THE SWIFT STALEY TEAM

# Paducah Gaseous Diffusion Plant
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(26)

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June 21, 2002

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Dear Sir/Ms.:

**CALENDAR YEAR 2001 ANNUAL NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS REPORT, PADUCAH GASEOUS DIFFUSION PLANT, MCCRACKEN COUNTY, KENTUCKY**



Enclosed is the Calendar Year (CY) 2001 Annual National Emission Standards for Hazardous Air Pollutants Report, required by 40 CFR 61, Subpart H. This report summarizes airborne radionuclide emissions from the Paducah Site, including both Department of Energy and United States Enrichment Corporation emissions for CY 2001.

The radiological dose to the most exposed member of the public resulting from site air emissions during CY 2001 is estimated as 0.18 mrem/year.

If you have any questions or require additional information, please call W. David Tidwell at (270) 441-6807.

Sincerely,

W. Don Seaborg, Site Manager
Paducah Site Office

Enclosure

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# United States Department of Energy
# Air Emissions Annual Report
# (40 CFR 61, Subpart H)
# Calendar Year 2001

*Site Name*: Paducah Gaseous Diffusion Plant

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## SECTION I FACILITY INFORMATION

### INTRODUCTION

The Department of Energy (DOE) Paducah Site contains the Paducah Gaseous Diffusion Plant (PGDP), which is leased to the United States Enrichment Corporation (USEC). DOE manages the remaining, non-leased facilities at the Paducah Site. The DOE-managed facilities consist of various waste management facilities, inactive buildings, depleted uranium storage facilities, and environmental restoration facilities. This report analyzes emissions from USEC and DOE portions of the Paducah Site.

### SITE DESCRIPTION

The Department of Energy (DOE) Paducah Gaseous Diffusion Plant (PGDP) is an active uranium enrichment facility consisting of a diffusion cascade and extensive support facilities. The cascade, including product and tails withdrawal, is housed in 6 process buildings covering a total of approximately 80 acres. The plant is located on a reservation consisting of approximately 1,350 acres in western McCracken County approximately 10 miles west of Paducah, Kentucky, and approximately 3 miles south of the Ohio River. Roughly 740 acres of the reservation are enclosed within a fenced security area. The raw water treatment plant and contained landfill are the only operating areas outside of the security area. An uninhabited buffer zone of at least 400 yards surrounds the entire fenced area. Beyond the DOE-owned buffer zone is an extensive wildlife management area consisting of approximately 2,100 acres either deeded or leased to the Commonwealth of Kentucky. During World War II, the Kentucky Ordnance Works (KOW), a trinitrotoluene production facility, was operated in an area southwest of the plant on what is now the wildlife management area. The water treatment plant used by PGDP was originally a KOW facility.

Construction of the PGDP facility began in 1951 and the plant was fully operational by 1955, supplying enriched uranium for commercial reactors and military defense reactors. Enriched uranium is defined as uranium in which the concentration of the fissionable uranium-235 ($^{235}U$) isotope has been increased from its natural assay. Natural uranium is mostly $^{238}U$ with about 0.71 percent $^{235}U$ and 0.0055 percent $^{234}U$. Uranium mills process the ores to produce concentrated uranium oxide ($U_3O_8$), which is then commercially converted to uranium hexafluoride ($UF_6$) for enrichment at a gaseous diffusion plant. Prior to calendar year (CY) 2001, PGDP served as a first step in the uranium enrichment process in which the $^{235}U$ was increased to approximately 2.75 percent. This product had to be further enriched to commercial grade specifications at the Portsmouth Gaseous Diffusion Plant in Portsmouth, Ohio before it could be forwarded to a nuclear fuel fabricating facility. During CY 2001, PGDP received authorization from the Nuclear Regulatory Commission (NRC) to enrich the $^{235}U$ isotope to commercial grade specifications (up to 5.5 percent). This authorization allowed USEC to bypass the Portsmouth plant in the enrichment process and the product from the Paducah plant can now be sent directly to nuclear fuel fabricators without further enrichment. Hazardous, nonhazardous, and radioactive wastes are generated and disposed of as a result of plant operations.

The Paducah Plant enriches the uranium isotope, $^{235}U$, via a physical separation process. The separation is based on the faster rate at which $^{235}U$ diffuses through a barrier compared with the heavier $^{238}U$ isotope. During enriching operations from 1953 to 1975, feed material (called "reactor tails") from government reactors was also used intermittently in addition to the $UF_6$ typically used. Reactor tails are the fuel from nuclear reactors that have had its $^{235}U$ content depleted, have been reprocessed to remove

most of the fission products, and which must have its $^{235}U$ content replenished before it can be recycled. The reactor fuel rods were processed at other DOE facilities (where most of the fission products were removed) and the enriched uranium and the remaining fission products were fed into PGDP cascade system. Use of the reactor tails resulted in the introduction of technetium-99 ($^{99}Tc$), a fission by-product, and transuranics, most notably neptunium-237 ($^{237}Np$) and plutonium-239 ($^{239}Pu$), into the cascade. $^{99}Tc$ is a man-made radioactive substance (radionuclide) having a half-life estimated at between 212,000 and 250,000 years. It decays by emitting beta radiation.

Extensive support facilities are required to maintain the diffusion process. Some of the major support facilities include a steam plant, four major electrical switchyards, four cooling tower complexes, a chemical cleaning and decontamination building, a water treatment plant, a cooling water blowdown treatment facility, maintenance facilities, and laboratory facilities. Several inactive facilities are also located on the plant site.

The West Kentucky Wildlife Management Area and lightly populated farmlands are in the immediate environs of PGDP. The population within the 50-mile radius is approximately 535,000 persons. Of these, approximately 36,500 live within 10 miles of the plant and approximately 104,000 within 20 miles. The unincorporated communities of Grahamville and Heath are 1.24 and 1.86 miles east of the plant, respectively. Portions of 28 counties, 11 of which are in Kentucky, 4 in Missouri, 10 in Illinois, and 3 in Tennessee, are included within the 50-mile radius of the plant. Larger cities in the region include Paducah, Kentucky, located approximately 10 air miles east of the plant; Cape Girardeau, Missouri, located approximately 40 air miles to the west; and Metropolis, Illinois, located approximately 6 air miles to the northeast.

Paducah is located in the humid continental zone. Summers are generally dry; precipitation occurs mainly in the spring and fall. Winters are characterized by moderately cold days; the average temperature during the coldest month, January, averages about 35 F. Summers are warm and humid; the average temperature in July is 79 F. Yearly precipitation averages about 44 inches. The prevailing wind direction is south to southwest.

In 1993, the United States Enrichment Corporation (USEC) was formed. USEC became a private corporation on May 1, 1999. Although all the facilities at PGDP are still owned by DOE, the uranium enrichment enterprise is now the responsibility of USEC. According to the Lease Agreement between DOE and USEC, USEC retained responsibility for quantification of airborne radionuclide emissions and preparation of the annual report required by 40 CFR 61, Subpart H. DOE remains responsible for compliance with other requirements for DOE-operated sources.

On March 3, 1997, the Nuclear Regulatory Commission assumed regulatory responsibility for the USEC-leased portion of the plant. However, because the entire facility is still owned by DOE, both the USEC and DOE facilities are still subjected to 40 CFR 61, Subpart H, requirements.

