THE FERNALD DOSIMETRY RECONSTRUCTION PROJECT

Task 1: Identification of Release Points

Submitted to the Centers for Disease Control in Partial Fulfillment of Contract No. 200-90-0803

by

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SUMMARY

The goal of Task 1 is to verify and confirm documentation by National Lead of Ohio (NLO) and Westinghouse Materials Company of Ohio (WMCO) of all significant points of release of radionuclides to the environment from the Feed Materials Production Center (FMPC) in Fernald, Ohio, since operations began in 1951. This report inventories the release points to air, to surface water, and to groundwater, and provides confirmatory references and verification of the FMPC-related documents whenever possible. Verification for the Task 1 report is based upon touring the FMPC site, evaluating engineering drawings and historic photographs of the site, and reviewing documents from NLO, WMCO, and FMPC-independent sources. Discussions with FMPC staff and long-time employees and retirees also provide a basis for verification.

The release points to air have been categorized as Stack Release Points, Other Release Points, and Non-Routine Release Points. A total of 131 Stack Release Points to air are identified in the report: 125 from the production plants and from six non-production release points, including the cooling towers, the graphite burner, the liquid organic incinerator, the new solid waste incinerator, the oil burner, and the old solid waste incinerator. The release points for the production plants include 101 dust collectors and scrubber stacks, 19 thorium emission points, and 6 unmonitored stacks. Using selected engineering drawings and Stack Traverse Data Sheets (STDSs) taken from August 1983 through April 1990, physical features such as stack height, diameter, and exhaust velocity measurements are described and compared to the data in FMPC documents.

The category of Other Release Points encompasses building exhausts, laboratory emissions from 55 hood vents in the Laboratory Building 15, and 7 hood vents in the Occupational Safety and Health Building 53, the K-65 storage silos, and six waste pits at FMPC. The building exhaust points are either passive or forced ventilation fans in building walls or roofs. The K-65 storage silos, which contain pitchblende residues from the processing of high-grade Belgian Congo uranium ores, represent important release points to air because of the diffusion of radon through the silo walls and roof and the exchange of contaminated air from within the silos. The Non-Routine

Release category includes all accidental or unusual events, such as uranium fires, spills, and UF_6 leaks and releases.

The Stack Release Points and Other Release Points are located onsite in both longitude/latitude and the Ohio State Plane coordinate systems. Because exact coordinates for all stack release points have not been determined, the center of the production plant having the stack is used to represent the Stack Release Point locations.

Finally, the report identifies the principal sources and points of release of radionuclides from the FMPC site to surface water and groundwater.

1.0 INTRODUCTION

The Feed Materials Production Center (FMPC) in Fernald, Ohio, is a government-owned, contractor-operated facility whose primary purpose was to convert uranium ore concentrates and materials recycled from other stages of nuclear weapons production to either uranium oxides or metal ingots for machining, or to metal ingots for extrusion into tubular form for production reactor fuel cores and target fuel element fabrication. Although uranium production has been the primary activity at the FMPC, lesser amounts of thorium production occurred intermittently from 1954 through 1979. Since operations began in 1951, uranium, uranium progeny, and other radioactive by-products have been released to the environment as part of routine operations and during accidental occurrences.

The purpose of the Fernald Dosimetry Reconstruction Project (the Project) is to provide an independent analysis of types and amounts of radioactive materials released to the environment from the FMPC and to establish a methodology that will estimate doses to persons living in the vicinity of the facility. The methodology can then be applied to retrospective dose estimates that could be used in an epidemiological study. The support for this project has been divided into 7 tasks.

This document describes Task 1, the identification of all points of release of radionuclides to the environment at the FMPC since the beginning of operation of the facility. The report presents locations and physical characteristics of release points to air, surface water, and groundwater, along with supporting documentation.

2.0 GENERAL APPROACH

Five general approaches were used in identifying all release points to air, surface water, and groundwater from the FMPC facility since operations began in the early fifties. These general approaches lay the foundation on which much of the technical data are based and highlight the importance of documentation in the verification of release point characteristics. The following subsections will summarize our findings for each of the general approaches. In Sect. 3, a more detailed evaluation of the release points will be presented.

The five general approaches included the following:

- Site Visit to the FMPC facility;
- Review of records and open literature pertaining to the FMPC;
- Keyword search and retrieval of documents from NLO Inc., using the NLO computer database of document titles;
- Discussions with current and former longtime employees; and
- Location and examination of engineering diagrams, site blueprints, aerial photographs, and maps.

