from the point of release. Site-specific averages of annual meteorological data are supplied as input for the model. Radioactive decay during the plume travel is taken into account in the AIRDOS-EPA code.[1] Daughters produced during plume travel are calculated and added to the source term.

The area surrounding the plant site is divided into 16 sectors by compass direction (Sect. 3.3). The meteorological χ/Q values (shown in Table A.5) are calculated for the midpoint of each sector. The sectors are bounded by the radial distances of 0.80, 2.4, 4.0, 5.6, 7.2, 12.0, 24.0, 40.0, 56.0, and 72.0 km. Concentrations in the air for each sector are used to calculate dose via inhalation and submersion in the air. The ground deposits result in external gamma dose and, in addition, are assimilated into food and contribute dose upon ingestion via the food chain.

The meteorological data required for the calculations are joint frequency distributions of wind velocity and direction summarized by stability class. Meteorological data (Tables A.6 and A.7) are used to calculate the concentrations of radionuclides at a reference point per unit of source strength. Depletion of the airborne plume as it is blown downwind is accounted for in the AIRDOS-EPA code by taking into account the deposition on surfaces by dry deposition, scavenging, and radioactive decay. Other parameters used in determining air concentration are shown in Table A.8.

REFERENCES FOR APPENDIX A

1. R. E. Moore, C. F. Baes III, L. M. McDowell-Boyer, A. P. Watson, F. O. Hoffman, J. C. Pleasant, and C. W. Miller, *AIRDOS-EPA. A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides*, ORNL-5532, Oak Ridge National Laboratory, June 1979.

2. D. H. Slade, ed., *Meteorology and Atomic Energy*, pp. 97-104, U.S. Atomic Energy Commission, July 1968.

3. J. F. Sangendorf, *A Program Evaluating Atmospheric Dispersion from a Nuclear Power Station*, NOAA Technical Memo ERL-ARL-42, 1974.

Table A.5. Ground-level χ/Q values for particulates at various distances in each compass direction

Distance (m)	χ/Q toward indicated direction (s/m³)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
805	0.156E-05	0.702E-06	0.691E-06	0.756E-06	0.908E-06	0.675E-06	0.108E-05	0.928E-06
2414	0.837E-06	0.379E-06	0.399E-06	0.332E-06	0.378E-06	0.254E-06	0.459E-06	0.395E-06
4023	0.453E-06	0.205E-06	0.217E-06	0.176E-06	0.199E-06	0.132E-06	0.242E-06	0.209E-06
5632	0.290E-06	0.131E-06	0.139E-06	0.111E-06	0.125E-06	0.828E-07	0.153E-06	0.132E-06
7240	0.202E-06	0.908E-07	0.959E-07	0.766E-07	0.862E-07	0.571E-07	0.106E-06	0.913E-07
12068	0.941E-07	0.419E-07	0.440E-07	0.352E-07	0.393E-07	0.263E-07	0.487E-07	0.422E-07
24135	0.293E-07	0.126E-07	0.129E-07	0.105E-07	0.115E-07	0.806E-08	0.148E-07	0.130E-07
40225	0.112E-07	0.465E-08	0.456E-08	0.387E-08	0.413E-08	0.307E-08	0.555E-08	0.492E-08
56315	0.515E-08	0.206E-08	0.192E-08	0.171E-08	0.180E-08	0.142E-08	0.252E-08	0.227E-08
72405	0.250E-08	0.969E-09	0.836E-09	0.798E-09	0.845E-09	0.707E-09	0.121E-08	0.112E-08
	S	SSE	SE	ESE	E	ENE	NE	NNE
805	0.105E-05	0.693E-06	0.759E-06	0.531E-06	0.492E-06	0.645E-06	0.152E-05	0.182E-05
2414	0.421E-06	0.239E-06	0.271E-06	0.224E-06	0.257E-06	0.307E-06	0.739E-06	0.703E-06
4023	0.221E-06	0.123E-06	0.140E-06	0.118E-06	0.139E-06	0.165E-06	0.397E-06	0.367E-06
5632	0.139E-06	0.771E-07	0.881E-07	0.750E-07	0.886E-07	0.105E-06	0.252E-06	0.232E-06
7240	0.965E-07	0.533E-07	0.610E-07	0.520E-07	0.615E-07	0.731E-07	0.175E-06	0.161E-06
12068	0.448E-07	0.248E-07	0.284E-07	0.242E-07	0.286E-07	0.343E-07	0.815E-07	0.758E-07
24135	0.140E-07	0.794E-08	0.910E-08	0.755E-08	0.870E-08	0.108E-07	0.252E-07	0.248E-07
40225	0.545E-08	0.318E-08	0.363E-08	0.292E-08	0.325E-08	0.423E-08	0.967E-08	0.101E-07
56315	0.258E-08	0.158E-08	0.177E-08	0.137E-08	0.146E-08	0.199E-08	0.449E-08	0.505E-08
72405	0.132E-08	0.857E-09	0.934E-09	0.686E-09	0.690E-09	0.989E-09	0.222E-08	0.272E-08