## USEC SOURCE DESCRIPTIONS

The following are the potential USEC airborne radionuclide sources at the Paducah Plant. Although not all of them were used in 2001, they are included in this report due to their potential for future restart.



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**C-310 Stack**

The primary source of potential radionuclide air emissions is the vent stack that serves the "top end" of the cascade process and the cylinder burping facility. This 200-foot stack, known as the C-310 stack, is located at the southwest corner of the C-310 Product Withdrawal Building. Low molecular weight gas compounds and contaminants, which have traveled up the cascade, are vented to the atmosphere via the C-310 purge vent stack. Small quantities of $^{234}U$, $^{235}U$, $^{238}U$, $^{99}Tc$, $^{237}Np$, $^{239}Pu$, and thorium-230 ($^{230}Th$) are also emitted. The cascade effluent is routed through alumina traps prior to being emitted via the C-310 stack. The alumina traps were upgraded in 1990 to provide greater criticality safety. The improved system consists of an on-line bank of 13 traps and a standby bank of 13 traps. Each trap contains approximately 200 pounds of alumina.

The cylinder burp facility, located on the east side of C-310, is used to vent the low molecular weight gases from product cylinders. This facility is also a potential source of uranium, $^{99}Tc$, minute quantities of transuranics, and $^{230}Th$. The effluent from the burp facility is routed through a bank of sodium fluoride (NaF) traps prior to being emitted from the C-310 stack. There are 2 banks of chemical traps associated with this system. The north bank has 3 sets of 2 traps each (primary, secondary, and standby). Each trap contains approximately 300 pounds of NaF. The south bank has 7 traps. These traps contain approximately 130 pounds of NaF each. The smaller size of the traps is due to criticality safety concerns. Uranium is recovered from the NaF traps back to the enrichment cascade.

Emissions from the C-310 stack were estimated based on daily results of the continuous potassium hydroxide bubbler stack sampling system, which was approved by the Environmental Protection Agency (EPA) in 1992.

As part of the Quality Assurance/Quality Control (QA/QC) requirements for the C-310 stack sampler, a range for the sample flow has been established. During 2001, there were 12 instances where the sample flow was outside of the established range. These instances did not compromise the integrity of the sample. From operational records, there were no indications of excess emissions during these periods; emissions immediately prior to and after the dates in question indicated that they were within normal ranges.

**Seal Exhausts**

Seals on the $UF_6$ compressors are supplied with an intricate array of air pressures to reduce any $UF_6$ release that may occur in the unlikely event of a seal failure. The seal exhaust flow is removed by large, oil-filled vacuum pumps and is routed from the seals through alumina traps, the pump, and to a common exhaust vent. There is one seal exhaust vent per cascade building, one on the C-310 Product Withdrawal Building and one on the C-315 Tails Withdrawal Building. Under normal operations, only trace amounts of $UF_6$ are present in the seal exhaust system. Occasionally, a seal or seal control system malfunction will allow greater quantities of $UF_6$ to enter the exhaust system. If $UF_6$ is allowed to enter the pump by virtue of trap breakthrough, it reacts with the pump oil creating a thick, gummy sludge, which overloads the pump in a short time. Due to the reaction between $UF_6$ and pump oil, the oil also serves as an excellent uranium emission control device; however, no credit is taken for the oil as a

pollution abatement system because the oil is an integral part of the pumping system and in no way is included for emission control. The list below indicates locations of the six seal exhausts at PGDP:

C-310 Product Withdrawal Building
C-315 Tails Withdrawal Building
C-331 Process Building
C-333 Process Building
C-335 Process Building
C-337 Process Building

Emissions from the seal exhaust grouped source were estimated based on results of Method 5 stack sampling performed in 1992. The seal exhausts were resampled in 1997. The results of the 1997 sampling were used for emission estimates for CY 2001.

A discussion of the potential to emit from the seal exhausts and wet air exhausts, and the conclusion that the alumina traps which protect the pump oil are not pollution control devices under 40 CFR 61, Subpart H, was forwarded to EPA on January 28, 1994.

**Wet Air Exhaust**

When maintenance is required on cascade piping and equipment, the process gas ($UF_6$) is evacuated to other sections of the cascade or surge drums. The subject equipment and piping are swept in a series of purges with "dry" plant air. After maintenance, the system is closed and the ambient (wet) air is pumped from the system by the wet air pumps. In the dry air purges and the five wet air withdrawals, the air is routed through alumina traps for uranium trapping to protect the wet air pump oil, and then to an exhaust vent. In process buildings C-310, C-333, C-335, and C-337, the exhaust vent is the same one that services the seal exhaust system for those buildings. Emissions from the wet air exhausts in 2001 were estimated based on results of Method 5 stack sampling performed in 1997. The list below indicates locations of the five wet air exhausts at PGDP:

C-310 Product Withdrawal Building (same as seal exhaust)
C-331 Process Building
C-333 Process Building (same as seal exhaust)
C-335 Process Building (same as seal exhaust)
C-337 Process Building (same as seal exhaust)

**Cylinder Valve Connection Activities**

Activities involving the connection and disconnection to $UF_6$ cylinders include cold pressure checks; sampling of feed, product, and tails cylinders; and product withdrawal, tails withdrawal, cylinder feeding, and cylinder burping. The cylinder valves are connected to the associated process via a "pigtail." Cylinder pigtails consist of a single length of copper tubing and threaded couplings. Pigtail disconnection procedures require a series of purges to ensure that no $UF_6$ remains in the pigtail prior to disconnection. Although adherence to these procedures minimizes $UF_6$ emissions, occasionally a "puff" of $UF_6$ is observed during disconnection of the pigtails. As an additional measure to control radionuclide

emissions, personnel performing the pigtail disconnects employ the use of a glove box containment device and/or portable high efficiency particulate air (HEPA) vacuums (vacs). The HEPA vacs are placed so that any minute "whiff or puff" of $UF_6$ which is emitted from the pigtail disconnect process is captured by the HEPA vac.

All cylinder disconnection activities in CY 2001 were serviced by permanent HEPA filter-equipped vac systems with the exception of the C-310 Burp Station. The list below indicates the locations of the pigtail systems:

| | |
|---|---|
| C-310 | Burp Station (located outside portable HEPA vacs used). |
| C-310 | Product Withdrawal Building. |
| C-315 | Tails Withdrawal Building. |
| C-333-A | Feed Facility ($UF_6$ Vaporizer). |
| C-337-A | Feed Facility ($UF_6$ Vaporizer). |
| C-360 | Toll Transfer and Sampling Facility. |

Emissions from all of these systems were estimated by determining the total number of pigtail disconnections in each facility. An estimated quantity of $UF_6$ in each pigtail (based on the system volume, temperature, and pressure) multiplied by the number of disconnections was used to estimate the total quantity of $UF_6$ that could have been released.

All pigtails are evacuated and purged numerous times to reduce the quantity of $UF_6$ in the pigtail to very low levels. The method described above assumes that each pigtail has been evacuated or purged in accordance with operating procedures. Quantities of $UF_6$ released as observed puffs are added to the releases estimated from normal operations.

In the case of C-360, there are two stacks one for the pigtail exhaust system and one for the sample cabinet exhaust.