2.1 FMPC Site Visit

Members of the Radiological Assessments Corporation (RAC) dose reconstruction team visited and toured the FMPC facility during August and September. John E. Till and Bernard Shleien toured the facility in mid-August as part of a trip to attend a public meeting on Thursday August 16. The remaining members of the RAC team , along with Project staff members of the Centers for Disease Control (CDC), visited the facility during the week of September 17, 1990. Representing RAC were George G. Killough, Kathleen R. Meyer, Robert E. Moore, Duane W. Schmidt, Paul Voillequé, and Vernon Ichimura. The CDC staff members were Christie Eheman, Felix Rogers, and James Smith. During that visit, members drove the outer and inner perimeters of the site and walked through the production and process plants within the fenced area of the facility. The tours of the site were led by Homer Bruce of the Public Affairs Department and DuWane Bonfer and Ev Henry of the Operations Department.

The goals of the site visit were to observe the general layout of the buildings, the location and dimensions of nearby structures, the status and physical features of the release points to air, surface water, and groundwater, and the natural environs of the facility.

During that week, we met at the FMPC with Jerry Westerbeck, Jane Powell, Steve Coil, and Susan Rice of DOE; and with Linda England, Phil Weddle, Lou Bogar, Stu Hinnefeld, Ed Schonegg, DuWane Bonfer, and Homer Bruce of Westinghouse Materials Company of Ohio (WMCO). In addition, members of our team met with various individuals from the site, including Steve Beckman (Restoration), Ken Broberg (Restoration), Tom Dugan (Operations), Bob Galbraith (IT Corporation Program Director), William Hertel (IT Corporation Project Scientist), Roger Grant (IRS&T), Cathy Hill (Operations), Joe Neyer (Restoration), Randy Palmer (Operations), Gerry Paul (Restoration), Ed Schonegg (Restoration), Jackie Schoultheis (Records Storage), and Nelson Weicholds (Operations).

In addition, we met with the Board of Trustees of the DOE settlement fund for the residents in the area of the FMPC, and we talked with Lisa Crawford of the Fernald residents group, Fernald Residents for Energy Safety and Health (FRESH).

2.2 Literature and Records Review

Considerable time has been spent identifying types and locations of documents pertinent to the completion of the dose reconstruction projects. The sources of these documents include (a) those published by NLO Inc. (NLO), the former operator of the site, and the Westinghouse Materials Company of Ohio (WMCO), the current site operator; and (b) those published by FMPC-independent sources.

2.2.1 WMCO Records

WMCO has provided an FMPC Records Storage Inventory list of documents. These documents are grouped together by department (General Accounting, Information Systems, Materials Control and Accountability, Procurement and Contracts, Emergency Preparedness, Public Affairs and Communications, Operations, Maintenance, Radiological Safety and Training, Human Resources, and Engineering Services). The documents are distributed among three locations: in Central Files at the FMPC site, at the Federal Storage Center in Dayton, and in a local storage unit in Cincinnati. There is an index card for each document type which indicates its location, dates of the documents, and number of boxes holding the documents. On a trip to the FMPC in November, we examined documents for the Project from Central Files, and we compiled a list, by topic and status, of the documents that we evaluated (Meyer, 5 Dec 1990). Some of these documents were obtained and have been referenced in this Task 1 report.

In addition, the FMPC has an Operations Document Program Index which lists Department Procedures, Section Procedures, Standard Operating Procedures/Manufacturing Specifications/-Production Supply Specification (SOP/MS/PSS) documents, Change In Operations (CIO) documents, Cancelled Documents (procedures cancelled July 9, 1973 or later), and documents placed on "Hold" (documents not required for current operations). These documents are identified by document number, type of document, title, issue date, revision date, and revision number. We have obtained SOP documents for selected processes in Plants 2/3, 6, 8, and 9 at the FMPC (Eheman, 28 Sep 1990).

Finally there is a list of Procedure Administration Obsolete Reports. These reports may provide details of processes and procedures that occurred in the fifties and sixties at the FMPC. All reports are identified with document number, title, type of document, and issue date. All of these document types are available.

2.2.2 FMPC-Independent Documents

Locating independent sources of documents was particularly important in verifying the data and records from the FMPC site. To accomplish this end, open literature searches were undertaken independently by CDC and RAC personnel. Two of the bibliographic database systems employed to search for published material relating to the FMPC were HP QUEST and GRATEFUL MED (Shleien, 14 Aug 1990).