Table A.6. Frequencies of wind directions and true-average wind speeds

Wind toward	Frequency	Wind speeds for each stability class (m/s)						
		A	B	C	D	E	F	G
N	0.110	1.88	2.35	3.29	4.80	3.68	1.40	0.0
NNW	0.046	1.17	2.20	3.11	4.27	3.32	1.25	0.0
NW	0.039	1.11	2.07	2.72	3.07	2.67	1.23	0.0
WNW	0.041	1.74	1.98	2.82	3.24	2.78	1.27	0.0
W	0.048	1.62	2.04	2.96	3.40	2.90	1.15	0.0
WSW	0.040	1.84	2.41	3.36	3.81	3.00	1.33	0.0
SW	0.063	1.80	2.71	3.07	3.66	3.26	1.33	0.0
SSW	0.061	1.86	2.38	3.64	4.60	3.56	1.34	0.0
S	0.069	1.17	2.09	3.62	4.91	3.75	1.38	0.0
SSE	0.053	1.38	2.65	3.83	5.63	4.03	1.40	0.0
SE	0.052	1.24	1.97	3.14	5.53	3.90	1.49	0.0
ESE	0.038	1.80	2.50	3.35	5.42	3.82	1.43	0.0
E	0.035	1.36	2.52	3.66	5.12	3.55	1.35	0.0
ENE	0.050	1.68	2.81	4.11	5.35	3.59	1.49	0.0
NE	0.114	1.99	2.64	3.97	5.19	3.86	1.36	0.0
NNE	0.141	1.97	2.81	4.06	5.55	3.94	1.53	0.0

Table A.7. Frequency of atmospheric stability classes for each direction

Sector[a]	Fraction of time in each stability class						
	A	B	C	D	E	F	G
1	0.0105	0.0540	0.0918	0.3725	0.1461	0.3251	0.0
2	0.0063	0.0813	0.0718	0.3745	0.1307	0.3354	0.0
3	0.0175	0.0986	0.1024	0.2466	0.0937	0.4412	0.0
4	0.0239	0.1272	0.1334	0.3130	0.0962	0.3063	0.0
5	0.0204	0.1319	0.1498	0.3386	0.0834	0.2760	0.0
6	0.0193	0.1113	0.1678	0.4080	0.0807	0.2129	0.0
7	0.0198	0.1081	0.1364	0.3848	0.0822	0.2686	0.0
8	0.0143	0.0694	0.1176	0.4765	0.0845	0.2376	0.0
9	0.0042	0.0665	0.0985	0.4989	0.1199	0.2121	0.0
10	0.0074	0.0458	0.0985	0.6032	0.1129	0.1322	0.0
11	0.0186	0.0515	0.1072	0.5420	0.1074	0.1734	0.0
12	0.0176	0.0664	0.1191	0.5057	0.0677	0.2234	0.0
13	0.0217	0.0903	0.1207	0.3778	0.0788	0.3108	0.0
14	0.0153	0.0724	0.1393	0.4280	0.0858	0.2593	0.0
15	0.0051	0.0658	0.1402	0.4037	0.1246	0.2606	0.0
16	0.0007	0.0386	0.1102	0.5209	0.1588	0.1707	0.0

[a]Wind directions are numbered counterclockwise starting at 1 for due north.

Table A.8. Other parameters used in determining exposure to air concentrations of radionuclides released in the building vent effluents

Parameters	Quantity or dimensions
Number of stacks	1
Release height, m	24
Diameter, m	0.16
Effluent velocity, m/s	18.4
Temperature (annual average for area), °C	14
Rainfall (annual average), cm/year	114
Height of lid (annual average), m	1000
Population within 80 km of radius of site, persons	500,000
Operating life of the plant, years	30

4. U.S. Nuclear Regulatory Commission, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109, Office of Standards Development, Washington, D.C., 1977.