**Laboratory Hoods**

The C-709/710 Laboratories are operated by Production Support and are the main facilities for sample analysis and research at PGDP. There are a total of 94 laboratory hoods and canopies in the C-709/710 buildings. Seventy-eight of the hoods were used for radiological activities in CY 2001. The radionuclides involved in analyses consist primarily of uranium, with a slight potential for emissions of $^{99}Tc$, $^{237}Np$, $^{239}Pu$, and the daughters of uranium ($^{230}Th$, $^{234}Th$, and $^{239}Pu$). In some cases, the hood exhausts combine with other hood exhausts, creating a discrepancy between the number of hoods and actual emission points. There are also 8 laboratory hoods in the C-409 Stabilization Facility. None of these hoods were used for work with radionuclides in 2001. The list below indicates the laboratory exhaust systems at PGDP:

| Building | Hoods/Canopies | Hoods/Canopies Used in Radiological Areas in 2001 |
|---|---|---|
| C-709/710 Laboratory | 94 | 78 |
| C-409 | 8 | Not used |

Four methods, depending on the type of operation occurring in the hood or radiological area in which the hood was located, were used to estimate emissions.

1. Estimation of the maximum quantity of uranium that could be lost based on laboratory methods (e.g., if an ASTM analytical method specifies a maximum of 1.6 percent loss of mass during analysis, all samples analyzed using the method were assumed to loose, as an emissions from the hood, 1.6 percent of the uranium in the sample.)

2. Use of 40 CFR 61, Appendix D, emission factors.

3. Use of chemical trap efficiencies and uranium throughput information.

4. Knowledge of the analytical or sample preparation process.

All methods used the total inventory of uranium processed in the hood or radiological area as the basis for the emission estimate.

**Chlorofluorocarbon-114 (CFC-114) $UF_6$ Separator**

The CFC-114/$UF_6$ separator is located in C-335 and can be used to separate relatively large amounts of CFC-114 coolant, which has entered the cascade system and mixed with $UF_6$. The separator was installed in 1978, and pilot tests were conducted in 1979. When in use, the separator air effluent is passed through a cold trap at 0 F which condenses approximately 98.5 percent of the gaseous $UF_6$. The residual $UF_6$ in the effluent is trapped by two NaF traps containing 900 pounds of NaF each. Uranium trapped by the NaF traps is recovered back to the gaseous diffusion cascade. The outlet of the NaF traps is monitored by a flow-through ionization chamber. The effluent passes from the NaF traps through alumina traps and a header to the C-335 wet air/seal exhaust system. This facility was not operated in 2001.

The emissions from this system also have to pass through the wet air/seal exhaust pump oil, which is an excellent scrubber of $UF_6$. Since this facility is used only when large amounts of CFC-114 leak into the cascade and is equipped with a two-stage control process, use of this facility is not expected to increase the emissions from the wet air/seal exhaust system. (Emissions from the wet air/seal exhaust were determined by EPA Method 5 stack sampling in 1997.) However, as a conservative measure, emissions from the unit are estimated using data from a sampling system similar to the C-310 system. No reduction in emission is assumed to occur as a result of system off-gas passing through the seal exhaust/wet air system.

**C-400 Decontamination Spray Booth**

This facility is used to decontaminate equipment. It consists of a large booth equipped with an ultra high-pressure sprayer, which sprays a water solution on the contaminated machinery. The potential of radionuclide emissions arises from entrainment of radionuclides in the spray solution during the decontamination process. The booth is equipped with a mist eliminator as an emission control device. The mist eliminator is not listed as a pollution control device in 40 CFR 61, Appendix D, and no credit is taken for it. Emissions were estimated in accordance with Appendix D. The concentration of radionuclides in the spray booth water multiplied by the total volume of water was considered as the curies "used."

**C-400 No. 5 Dissolver/Rotary Vacuum Filter**

This facility is used to dissolve and precipitate the uranium in the solutions from the C-400 cylinder wash and decontamination spray booth. It is also used to treat uranium salvaged from C-710. The solution is chemically treated to precipitate the uranium that forms a slurry. The slurry is then passed through a rotary vacuum filter, which collects the precipitate (filter cake) for future disposal. After sampling, the filtrate is then discharged via permitted Kentucky Pollutant Discharge Elimination System outfalls. The possibility for radionuclide emissions arises from the vent on the pump that pulls the slurry through the rotary vacuum filter. Emissions from this vent should be minimal because the pump and its vent are downstream of the rotary vacuum filter that should trap the uranium as filter cake. Emissions were estimated in accordance with Appendix D. The concentrations of radionuclides in the filtrate multiplied by the filtrate volume were considered as the curies "used."

**C-400 Cylinder Drying Station**

This facility is used to dry $UF_6$ cylinders after the "heel" has been removed in the C-400 cylinder washstand. Dry "plant air" is passed through the cylinder to evaporate any moisture from the washing and hydrostatic testing processes. Emissions were estimated in accordance with Appendix D. The concentrations of radionuclides in water used to hydrostatically test the cylinders prior to drying, multiplied by the total volume of water used in the hydrostatic test, were considered as the curies "used."

**Radiological Areas**

Radiological areas are established under specific criteria listed in various worker protection procedures and standards. There are a number of radiological areas at PGDP that are monitored by Health Physics (HP) low-volume air samplers. The sampling systems consist of a low-volume pump (20 to 40 liters per minute) drawing the ambient building air through a Whatman No. 41 cellulose filter. The samplers run 24-hours per day and the filters are changed on 2-, 3-, 4-, or 5-day basis, depending upon weekend and holiday schedules. Typically, a minimum of 2 days of sample air is collected on each filter. After sample collection, the filters are counted for airborne radioactivity concentrations.

For the 2001 NESHAP report, PGDP estimated the building ventilation grouped source according to the method stated in Section 3.1 of the revised PGDP NESHAP Compliance Plan submitted to EPA in January 1992.

According to PGDP's compliance plan, building emissions from non-radiological areas are not estimated due to their lack of potential for airborne radiological emissions.

For CY 2001, the following is a list of PGDP's radiological areas from which emissions were evaluated using HP data:

C-310 Product Withdrawal Building
C-315 Tails Withdrawal Building
C-331 Uranium Enrichment Process Building
C-333 Uranium Enrichment Process Building
C-333-A Uranium Feed Facility
C-335 Uranium Enrichment Process Building
C-337 Uranium Enrichment Process Building
C-337-A Uranium Feed Facility
C-360 Toll Transfer/Sampling Building
C-400 Decontamination Building
C-710 Laboratory
C-720 Maintenance Building This building is the primary maintenance building at PGDP. Maintenance on contaminated and uncontaminated machinery is performed here. Transferable contamination has been removed prior to maintenance; however, there is a potential for airborne radionuclide emissions from fixed contamination during maintenance procedures. Portable negative air machines, which are equipped with HEPA filters, are utilized whenever there is a potential for airborne radionuclide emissions.

Buildings C-754, C-757, and the USEC-controlled side of C-746-Q are also categorized as radiological areas. However, these buildings have no ventilation system. Any emissions from these buildings would be fugitive or diffuse in nature. Fugitive and diffused emissions are discussed later in this report.