HP QUEST is advantageous in that it is simple to use and fast. On the other hand, it is limited to a specific database that includes only eight publications, all devoted to the field of health physics. GRATEFUL MED is the National Medical Library search system. It is more complex to use, but it offers a broader database, and it permits the printing of abstracts when they are available. It should be noted that documents searched with HP QUEST were also reviewed by GRATEFUL MED, and this overlapping may have caused some duplication of effort, but it probably yielded some references that might otherwise have been missed since different search criteria and keywords were employed. For both databases, the keywords "Fernald" or "fuel fabrication" yielded a negative or meager response.

Utilizing the HP QUEST database, the journals *Health Physics* (1958-1989), *Radiation Protection Management* (1983-1989), *Radiation Protection Dosimetry* (1981-1989), and *Medical Physics* (1974-1989) were searched for FMPC-related documents, as were all NCRP, ICRP, ICRU, and UNSCEAR reports. Searching for the keywords URANIUM, THORIUM, RADON, ALPHA, or PLUTONIUM, with LUNG, DOSE, MONITORING, POPULATION, FUEL, FABRICATION, and BIOASSAY yielded a large number of references. A total of 221 articles were referenced from *Health Physics*, 3 from *Radiation Protection Management*, 130 from *Radiation Protection Dosimetry*, 1 from *Medical Physics*, as well as 4 NCRP reports and one ICRP report. Forty-one of these documents were identified as potentially useful for the project and are being reviewed.

A search for keywords URANIUM, THORIUM, or PLUTONIUM, with AIR, AIRBORNE, and ENVIRON* (the wildcard character * permits various endings for preface) yielded 64 references to *Health Physics*, 41 to *Radiation Protection Dosimetry* articles, and one to an NCRP Report. Thirteen articles were identified and are being reviewed.

With the GRATEFUL MED database, the keywords: URANIUM, THORIUM, RADON, or PLUTONIUM were combined with RADIATION PROTECTION or RADIATION MONITORING. Documents were searched back to 1970 for all keywords, except RADON, for which only the most recent database (MEDLINE 1988 and 1989) was searched. Over 50 documents were referenced in the GRATEFUL MED search, of which 7 are being reviewed.

A literature search of the Toxline database from 1965-1990 yielded 37 FMPC-related documents, 11 of which were from sources other than NLO, WMCO, or DOE (Eheman, 10 Aug 1990). The Nuclear Science Abstracts database yielded 5 FMPC documents, one from an independent source. Six of 24 FMPC-related documents in the DOE Energy Database were from independent sources. A search of the Occupational Safety and Health (NIOSH) database from 1973 to 1990 yielded four FMPC-related documents, one from an independent source. We are in the process of retrieving these documents from independent sources, and we will evaluate them for their usefulness in verifying the release points and source term data.

2.3 NLO Database Evaluation

Approximately 180,000 documents pertaining to the Feed Materials Production Center (FMPC) were gathered by NLO for litigation purposes. These documents are stored at the NLO office in Cincinnati, and each has been assigned a unique identifying ICN number. For each of the 180,000 documents, NLO has listed the ICN number, the title, the author(s), and the date in a computer database file.

Radiological Assessments Corporation (RAC) received a computer database file of these documents through the Centers for Disease Control (CDC) and has used the database in several ways to identify and sort documents that pertain to release point identification and physical description. In addition, we have questioned how documents were selected for the database (Killough 1990).

2.3.1 Keyword Searches

We have used a computer program to search the NLO file for particular keywords, dates, names, and document titles, and to gather the appropriate documents into separate lists. These lists of documents were examined for their usefulness in determining FMPC release point information. Many of the documents were eliminated from further consideration by an examination of their complete titles. Relevant documents were requested from NLO to be copied and sent to us. Since the Project began, approximately 3000 titles in the NLO database have been reviewed. Through the efforts of both RAC and the CDC, we now have copies of more than 500 documents, many of which were obtained through NLO (Eheman, Oct 1990; Meyer, Nov 1990). Appendix C contains the bibliography of useful FMPC-related documents that we have assembled since the Project began. New documents will be added to this collection throughout the Project.

