

## **Brief Overview of Worker Radiation Protection Practices at Gaseous Diffusion Plants**

The following write-up is an initial effort to identify the personnel radiation monitoring practices and the potential exposure areas at the three gaseous diffusion plants (GDPs). The monitoring programs for the workers are briefly discussed in terms of external (dosimeter) and internal (bioassay) components. It should be noted that inhalation of airborne radioactive material was the primary exposure pathway.

The areas of potential worker radiation exposure at each site address building locations, activities, and time periods that most likely would have involved potential worker exposure, i.e., through direct physical contact or airborne dust. The time periods shown in the tables below may have been periods of significant potential exposure, but exposure could have occurred during all years of operation at the site.

### **Paducah GDP**

#### Personnel Radiation Monitoring Program

Worker external radiation exposures were monitored from the 1950s to 1990. Personnel exposures were primarily monitored by the use of film badges. After July 1, 1960 (site health physicists stated that definitely by 1961) film badges were assigned to most employees, and were supplied to individuals who visited the plant from other locations and who might have been exposed to as much as one-tenth of the radiation protection guidance. Before July 1960, only selected workers were in the film badge service based on their work activities. In 1956 and 1958, there were 350 and 450 employees in the film badge service, respectively. Employees with the greatest potential for radiation exposure were primarily involved in chemical processing, maintenance of chemical processing facilities, and uranium metal production.

Worker internal radiation exposures were monitored through a bioassay program. One part of the program involved urinalysis. The frequency of routine urine samples, for uranium, varied from a maximum frequency of four weeks for all personnel in chemical operations and metal production (primarily C-310, C-315, C-340, C-400, and C-410) to a minimum frequency of 12 months for those working in locations deemed to have little likelihood of exposure. In vivo radiation monitoring via lung counting for workers was conducted initially at fixed facilities in Oak Ridge. Later, the plant conducted in vivo radiation monitoring using a mobile system from Oak Ridge.

Discussions with site health physicists found that worker doses were recorded for individuals, but there was no breakdown by job classification or building. Periodic summaries of worker external doses were reported by dose ranges, e.g., number of workers less than 10 mrem, number of workers between 10 – 100 mrem, etc.

### Areas of Potential Worker Exposure

The following table summarizes building locations, activities, and time periods that most likely would have involved potential worker exposure, i.e., through direct physical contact or airborne dust. The time periods shown may have been periods of significant potential exposure, but exposure could have occurred during all years of operation, i.e., 1953 to present.

#### **Likely Locations, Activities, and Time Periods for Worker Radiation Exposure**

<b>Location</b>	<b>Activity</b>	<b>Time Period</b>
C-333 C-337 C-410	Cascade operations	1953-1964 1969-1970 1972-1976
C-331 C-333 C-335 C-337 C-400 C-409 C-720	Cascade maintenance	Anytime, but especially during major maintenance campaigns  1954-1961 1973-1981
C-410 C-420	Feed plant operations	1953-1964 1969-1977 1982-1983
C-400 C-710	Uranium/Neptunium recovery (salvage U from cleaning solutions and waste products)	1952-1990 1956-1976
C-400	UF <sub>6</sub> cylinder cleaning	All years
C-405	Handling incinerator ash from contaminated items – incinerator (filter bags, etc.)	1953-1990
C-410 C-310	Changing/cleaning Magnesium Fluoride (MF <sub>2</sub> ) traps	1964-1966
C-340	Handling MF <sub>2</sub> in U-metal manufacturing – cleaning, roasting, liner preparation, knock out and drumming	1957-1962 1968-1977

A DOE ES&H Exposure Assessment noted that certain workers had an increased potential of internal and external radiation exposures. The primary departments identified included: Process Operators, Chemical Operators, Maintenance Mechanics, Instrument Mechanics, and Electricians. While this list was developed for Paducah, it should be applicable to all the GDP sites, since operations were relatively similar.

## Portsmouth GDP

### Personnel Radiation Monitoring Program

Worker monitoring began in 1954 with the Film Badge and Bioassay Programs. Workers with potential for external radiation exposure were provided film badges for monitoring. However, not all workers were provided film badges, and not all badges issued to workers were read. This changed in the mid-1970s when the film badges were replaced with thermoluminescent dosimeters (TLDs). All workers, regardless of exposure potential since that time, have been provided TLD badges. Some badges are not read unless there is cause to believe a significant dose may have been recorded. Records of badge readings obtained since 1954 were retained by U.S. Enrichment Corporation (USEC).