Data from HP air sampling in radiological areas indicated that the trigger level of 10 percent of the most restrictive Derived Air Concentration (DAC) guideline in 10 CFR 20, Appendix B, (2E-12 uCi/ml for $^{237}Np$) was exceeded multiple times in 2001. Using these samples, the maximum air concentration of alpha-emitting particles was calculated. Using a conservative approach, 10 percent of the alpha particles were assumed to be $^{237}Np$ and 90 percent of the particles were assumed to be uranium. Using the air exchange rates determined from facility engineering data, the total emissions from each facility were estimated for the periods during which the samples exceeded 10 percent of the $^{237}Np$ DAC.

The compliance plan states that non-radiological areas will not be evaluated as an airborne radiological source due to average concentrations of radionuclides less than 10 percent of the most stringent DAC. HP sample results indicate the average radionuclide air concentrations, even in radiological areas, are usually less than 10 percent of the most stringent DAC. Therefore, building ventilation emissions from non-radiological areas will not be considered an airborne radionuclide source and emissions will not be evaluated.

Finally, the dilution factor due to dispersion at PGDP based on 1992 meteorological data is 7.9E-7. Therefore, even if the average concentration of airborne nuclides was 10 percent of the most stringent DAC, the resulting off-site dose to the public due to dispersion would not exceed 0.0004 mrem/year (0.000004 millisieverts/year).

### C-400 Laundry

The C-400 Laundry washes and dries coveralls and clothing used to prevent skin contamination on personnel working in radiological areas. The driers are equipped with lint filters. Emissions from the laundry are estimated using data from Health Physics surveys of the lint filters. The alpha radiation is assumed to be 10 percent due to $^{237}Np$ and 90 percent due to uranium. The beta emissions are assumed to be due to $^{99}Tc$. The emission factor for cloth filters in 40 CFR 61, Appendix D, is used to estimate the emissions.

### Nonpoint Sources

Guidance from EPA which stated that provisions of 40 CFR 61, Subpart H, applied to fugitive and diffused emissions, was contained in correspondence dated March 24, 1992. EPA also forwarded to PGDP on September 21, 1992, questions pertaining to 1992 ambient air sampling results and their use as indications that fugitive and diffused emissions from PGDP operations were insignificant. PGDP's reply satisfied all of EPA's questions except the one pertaining to resuspension of contaminated soil that could result from such activities as well drilling activities or vehicular traffic upon contaminated earth. The question as to whether such activities actually constitute fugitive or diffused sources was forwarded to EPA headquarters for resolution. USEC has not, as of this submittal, received guidance on this question. It is not expected that any activity that would result in fugitive or diffused emissions would result in emissions that would be distinguishable from background at off-site locations.

Another potential fugitive or diffused source of radionuclides, albeit a minor one, results from the decontamination of machinery and equipment used in remediation activities such as well drilling. The equipment is washed with high-powered sprayers to remove any contaminants (radiological or non-radiological). The contaminants originate from the soil and groundwater.

## DOE SOURCE DESCRIPTION

### Northwest Plume Interim Remedial Action Pilot Plant

On September 1, 1995, DOE began operation of a pilot groundwater treatment plant designed for the removal of trichloroethylene and $^{99}Tc$. The facility is located at the northwest corner of the PGDP site security area. The facility consists of an air stripper to remove volatile organics from water and an ion exchange unit for the removal of $^{99}Tc$. The air stripper is located upstream of the ion exchange unit.

Emissions of $^{99}Tc$ were estimated using the analysis of the influent groundwater and the effluent water leaving the air stripper. Comparison of the $^{99}Tc$ concentration in the influent and effluent of the air stripper and the quantity of the water passing through the stripper were used to estimate the total quantity of $^{99}Tc$ emitted from the facility. The exhaust from the air stripper is passed through a carbon adsorption unit prior to exhaust. Extensive sampling has shown that $^{99}Tc$ is not retained in the carbon; therefore, no reduction in $^{99}Tc$ emissions due to the use of the adsorption unit was assumed.

## Concrete Crushing Project

The Concrete Crushing Project crushed concrete stored in rubble piles on-site as well as in the Adjacent West Kentucky Wildlife Management Area. The concrete was crushed in an impact crusher commonly used for crushing rock. Water dust suppression control is used during the crushing. Some of the rubble had radiological contamination. The amount of radionuclides released during crushing was estimated based on characterization of the rubble piles before sampling and emission factors from the Environmental Protection Agency, Document AP-42.

## Fugitive and Diffuse Sources

DOE has identified the areas listed below as potential fugitive and diffuse sources. Based on prior health physics data and historical ambient air monitoring, it is unlikely that any of these potential sources are significant; however, ambient air monitoring is being conducted around the Paducah Site to verify this position. In addition, some of these sources are listed due to posting of direct radiation, not airborne radiation emissions.

## List of DOE Fugitive and Diffuse Potential Emission Sources

1. C-745-T Cylinder Storage Yard
2. Area From C-745-U to East Perimeter Fence to Cylinder Yard
3. C-745-K Cylinder Storage Yard
4. Dirt Storage Area Near C-333
5. C-740 Material Yard
6. C-747 and C-748-B Burial Area
7. C-745-A Southeast Contamination Area
8. C-745-A Southwest Contamination Area
9. C-746-H3 Storage Area
10. C-410 Building
11. C-745-C
    C-749 Cylinder Storage Yards
    C-404 Burial Ground
12. C-746-P Scrap Material Storage Area
13. C-746-A and B Warehouses
    C-746-C Scrap Material Storage Yard
14. Burial Area North of C-746-F
15. C-746-P Burial Area
16. C-747-A Burial Area - Drum Mountain
17. C-747-A Burial Area - Burial Grounds
18. Rubble Pile - South of Perimeter Fence
19. Rubble Pile - South of Plant Near Ogden Landing Road
20. Rubble Pile - Southeast Between Perimeter Fence and Dyke Road
21. Rubble Pile - East of Plant Near Outfall K002
22. C-301 Low-Level Waste Storage Area
23. C-340 Building
24. Rubble Pile - East of Plant near Outfall K010
25. KPDES Outfall 011
26. Little Bayou Creek and Dyke Road
27. Little Bayou Creek Confluent with KPDES Outfall 002
28. Little Bayou Creek Crossing and McCaw Road
29. Little Bayou Creek and Ogden Landing Road
30. North-South Diversion Ditch and Ogden Landing Road
31. Contaminated Ditch Flowing to KPDES Outfall 001
32. Contamination Area West of Plant
33. C-615 Sewage Treatment Facility
34. North-South Diversion Ditch Near Perimeter Fence
35. North-South Diversion Ditch Near Ogden Landing Road
36. C-746-U Landfill

*37. C-746-S and C-746-T Landfills

*38. C-746-S and C-746-T Landfill Area

* DOE monitored the C-746-S Landfill vents for radionuclides on October 6, 1999. No radionuclides were detected either in air emissions or smears of the inside surface of the vent pipe surfaces.

**Miscellaneous Sources**

Another potential fugitive or diffuse source of radionuclides, albeit a minor one, results from the decontamination of machinery and equipment used in remediation activities such as well drilling. The equipment is washed with high-powered sprayers to remove any contaminants (radiological or non-radiological). The cleansing solutions and wash products could contain small amounts of radionuclides. No emission controls are used during the decontamination process. The contaminants originate from the soil and groundwater.