Some of the keywords used in the search of the database include the following: AERIAL; BLUEPRINT; ARCHITECTURE; CAPS; CHANGE ORDER; ENVIRONMENTAL MONITORING; LIQUID EFFLUENT; MAINTENANCE WORK ORDER; PLANT 2; PARTICLE SIZE; PITCHBLENDE; RAINCAPS; RELEASE POINT; REQUEST AND APPROVAL FOR EQUIPMENT, MAINTENANCE, AND EXPERIMENTAL PROJECTS;

ROUTINE OPERATING LOSSES–1961; ROUTINE OPERATING LOSSES–1965; ROUTINE OPERATING LOSSES–1966; STACK FILTER; STACK MONITOR; STACK SAMPLER; URANIUM STACK LOSS SUMMARY; and WORK ORDER.

2.3.2 Document Retrieval at NLO, Inc.

During the week of September 17, 1990, we visited the NLO offices, toured the document storage area, observed the document retrieval procedure, and accompanied the personnel while they retrieved documents for us. During the week, we reviewed almost 1000 documents, compared them to our list of ICN numbers and titles obtained through our keyword searches, and determined their usefulness for the project tasks. This verification was important so that when we request documents from NLO in the future we will feel confident about the procedures for retrieving and copying documents.

2.3.3 Random Selection of Documents at NLO

To verify that the documents located at NLO are represented in the NLO database by an ICN number, we accompanied an employee of NLO and requested documents at random from the files at NLO. The documents are located in stacks, six shelves high, with seven boxes of documents on each shelf. Generally, one box per shelf was randomly selected and one document from this box was pulled. The ICN numbers of these documents were recorded. Later, the NLO database was searched for these ICN numbers to verify that these randomly pulled documents were in the database.

We pulled 291 documents at random and compared their ICN numbers to those in the computer file. Surprisingly, ICN numbers for 97 of the 291 documents were not listed in the computer database file (Meyer, Oct 1990). In communications with NLO and CDC regarding this problem, we learned that several files were missing from our version of the NLO database that we had received from CDC. Subsequently, we received the missing files from the database and have found the ICN numbers from all randomly selected documents in our copy of the NLO database (Meyer, 4 Dec 1990).

At the present time, the NLO database appears to list representative documents from the FMPC site. It seems clear that obvious selection criteria were not applied in gathering documents for inclusion in the database. The database can be useful, however, in identifying types of documents or records that may be available in the Central Files at the FMPC site.

2.4 Discussions with Long-Time Employees and Retirees

We met with several individuals who had been or are currently employed at the FMPC to discuss their recollections on processes and procedures that routinely occurred since the facility start-up. The primary purpose of these discussions was to identify sources and locations of information so that we could verify data that we were assembling in other ways. These individuals had been at the facility since the early fifties and had served in various capacities, including maintenance, engineering, production, and plant management.

During the discussions, we asked both general and specific questions regarding each individual's personal employment history at the site. The following examples are an indication of the types of questions asked:

- What were the normal operating procedures with respect to processes in a particular building (the building the individual was most familiar with)?
- What was considered a "minor event"? What criteria were used? What was the procedure for reporting such an event or unusual occurrence?
- Have stack monitors always been in place? In all stacks? When did monitoring begin? When were the rain caps on stacks removed? Were particle size studies of emissions done and when?
- When was wastewater effluent monitoring begun? Where were sampling locations? How were results of stack and effluent monitoring recorded?
- Which departments were responsible for keeping and reporting effluent results? Incoming inventory records? Monthly progress reports? Routine operating losses? Where are these types of documents located? What are they called? Were names of reports, procedures, and documents changed over the years?

2.5 Engineering Drawing and Photograph Searches

During the visit to the FMPC in September 1990, a search for engineering diagrams, site blueprints, aerial photographs, and maps was begun.

2.5.1 Historical Engineering Drawings

According to the Supervisor of Drafting, about 70,000 engineering drawings are stored on microfilm in the Drafting Department. The FMPC has been developing a database of the microfilm drawings, and this database now contains information for about 90 percent of the drawings.

Each drawing in the database is identified by its plant or building location, the originator of the drawing, a code for the classification of drawings, drawing number, drawing title, and other information not needed for this task. Two types of searches were done: first, keyword searches of the titles of drawings in the database were performed; and second, an exploratory search of the microfilm files was undertaken to get a sense of what kinds of potentially useful drawings might have been missed by the keyword searches.