The bioassay program began with urine sampling for uranium or gross alpha. Uranium sampling was used to monitor intake of workers with the potential for exposure to low assay soluble uranium. Workers with the potential for exposure to high assay uranium were monitored by gross alpha. In the mid-1990s, both methods were replaced with state-of-the-art spectroscopy methods. Results of urine bioassay monitoring since 1954 were retained by USEC. From 1965 until the early 1990s, a portable In-Vivo counter was used to monitor lungs of workers for insoluble uranium. The counter was usually brought to the site twice per year.

### Areas of Potential Worker Exposure

The following table summarizes building locations, activities, and time periods that would have most likely involved potential worker exposure, i.e., through direct physical contact or airborne dust. The time periods shown may have been periods of significant potential exposure, but exposure could have occurred during all years of operation, i.e., 1955 to present.

#### **Likely Locations, Activities, and Time Periods for Worker Radiation Exposure**

<b>Location</b>	<b>Activity</b>	<b>Time Period</b>
X-705	Oxide conversion	1957-1978
X-333 X-330 X-326 X-342A X-343 X-344A	Cascade operations and maintenance, including associated feed, withdrawal, and sampling	1955-present
X-705	Equipment decontamination and recovery and oxide conversion	All years
	UF <sub>6</sub> cylinder cleaning	All years

## Oak Ridge GDP

### Personnel Radiation Monitoring Program

Worker radiation monitoring was in place after the earliest days of operation (external dosimetry and bioassay stated in 1948). Film badges or film rings (for potential hand exposures) were requested by supervisors for those employees routinely assigned to work in areas where penetrating radiation was likely to be encountered. Supervisors would also request the termination of this service when it was no longer required. The film badges were processed every two weeks. In all areas where process equipment was used, visitor badges were maintained for use by visitors or by employees assigned to that area on an intermittent basis. These badges were processed in the same manner as badges for the regular employees.

Local supervision assigned pocket chambers and dosimeters to employees, with a listing of all employees recorded on IBM records. Readings were recorded daily. Each week the IBM records were forwarded for inclusion in the plant exposure record.

### Areas of Potential Worker Exposure

The following table summarizes building locations, activities, and time periods that most likely would have involved potential worker exposure, i.e., through direct physical contact or airborne dust. The time periods shown may have been periods of significant potential exposure, but exposure could have occurred during all years of operation, i.e., 1945 to 1987.

#### **Likely Locations, Activities, and Time Periods for Worker Radiation Exposure**

<b>Location</b>	<b>Activity</b>	<b>Time Period</b>
K-1131	Oxide conversion operations, ash collection, uranium recovery, and maintenance and repair of fluorination tower and associated equipment	1952-1961
K-1420		1960-1963
K-1231		1952-1963
K-1410		1952-1962
K-25 K-27 K-29 K-31 K-33	Cascade operations and maintenance	1952-1985
K-1410 K-1420 K-1303 K-1037 K-1421 K-1407 K-1419	Recovery operations, including UF <sub>6</sub> cylinder cleaning, equipment decontamination, and recovery from process fluids and wastes	1952-1979 1954-1993 1952-1955 1952-1981 1954-1986 1952-1988 1987-1988

RUBB		1991-1992
K-25 K-27 K-29 K-31 K-33	Post-shutdown recovery of uranium deposits from cascade process equipment	1987-present
K-1004 A, B, C, D, J K-1006	Analytical laboratories	1952-1985

References:

Recycled Uranium Mass Balance Project Paducah Gaseous Diffusion Plant Site Report (BJC/PGDP-167), Final Draft, June 14, 2000

Recycled Uranium Mass Balance Project Oak Ridge Gaseous Diffusion Plant Site Report (BJC/OR-584)

Recycled Uranium Mass Balance Project Portsmouth, Ohio Site Report (BJC/PORTS-139/R1), June 19, 2000

Exposure Assessment Project at the Paducah Gaseous Diffusion Plant, DOE ES&H, December 2000

Conversations with Orville Cypret and Spence Childers, Paducah Health Physicists, and Julie Olivier, Paducah Project Manger, NMSS, NRC HQ.