5. J. C. Pleasant, *INGDOS—A Convention Computer Code to Implement U.S. Nuclear Regulatory Guide 1.109 Models for Estimating the Annual Doses from Ingestion of Atmospherically Released Radionuclides in Food*, ORNL/TM-6100, Oak Ridge National Laboratory, 1979.

6. D. C. Kocher, *Dose-Rate Conversion Factors for External Exposure to Photons and Electrons*, ORNL/NUREG-79, Oak Ridge National Laboratory, August 1981.

7. ICRP Task Group on Lung Dynamics, "Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract," *Health Phys.* **12**, 173-207 (1966).

8. ICRP, *The Metabolism of Compounds of Plutonium and Other Actinides*, Publication 79, Pergamon Press, Oxford, 1972.

9. I. G. Eve, "A Review of the Physiology of the Gastrointestinal Tract in Relation to Radiation Doses from Radioactive Materials," *Health Phys.* **12**, 131-62 (1966).

10. D. E. Dunning, Jr., G. G. Killough, S. R. Bernard, J. C. Pleasant, and P. J. Walsh, *Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities, Vol. III*, ORNL/NUREG/TM-190/V3, Oak Ridge National Laboratory, October 1981.

11. G. G. Killough and L. R. McKay, eds., *A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment*, ORNL-4992, Oak Ridge National Laboratory, March 1976.

12. D. L. Shaeffer and E. L. Etnier, *AQUAMAN—A Computer Code for Calculating Dose Commitments to Man from Aqueous Releases of Radionuclides*, ORNL/TM-6618, Oak Ridge National Laboratory, February 1979.

Appendix B

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT

FOR

ALLIED CHEMICAL COMPANY UF_6 CONVERSION PLANT
METROPOLIS, ILLINOIS

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/sp2850h

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)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MG[illegible]	-	-	-	-	Daily	calculated
Total Suspended So[illegible]	-	-	-	90 mg/l	2/week	composite
Total Dissolved So[illegible]	-	-	-	-	"	"
Fluoride	-	-	-	45 mg/l	"	"
*Arsenic	-	-	-	0.5 mg/l	"	"
*Silver	-	-	-	0.13 mg/l	"	"

There shall [illegible] 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 Frequency	Sample Type
	Daily Avg	Daily Max	Daily Avg	Daily Max		
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.

Permit No. IL0004421
AS MODIFIED April 15, 1980

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 proceuures may be required.

5. Recording of Results

For each measu ement or sample taken pursuant to the requirements of this permi , 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

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 discha s 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.

NRC FORM 335 (11-81) U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET**	1. REPORT NUMBER (Assigned by DDC) NUREG-1071	
4. TITLE AND SUBTITLE (Add Volume No., if appropriate) Environmental Impact Appraisal for Renewal of Source Material License No. SUB-526 Allied Chemical Company UF_6 Conversion Plant	2. (Leave blank)	
	3. RECIPIENT'S ACCESSION NO.	
7. AUTHOR(S)	5. DATE REPORT COMPLETED MONTH May	YEAR 1984
9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555	DATE REPORT ISSUED MONTH May	YEAR 1984
	6. (Leave blank)	
	8. (Leave blank)	
12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Same as above	10. PROJECT/TASK/WORK UNIT NO.	
	11. FIN NO.	
13. TYPE OF REPORT Environmental Appraisal	PERIOD COVERED (Inclusive dates)	
15. SUPPLEMENTARY NOTES Pertains to Docket No. 40-3392	14. (Leave blank)	

16. ABSTRACT (200 words or less)

This Environmental Impact Appraisal is issued by the U.S. Nuclear Regulatory Commission in response to an application by Allied Chemical Company for renewal of Source Material License No. SUB-526.

17. KEY WORDS AND DOCUMENT ANALYSIS	17a. DESCRIPTORS
Environmental Impact Appraisal uranium hexafluoride	

17b. IDENTIFIERS/OPEN-ENDED TERMS

18. AVAILABILITY STATEMENT	19. SECURITY CLASS (This report)	21. NO. OF PAGES
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