The keyword-directed database searches concentrated on drawings related to atmospheric release points from Plant 2/3, Plant 4, Plant 8 scrubbers, and various incinerators. More than 300 drawings were identified by these keyword searches, many of which were eliminated from further consideration, based on examination of the complete title of the drawing. Drawings not eliminated have been listed by plant and title keywords in Table A-1, Appendix A. The drawing numbers used in this report are actually the drawing index codes, with the originator code deleted. Thus, a code such as 04A-H-01072 refers to plant and area 4A, classification H, and drawing number 1072. These shortened index codes are still unique identifiers.

Drawings that were considered potentially useful were located in the microfilm file, examined, and copied if relevant to the task. The titles of the drawings immediately before and after the target drawing were also examined for applicability. The last column in Table A-1 indicates whether the drawing was located and copied.

In addition to the title keyword search of the database, an exploratory search of the microfilm files was performed.

Drawings with titles pertaining to plants and areas of potential interest were located, and a number of the microfilm cards were examined. Drawings containing possibly useful information were viewed on the microfilm reader, and copies were made of those that warranted further consideration.

All copied drawings have been reviewed to confirm atmospheric release point locations for this Task 1 report. It must be recognized that only a few of the drawings indicated "as built" specifications. Table A-2, Appendix A, provides a complete reference for the drawings that were copied. These drawings are referenced throughout this Task 1 report where applicable.

The results of the searches for drawings show that historical engineering drawings can be an excellent resource to confirm physical features of stack release points, especially diameters, heights, and locations.

2.5.2 Historical Aerial Photos

With regard to actual photographs of the FMPC facility, we were successful in locating series of aerial photographs taken of the FMPC site in 1954, 1965, 1968, and 1987. We have obtained 82 photographic prints of various plants and areas of the facility, which will be published separately in an addendum to this report. With minor exceptions, these photographs show that the general building layout, and physical characteristics of the buildings (e.g., vent and stack locations, window openings, stack residues on roofs) have not changed significantly over the past 35 years. These photographs are useful in verifying stack and dust collector locations for some of the plants.

3.0 POINTS OF RELEASE TO AIR

3.1 Introduction

Most uranium production operations resulted in the generation of dust, fume or reaction gases, according to FMPC documents. These operations were conducted in ventilated enclosures and, in many cases, the air was passed through dust collectors or scrubbers before the air was exhausted to the atmosphere. This section presents the identifications of radioactivity release points to air. Physical features and building locations for these release points are given.

The release points to air are categorized as STACK RELEASE POINTS, OTHER RELEASE POINTS, and NON-ROUTINE RELEASE POINTS. Stack release points are locations at which gaseous effluents were discharged through a stack to the outside air. Many of the discharges passed through dust collectors or scrubbers before entering the stack. OTHER RELEASE POINTS include release points that are less defined, area source releases. NON-ROUTINE RELEASE POINTS include accidental releases that are typically of very short duration. The three categories of release points are discussed in sections 3.2, 3.3, and 3.4.

A major objective of release point identification was to confirm and verify historical emissions reports that had been published by WMCO since the mid-eighties (Shleien, 10 Aug 1990). The most recent report "History of FMPC Radionuclide Discharges," FMPC-2082 (Boback et al. 1987), and two addenda (Dolan and Hill 1988; Clark et al. 1989) have been the source of the "previous reference" data listed in Tables for this section.

3.2 Stack Release Points

3.2.1 Identification of Release Points

The stack release points to air are listed in Table B-1, in Appendix B. For dust collectors, the stack is designated by the dust collector number, for compatibility of identification.

Additional resources were reviewed to confirm these release points and to identify release points not considered in the past (Voillequé 10 Oct 1990). Documents that were used to verify a stack as a point of release have been listed in Table B-1 as confirmatory references.

Monthly reports of estimated stack losses, prepared by the Health and Safety Division at the FMPC, have been obtained (NLCO 1959). The monthly stack loss reports from April 1955 through December 1959 have been reviewed to confirm the stack release point identifications. (Monthly stack loss reports are available for other years, but have not been systematically reviewed yet.) This monthly stack loss report survey confirmed 54 of the stacks had been sampled and had released uranium during this time period. References to the monthly stack loss reports have been added to Table B-1 where appropriate.