In accordance with PGDP DOE NESHAP Management Plan (BJC/PAD-141, dated February 2000), DOE utilized ambient air monitoring data to verify insignificant levels of radionuclides in off-site ambient air. Ambient air stations collect radionuclide samples at sites surrounding the plant. The ambient air monitors capture airborne radionuclides emitted from all sources including fugitive and diffuse. Potential fugitive or diffuse sources and ambient air monitoring locations are shown in Fig. 1. The Radiation/Environmental Monitoring Section of the Radiation Health and Toxic Agents Branch of the Department for Public Health of the Kentucky Cabinet for Health Services has operated the ambient air monitors during CY 2001. Additional air monitors were installed during the year. Based on observations for CY 2001, plant derived radionuclides were not detected. The results of the ambient air monitoring are in Table A-1 of this report.

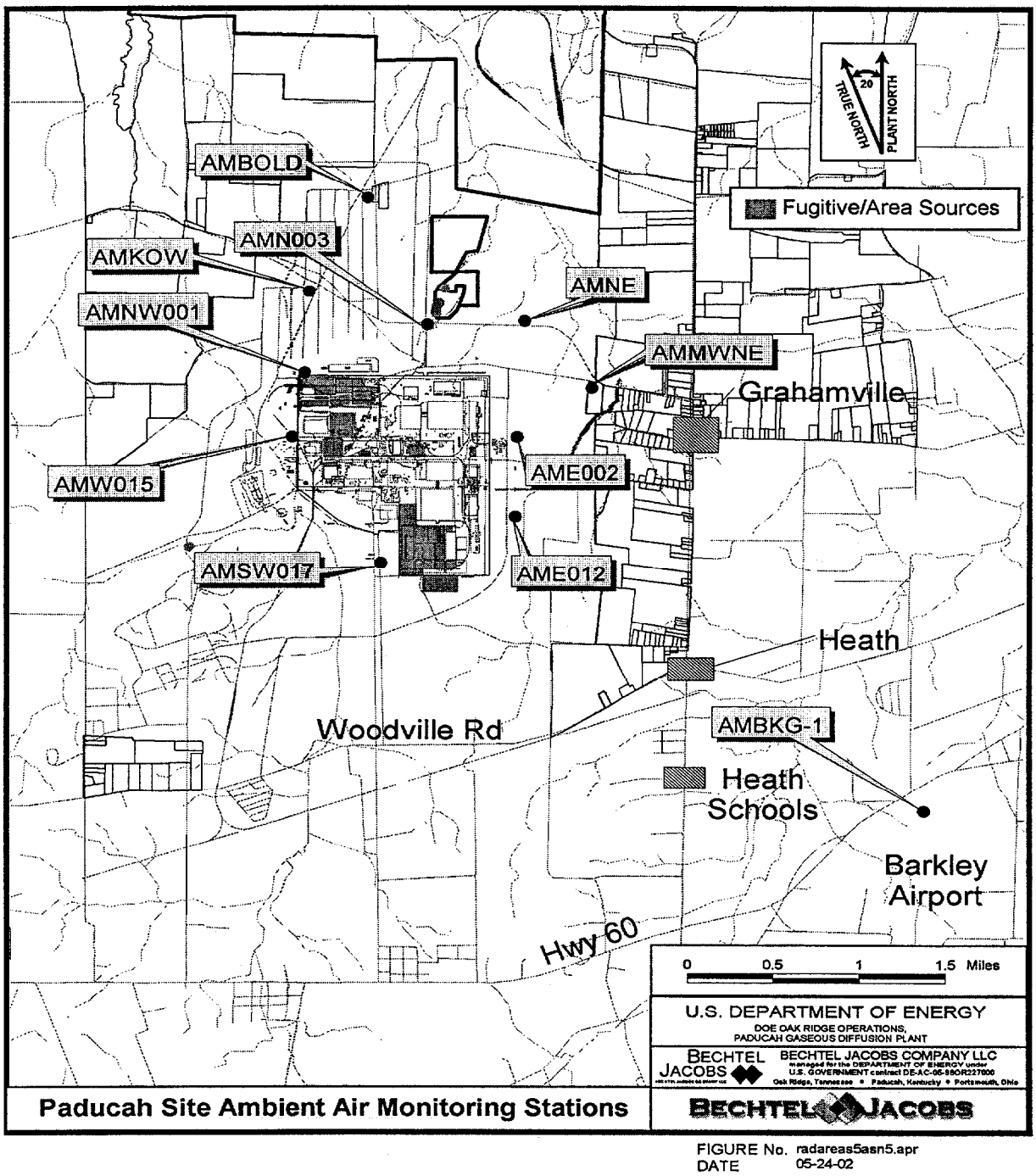


FIGURE No. radareas5asn5.apr
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Figure 1. Location of Paducah Site fugitive and diffuse sources and ambient air monitors.

## SECTION II SOURCE CHARACTERISTICS AND AIR EMISSIONS DATA

## USEC SOURCE CHARACTERISTICS AND RADIONUCLIDE EMISSIONS

### MAJOR POINT SOURCE

| Major Point Source | Type Control | Efficiency % | Distance (m) and Direction to Nearest Receptor[1] |
|---|---|---|---|
| C-310 Purge Stack | NaF Traps[2] | >99.9 | 1740 ESE |
| | Alumina Traps[4] | ~98.6 | |
| C-315[3] | None | 0 | 1314 ESE |

### MINOR POINT AND AREA SOURCES

| Minor Point and Area Sources | Type Control | Efficiency % | Distance (m) and Direction to Nearest Receptor[1] |
|---|---|---|---|
| C-360[4] | None | 0 | 1180 SE |
| C-400 Cylinder Drying Station[4] | None | 0 | 1900 ESE |

### MINOR GROUPED SOURCES

| Minor Grouped Sources | Type Control | Efficiency % | Distance (m) and Direction to Nearest Receptor[1] |
|---|---|---|---|
| Seal/Wet Air exhausts (6) | Alumina Traps[2] | ~98.6 | 1490 ESE |
| Cylinder valve connection activities not included above (i.e., not serviced by a stack) (7).[4] | HEPA Vacuums[5] | 99.0 (Appendix D) | 1490 ESE |
| C-400 grouped sources (3)[4] | None | 0 | 1920 ESE |
| C-710 laboratory hoods (78)[4] | None | 0 | 1960 ESE |
| Building ventilation (10) | None | 0 | 1490 ESE |

**NOTE:** The building ventilation and cylinder valve connection activities not serviced by a stack are grouped with the Seal/Wet Air Exhausts Group in further analyses.

[1]Distances in receptors were resurveyed in 2001 due to residential construction in the vicinity of the plant.

[2]See January 28, 1994 correspondence from D. F. Hutcheson to W. A. Smith discussing "Potential to Emit."

[3] Source included due to single release (October 1, 2001) greater than 500 grams U.

[4]Emissions estimated in accordance with 40 CFR 61, Appendix D.

[5]Credit for the use of HEPA vacuums for pigtail operations is not taken for the purposes of estimating emissions.