One stack in Plant 9, referred to as the "Rotoclone," was identified from the monthly stack loss reports, but was not listed in the FMPC-2082 report. Additional monthly stack loss reports, covering the period of January 1960 through February 1962, were examined for information about this stack (NLCO 1962). These reports indicated that the Rotoclone was sampled from April 1958 through July 1961 (NLCO 1959 and NLCO 1962). The monthly report of August 1961 indicated that the Rotoclone and two other dust collectors were removed from service due to construction. When construction was completed, sampling records are available for the two other dust collectors, but not for the Rotoclone. Additional research will be performed to try to verify the information about the Rotoclone, and to substantiate that it is different from the previously recognized dust collectors for Plant 9.

Other confirmatory data for release points are annual reports produced by the FMPC to comply with the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations. These NESHAPs reports, which describe annual air releases of radioactivity to the environment from FMPC operations, were requested from the manager of the Air and Water Compliance Department at FMPC at the time of our site visit in September.

Most of the release points listed in Table B-1 are specifically identified, and associated with a particular process. However this is not always the case. For example, specific dust collectors and scrubbers are not identified for the thorium releases described in the 1989 addendum to FMPC-2082. The report indicates the numbers of dust collectors and scrubbers involved in the thorium processes, but does not associate a particular stack by number with a particular process.

3.2.2 (Coordinate) Locations of Release Points

The FMPC-2082 report tabulated the stack release points by production plant (Boback et al. 1987). This was the extent of the location information provided in this report.

For this Task 1 of the Project, it was desired to visually verify and locate each of the existing stacks while onsite. During a two-day tour of the FMPC facility in 1989, 63 of 98 dust collectors were visually located, with the number varying from building to building. During the September 1990 site visit, many areas in the production plants had been designated zone 3 contaminated areas, to which access was limited. Thus it has been necessary to obtain location information from other resources.

Because the locations for all of the stack release points have not been determined exactly, the center of the plant that contains the stack will be used to represent the stack locations at this time. Table B-2, in Appendix B, presents the coordinate locations for the centers of the plants and the non-production stack release points. The coordinates are given in both latitude and longitude and in the Ohio state plane coordinate system. The latitude and longitude coordinates were scaled from figures in the FMPC-2082 report and the dose assessment report prepared by IT Corporation (Boback et al. 1987, IT 1989). The Ohio state plane coordinates were obtained by translating the latitude and longitude coordinates, using a computer program from the U.S. Geological Survey (USGS 1985).

For purposes of modeling the air releases, more precise locations of the stack release points may be required. Some tasks that may require precise location information include the modeling of the effects of building wakes on the atmospheric dispersion; modeling to obtain concentrations of radioactivity in media close to the production area, for validation with environmental monitoring data; and the modeling to estimate the concentrations of radioactivity to which people around the facility were exposed. If more precision in location information is deemed necessary, additional research will be performed to obtain the necessary data.

3.2.3 Heights of Release Points

The FMPC-2082 report provided stack height data for all of the dust collector and scrubber stacks included in that report (Boback et al. 1987). Resources found to verify these data include engineering drawings from the FMPC drafting section and aerial photographs from 1954, 1965 and 1987 (see section 2.5). Several engineering drawings have been obtained which include information about the stack heights. It should be noted that many of the drawings are plans for construction, and may not include the "as built" specifications.

Engineering drawing 02A-H-02633 (reference Table A-2, Appendix A) showed the installation plans for moving dust collector G5-252 from Plant 5 to Plant 2/3, after which the collector is referred to as G1-252. The mouth of the stack for this dust collector is shown to be at elevation 650 feet, for a height of 70 feet above the floor (floor at elevation 580 feet). The mouth of the stack is the opening of the stack to the air and would be the top of the stack if the rain caps were not in place. This height is essentially the same as the 72-foot height given in the FMPC-2082 report.

Engineering drawing 04A-H-00682 (reference Table A-2, Appendix A) was a diagram of stack locations for Plant 4. The elevations of the mouths of stacks G4-2 and G4-5 were shown to be about 688 feet. Drawing 04A-H-01498 (reference Table A-2, Appendix A) indicated that the floor elevation of Plant 4 was 580 feet. Thus the stack heights for these two stacks are about 98 feet. These heights are essentially the same as the 97-foot heights given in the FMPC-2082 report.

Engineering drawing 04A-H-01476 (reference Table A-2, Appendix A) showed the location of a new exhaust fan for dust collector G4-7. In addition, the stack mouth elevation was shown to be 682 feet. With a floor elevation of 580 feet, the stack height is about 102 feet. This value agrees reasonably well with the 97-foot height given in the FMPC-2082 report.