## USEC SOURCE CHARACTERISTICS

| Source Name | Type | Height (m) | Diameter (m) | Gas Exit Velocity (m/s) | Gas Exit Temperature (°C) | Distance (m) and Direction to Maximally Exposed Individual | |
|---|---|---|---|---|---|---|---|
| | | | | | | Source | Plant |
| C-310 | Point | 61.0 | .03 | 0 | 21.7 | 3040 NNE | 2430 N |
| C-315 | Point[1] | 6.56 | N/A | 0 | Ambient | 1314 ESE | 2640 N |
| C-360 | Point[1] | 16.00 | N/A | 0 | Ambient | 1180 SE | 2370 NNW |
| C-400 Group | Point[1] | 11.3 | N/A | 0 | Ambient | 2040 N | 2040 N |
| C-400 Cylinder Drying Station | Point[1] | 2.4 | 0.5 | 0 | Ambient | 2120 N | 2120 N |
| C-709/C-710 Lab | Point[1] | 7.1 | N/A | 0 | Ambient | 2490 S | 2370 N |
| Seal/Wet Air Exhaust Group[2] | Point[1] | 21.0 | N/A | 0 | Ambient | 2350 N | 2350 N |

| Source Name | Distances (m) to Selected Receptors | | |
|---|---|---|---|
| | Nearest Individual/Farm | Nearest Business | Nearest School |
| C-310 | 1740 | 2705 | 3840 |
| C-315 | 1816 | 2747 | 3446 |
| C-360 | 1180 | 2000 | 3840 |
| C-400 Group | 1920 | 2819 | 4225 |
| C-400 Cylinder Drying Station | 1900 | 2819 | 4100 |
| C-709/C-710 Lab | 1960 | 2705 | 3900 |
| Seal/Wet Air Exhaust Group | 1460 | 2438 | 3840 |

[1] Modeling was performed assuming a theoretical stack located at the approximate center of each grouped source.

[2]Grouped source includes building ventilation and cylinder valve disconnections from systems not served by permanent HEPA filter systems.

## PGDP USEC RADIONUCLIDE EMISSIONS

| Radionuclide Emissions (Ci)[1] During 2001 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Emission Source | | | C-310 | C-315 | C-709/ C-710 Lab | Seal/Wet Air Exhaust Grouped Sources | C-400 Grouped Sources | C-400 Cylinder Drying Station | C-360 Sampling | Total |
| Nuclide | Solubility | AMAD | | | | | | | | |
| $^{99}$Tc | W | 1.0 | 1.49E-3 | NA[2] | 2.76E-5 | 2.65E-3 | 1.07E-3 | 2.71E-3 | 5.22E-6 | 7.95E-3 |
| $^{230}$Th | W | 1.0 | 4.19E-6 | NA[2] | NA[2] | 2.07E-6 | 1.34E-7 | 9.13E-6 | NA[2] | 1.55E-5 |
| $^{234}$U | D | 1.0 | 9.00E-5 | 7.11E-5 | 1.87E-3 | 7.19E-3 | 2.94E-3 | 1.44E-3 | 5.41E-6 | 1.36E-2 |
| $^{235}$U | D | 1.0 | 3.10E-6 | 9.08E-4 | 6.46E-5 | 2.53E-4 | 1.01E-4 | 4.96E-5 | 1.86E-7 | 1.40E-3 |
| $^{238}$U | D | 1.0 | 8.59E-6 | 3.68E-3 | 1.73E-4 | 5.00E-3 | 7.65E-4 | 3.75E-4 | 5.17E-7 | 1.00E-2 |
| $^{237}$Np | W | 1.0 | 6.03E-6 | NA[2] | 2.66E-6 | 3.14E-3 | 4.18E-4 | 3.68E-8 | 6.78E-7 | 3.57E-3 |
| $^{239}$Pu | W | 1.0 | 1.28E-6 | NA[2] | NA[2] | 1.38E-6 | 2.06E-9 | 2.17E-8 | NA[2] | 2.68E-6 |
| Total Ci/year | | | 1.60E-3 | 4.66E-3 | 2.14E-3 | 1.82E-2 | 5.29E-3 | 4.58E-3 | 1.20E-5 | 3.65E-2 |
| Check Totals | | | | | | | | | | 3.65E-2 |

[1] 1 Curie = $3.7 \times 10^{10}$ Becquerels

[2] NA = Not Analyzed

## DOE SOURCE CHARACTERISTICS AND RADIONUCLIDE EMISSIONS DATA

| Minor Point and Area Sources | Type Control | Efficiency% | Distance (m) and Direction to Nearest Receptor[1] |
|---|---|---|---|
| Northwest Plume Treatment Facility | None | 0 | 1080 NNE |
| Concrete Crushing Project | Water Spray | 0 | 1848 E |

| Radionuclide Emissions (Ci)[2] During 2001 | | |
|---|---|---|
| **Emission Source** | **Northwest Plume Treatment Facility** | **Concrete Crushing Project** |
| $^{99}Tc$ | 1.85E-2 | 3.6E-5 |
| $^{241}Am$ | N/A | 3.7E-10 |
| $^{233/234}U$ | N/A | 2.4E-7 |
| $^{235}U$ | N/A | 1.4E-8 |
| $^{238}U$ | N/A | 4.1E-7 |
| $^{137}Cs$ | N/A | 9.6E-7 |
| $^{237}Np$ | N/A | 3.75E-7 |
| $^{238}Pu$ | N/A | 2.9E-9 |
| $^{239/240}Pu$ | N/A | 1.8E-9 |
| $^{228}Th$ | N/A | 1.8E-9 |
| $^{230}Th$ | N/A | 5.6E-9 |
| $^{232}Th$ | N/A | 3.4E-10 |
| $^{234}Th$ | N/A | 4.2E-6 |
| Total Ci/year | 1.85E-2 | 4.2E-5 |
| DOE Total Ci/year | 1.85E-2 | |

| Source Name | Distances (m) to Selected Receptors | | |
|---|---|---|---|
| | Nearest Individual/Farm | Nearest Business | Nearest School |
| Northwest Plume Treatment Facility | 1080 | 2550 | 5150 |
| Concrete Crushing Project | 1977 | 3067 | 3885 |

| Source Name | Type | Height (m) | Diameter (m) | Gas Exit Velocity (m/s) | Gas Exit Temperature (°C) | Distance (m) and Direction to Maximally Exposed Individual (MEI) Source MEI |
|---|---|---|---|---|---|---|
| Northwest Plume Treatment Facility | Point | 7.0 | 0.3556 | 9.45 | 37.8 | 1080 NNE |
| Concrete Crushing Project | Point | 1 | 3.6 | 0 | Ambient | 2726 N |

[1]Distances in receptors were resurveyed in CY 2001 due to residential construction in the vicinity of the plant.

[2]1 Curie = $3.7 \times 10^{10}$ Becquerels.

## SECTION III DOSE ASSESSMENT

### DESCRIPTION OF DOSE MODEL

The radiation dose calculations were performed using the Clean Air Act (CAA) Assessment Package-88 of computer codes. This package contains EPA's most recent version of the AIRDOS-EPA computer code which implements a steady-state, Gaussian plume, atmospheric dispersion model to calculate environmental concentrations of released radionuclides and Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to radionuclides deposited in the environment. The human exposure values are then used by EPA's latest version of the DARTAB computer code to calculate radiation doses to man from radionuclides released during the year. The dose calculations use dose conversion factors in the latest version of the RADRISK data file, which is provided by EPA with CAA Assessment Package-88.

### SUMMARY OF INPUT PARAMETERS

Except for the radionuclide parameters given in Section II and those given below, all important input parameter values used are the default values provided with the CAP-88 computer codes and databases.

| | |
|---|---|
| Joint frequency distribution: | Five-year STAR distribution from 60-meter station on PGDP meteorological tower for the years 1988 through 1992. |
| Rainfall rate: | 121 centimeters/year |
| Average air temperature: | 20° C |
| Average mixing layer height: | 930 meters |

| Fraction of foodstuffs from: | Local Area | 50-Mile Radius | Beyond 50 Miles |
|---|---|---|---|
| Vegetables and produce[1]: | 0.700 | 0.300 | 0.000 |
| Meat: | 0.442 | 0.558 | 0.000 |
| Milk: | 0.399 | 0.601 | 0.000 |

### DISCUSSION OF RESULTS

Due to the conservative nature of the estimates, it is likely that the actual radiological dose from site operations was significantly lower than the calculated does. Using the conservative estimates, however, PGDP was in compliance with requirements of 40 CFR 61.

[1]Rural default values.

## COMPLIANCE ASSESSMENT

Effective dose equivalent (mrem)[1] to maximally exposed individual for each individual source and the plant:

| USEC Emission Sources | Maximum for Source | Maximum for Plant |
|---|---|---|
| C-310 | 3.1E-4 | 3.0E-4 |
| C-315 | 3.6E-3 | 2.3E-3 |
| C-360 | 5.9E-5 | 2.6E-5 |
| C-400 Group | 2.7E-2 | 2.7E-2 |
| C-400 Cylinder Drying Station | 1.7E-3 | 1.7E-3 |
| C-709/C-710 Lab | 1.3E-3 | 1.3E-3 |
| Seal/Wet Air Exhaust Group | 1.4E-1 | 1.4E-1 |
| **Total From USEC Sources** | | **1.7E-1** |
| | | |
| **DOE Emission Sources** | **Maximum for Source** | **Maximum for Plant** |
| Northwest Plume Treatment Facility | 3.7E-3 | 3.7E-3 |
| Concrete Crushing Project | 2.4E-5 | 1.6E-5 |
| Total From DOE Sources | | 3.7E-3 |
| **Total From All Sources** | | **1.74E-1** |

**Maximum effective dose equivalent to the maximum exposed individual for the plant = 1.74E-1 mrem.**

Location of maximally exposed individual: 2350 meters north of greatest contributor to dose which is the SX/WA Group Source.

NOTE: Based on 1990 census data, the total collective effective dose equivalent (CEDE) to the 50-mile population (approximately 500, 502 persons) was 1.1 person-rem.

[1] 1 mrem=0.01 millisieverts.

# CERTIFICATION

This certification pertains to the following USEC emission sources:

C-310 Purge and Vent Stack
C-315 Tails Withdrawal Facility
C-360
C-400 Group
C-400 Cylinder Drying Station
C-709/C-710 Lab
Seal Exhaust/Wet Air Group

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.
(See 18 U.S. C1001.)

R. Michael Ri
United States Enrichment Corporation

6/21/02
Date

# CERTIFICATION

This certification pertains to the following DOE emission source:

Northwest Plume Treatment Facility
Concrete Crushing Project
Fugitive and Diffuse Sources

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.
(See 18 U.S. C1001.)

Department of Energy

6/21/02
Date

## SECTION IV ADDITIONAL INFORMATION

### UNPLANNED RELEASES USEC

There were 8 unplanned releases in USEC facilities occurring outside of a building not included in HP air sampling program during CY 2001. The estimated total quantity of uranium released was less than 29g. These releases were included in the seal/wet air exhaust group.

### DIFFUSE/FUGITIVE EMISSIONS DOE

Diffuse/fugitive sources include any source that is spatially distributed, diffuse in nature, or not emitted with forced air from a stack, vent, or other confined conduit. Diffuse/fugitive sources also include emissions from sources where forced air is not used to transport the radionuclides to the atmosphere. In this case, radionuclides are transported entirely by diffusion and/or thermally driven air currents. Typical examples of diffuse/fugitive sources include emissions from building breathing; resuspension of contaminated soils, debris, or other materials; unventilated tanks; ponds, lakes, and streams; wastewater treatment systems; outdoor storage and processing areas; and leaks in piping, valves, or other process equipment.

EPA has not identified a methodology or requirements for determining airborne radionuclide source terms for many unique fugitive and diffuse emission sources characteristic of DOE facilities, nor does the Paducah Site currently have any available methods to selectively and accurately quantify airborne radionuclide source terms from specific fugitive emission sources. However, consistent with the April 1995 Memoranda of Understanding between DOE and EPA Headquarters, information on diffuse/fugitive emissions is being provided to EPA as additional information. On February 8, 2000, DOE submitted to Kentucky Division for Air Quality and EPA Region IV the *Paducah Gaseous Diffusion Plant Department of Energy National Emission Standards for Hazardous Air Pollutants (NESHAP) Management Plan.* This plan outlined the DOE Paducah Site plans for using ambient air monitors to demonstrate that total emissions (from point, diffuse, and fugitive sources) result in doses significantly less than the 10-mrem/year (0.1-mSv/year) standard. Section I provides a list of potential fugitive/diffuse sources on the Paducah Site.

The Radiation/Environmental Monitoring Section of the Radiation Health and Toxic Agents Branch of the Department for Public Health of the Kentucky Cabinet for Health Services has conducted ambient air monitoring around the Paducah Site during CY 2000. The Radiation Health and Toxic Agents Branch reports that weekly air filters were screened for gross alpha and beta activity and then composited on a quarterly basis. The quarterly composites were analyzed by gamma spectroscopy using a thin window 40 percent high purity germanium detector which allows for detection of low energy gamma emitters. Americium-241 ($^{241}$Am) and thorium-234 ($^{234}$Th) were not detected by gamma spectroscopy for the quarterly composites.

Because $^{241}$Am and $^{234}$Th were not detected, plutonium and uranium isotopic analyses were not performed on the quarterly composites. Since $^{241}$Am and $^{234}$Th were not present, the quarterly composites were analyzed for $^{99}$Tc. $^{99}$Tc was also not detected in the quarterly composites. $^{210}$Pb and $^{40}$K were detected on filters, which accounts for the presence of the gross alpha and beta activities.

Based on observations for CY 2001, plant derived radionuclides were not detected by the Radiation Health and Toxic Agents Branch's air monitoring network.

## STATUS OF NESHAP MONITORING REQUIREMENTS, SUBPART H COMPLIANCE

The status of compliance with the new NESHAP monitoring requirements is described in the revised NESHAP Compliance Plan, which was submitted to EPA January 1992. PGDP has only one stack subject to the continuous monitoring requirements of Subpart H, the C-310 Stack.[1] Particulate stack sampling was performed on the C-310 Purge Cascade Stack February 1992. Results of the sampling project were forwarded to EPA by March 31, 1992. Documentation from EPA[2] stated that PGDP is exempted from the requirement to install an isokinetic sampling system.

Minor Sources: The periodic confirmatory measurement plan for minor sources is outlined in detail in the Revised NESHAP Compliance Plan for PGDP, which was submitted to EPA on January 15, 1992. The initial plan for confirmatory measurements is to estimate emissions using Appendix D and/or mass balance methods on an annual basis, and to stack sample those sources for which stack sampling is the only feasible estimation method on a five-year basis.

On May 26, 1992, PGDP and EPA entered into a Federal Facility Compliance Agreement (FFCA) to bring PGDP into compliance with the sampling provisions established in accordance with 40 CFR 61, Subpart H. Appendix A of the FFCA contains a schedule establishing compliance commitments. The major effort of the compliance schedule was the site evaluation in which all potential sources of airborne radionuclides were identified and emissions were determined. The radionuclide sources were identified through a preliminary stack vent survey which was completed in 1991. In November 1992, a more in-depth survey was completed which did not discover any previously unknown airborne radionuclide sources. In September 1992, representatives from EPA inspected PGDP for NESHAP compliance. Correspondence from EPA summarizing the inspection stated there were no NESHAP violations identified during the inspection. PGDP fulfilled all commitments in accordance with Appendix A of the FFCA in June 1992; submitted results of the updated, in-depth vent stack survey in December 1992; and officially requested a Certification of Completion of the FFCA on March 11, 1993. EPA issued the Certification of Completion on March 26, 1993. Certification of Completion of the FFCA indicates that PGDP is in compliance with the provisions in accordance with 40 CFR 61, Subpart H.

DOE has remained in compliance since 1993. KDAQ received a delegation of authority to administer the NESHAP program in July 1999. A NESHAP Management Plan has been developed by DOE, which addresses fugitive and diffuse emissions. EPA Region 4 concurred with the DOE NESHAP Management Plan on September 19, 2000. In accordance with the management plan, ambient air monitoring was utilized to verify compliance of the Paducah Site with 40 CFR 61, Subpart H for all emissions. Ambient air monitoring conducted by the Kentucky Radiation Health and Toxics Branch detected $^{241}Am$ at the AMNE monitor during the first quarter of CY 2000. The concentration detected is less than the 40 CFR 61 Appendix E, Table 2 value for environmental compliance. No other radionuclides were detected for the remainder of the year at any of the air monitors.

The actual results, even though less than the measurement error, of each air monitor are listed in Table A-1. The sum of the ratio of the ambient air result to the corresponding Table 2 value for each monitoring location for each quarter is also included in Table A-1.

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[1]See correspondence from D. F. Hutcheson to D. C. Booher, dated January 28, 1994, discussing "Potential to Emit."

[2]See correspondence from W. A. Smith to D. C. Booher, dated April 20, 1992.

## Table A-1. Kentucky Radiation Health and Toxics Branch Ambient Air Monitoring Results

| | | AMSW017 | AMW015 | AMNW001 | AMN003 | AMNE | AME002 | AME012 | AMBKG2 | AMBOLD | AMKOW | AMMWNE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quarter | Nuclide | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 | Ci/m3 |
| 1 | Am-241 | -2.109E-16 | -1.229E-16 | -1.971E-16 | 4.506E-16 | 6.364E-16 | 5.945E-16 | 5.246E-16 | -2.896E-16 | | | |
| 1 | Np-237 | 2.63E-16 | 7.091E-17 | -4.104E-16 | -5.355E-19 | 7.757E-18 | -7.26E-17 | -6.211E-17 | -3.238E-16 | | | |
| 1 | Tc-99 | 1.44E-15 | 1.74E-15 | 1.64E-15 | 1.61E-15 | | 2.09E-15 | 1.11E-15 | 2.11E-15 | | | |
| 1 | U-238/Th-234 | -3.17E-15 | -1.678E-15 | -3.303E-15 | 3.551E-15 | 8.84E-16 | -2.674E-15 | 1.551E-16 | 8.351E-16 | | | |
| 1 | Sum of ratios[1] | -0.26 | -0.20 | -0.83 | 0.68 | 0.45 | -0.05 | 0.25 | -0.31 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | | | | |
| 2 | Am-241 | 3.629E-17 | -3.106E-16 | -2.39E-16 | 7.329E-17 | 2.622E-16 | 8.325E-17 | 1.77E-16 | 5.912E-17 | | | |
| 2 | Np-237 | 1.861E-16 | 1.698E-16 | 2.675E-16 | -2.195E-17 | -7.828E-17 | -5.666E-17 | -5.096E-17 | -2.124E-16 | | | |
| 2 | Tc-99 | -7.0233E-17 | -2.006E-16 | 1.8903E-16 | 1.4447E-15 | 3.8623E-17 | -3.196E-16 | 8.4796E-17 | 2.5524E-16 | | | |
| 2 | U-238/Th-234 | 2.104E-16 | 3.79E-15 | 2.774E-16 | 4.249E-15 | -4.98E-16 | -1.32E-15 | -1.672E-15 | -1.641E-15 | | | |
| 2 | Sum of ratios | 0.20 | 0.43 | 0.13 | 0.54 | 0.01 | -0.16 | -0.15 | -0.34 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | | | | |
| 3 | Am-241 | 3.442E-16 | 5.001E-16 | 3.734E-16 | 5.475E-16 | 5.355E-16 | 4.049E-16 | 4.053E-16 | -5.105E-16 | | | |
| 3 | Np-237 | 7.45E-17 | -1.012E-16 | 2.401E-16 | 2.496E-16 | 3.023E-16 | -8.006E-17 | -3.339E-16 | 3.072E-16 | | | |
| 3 | Tc-99 | 1.9163E-16 | -3.555E-17 | 2.5318E-16 | 2.8706E-16 | 1.7346E-16 | 4.3026E-16 | 4.3361E-16 | 3.5067E-16 | | | |
| 3 | U-238/Th-234 | -3.305E-15 | -2.501E-15 | -3.896E-15 | -1.169E-15 | -1.987E-15 | -4.647E-16 | 5.826E-16 | -1.046E-15 | | | |
| 3 | Sum of ratios | -0.15 | -0.12 | -0.07 | 0.36 | 0.30 | 0.09 | 0.01 | -0.14 | 0.00 | 0.00 | 0.00 |
| | | | | | | | | | | | | |
| 4 | Am-241 | 3.794E-16 | 3.693E-16 | -2.461E-16 | | -2.79E-16 | 6.437E-17 | -6.428E-17 | -2.564E-16 | -1.476E-16 | -1.395E-16 | -3.706E-16 |
| 4 | Np-237 | 7.686E-17 | 1.158E-16 | 2.767E-17 | | -3.05E-17 | 1.039E-17 | -2.233E-16 | 7.727E-17 | 6.822E-17 | -4.545E-17 | 7.837E-17 |
| 4 | Tc-99 | -2.5377E-16 | -1.169E-16 | 3.4489E-17 | | 9.0124E-17 | 2.667E-16 | 1.252E-16 | 1.1834E-16 | 1.1052E-16 | 2.3497E-16 | 4.3787E-17 |
| 4 | U-238/Th-234 | -1E-15 | 1.93E-15 | -6.479E-15 | | -5.325E-15 | -2.139E-15 | -8.122E-16 | -6.491E-15 | 6.063E-16 | -3.099E-15 | -2.69E-15 |
| 4 | Sum of ratios | 0.14 | 0.52 | -0.89 | 0.00 | -0.81 | -0.21 | -0.32 | -0.85 | 0.05 | -0.48 | -0.45 |

[1]The sum of ratios is calculated by dividing the measured ambient air concentration for each isotope by the corresponding concentration listed in 40 CFR 61, Table 2. Table 2 values are: $^{241}$Am 1.90E-15, $^{237}$Np 1.20E-15, $^{99}$Tc 1.40E-13, $^{238}$U/$^{234}$Th 8.30E-15. The ratios for all of the isotopes are added. Sums of ratios less than 1 demonstrate compliance.