Engineering drawing 08X-H-02315 (reference Table A-2, Appendix A) was revised in 1969 for the planned removal of dust collector G43-44C in Plant 8. This drawing showed the elevation of the stack mouth to be about 629 feet. Drawings 08X-H-02312 and 08X-H-02313 (reference Table A-2, Appendix A) showed the first floor elevation of Plant 8 to be 580 feet. The stack height is thus about 49 feet. This height is slightly less than the 53-foot height given in the FMPC-2082 report.

Engineering drawings 08X-H-02312 and 08X-H-02313 (reference Table A-2, Appendix A) showed the planned installation of the scrubber serving the box furnace in Plant 8. The mouth of the scrubber stack is shown at an elevation about 624 feet, which is a few feet lower than the roof peak. The first floor elevation is shown to be 580 feet, so the stack height is about 44 feet. This height does not agree with the 53-foot height for this scrubber stack given in the FMPC-2082 report.

Engineering drawing 09X-H-00275 (reference Table A-2, Appendix A) was a diagram of stack locations for the construction of Plant 9. This drawing indicated the heights of the stack mouths to be 43 feet above the high point of the floor for all stacks shown. There were nine stacks shown, but the designations were by a stack number which does not correspond to a dust collector number. Each of the production plants has most of its stacks at only one or two different heights, according to the FMPC-2082 report. Thus, the stack height of 43 feet seems to confirm the height of 44 feet for the four Plant 9 dust collector stacks given in the FMPC-2082 report.

Engineering drawing 39X-G-00009 (reference Table A-2, Appendix A) showed a planned addition to the "old" solid waste incinerator (sewage treatment area), which included the replacement of the incinerator stack. This drawing, from April 1969, showed the existing stack to be 36 feet in height, and indicated the new stack to be of equal height. However, drawing 39X-M-00012 (reference Table A-2, Appendix A) shows the incinerator after the addition had been completed. This later drawing, first drawn in September 1972, shows the height of the "new" stack (by then the existing stack) to be 45 feet. The combination of these drawings indicates that the original stack had a height of 36 feet, while the replacement stack, added sometime between 1969 and 1972, had a height of 45 feet. The height of this release point was not given in the FMPC-2082 report.

Engineering drawing 02F-A-00957, also indexed as 39A-A-00054 (reference Table A-2, Appendix A), showed side elevations of building 39A, which, according to the FMPC-2082 report, contains the liquid organic waste incinerator and the "new" solid waste incinerator. This drawing shows the exhaust stacks, on the west and east sides of the building, to be 51 feet in height. Although the stacks were not specifically identified, they were the only exhaust stacks shown for this building, and are assumed to service the two incinerators.

Table B-3, in Appendix B, presents the compilation of stack heights from the FMPC-2082 report and from these drawings. From the small number of confirmatory references obtained, the stack heights appear to agree reasonably well with those of the FMPC-2082 report. It is not known at this stage how important the release heights will be to the accurate modeling of the dispersion of air releases from the FMPC. This question will be investigated in developing the source term estimates for Task 2 of the Project. If necessary, additional investigation and verification of the release heights will be performed.

3.2.4 Diameters and Flow Rates of Release Stacks

The FMPC-2082 report presents stack diameter and stack exhaust velocity information for the dust collector and scrubber stacks considered in that report (Boback et al. 1987). Stack traverse data sheets (STDSs) are used at the FMPC by the Industrial, Radiological Safety and Training Department to record measurements of stack exhaust velocities and to record calculated volumetric flow rates. The STDSs also include measurements of the stack diameter. The current log notebook of STDSs, covering measurements taken from August 1983 through April 1990, has been examined (WMCO 1990). The measured stack diameters and exhaust velocities are used here as a verification of the values presented in the FMPC-2082 report. A compilation of the data from the STDSs in the log notebook is included as Table B-4, in Appendix B (Voillequé 26 Sep 1990).

In addition to the STDSs, engineering drawings have been reviewed for information about stack diameters and flow rates. Section 2.5 discusses the searches of the engineering drawings at the FMPC. Ten engineering drawings were obtained that include confirmatory information on stack diameters. Table B-5, in Appendix B, presents the confirmed diameters and reference drawing numbers.

Table B-6, in Appendix B, presents the following stack data:

- stack diameters and exhaust velocities from the FMPC-2082 report;
- confirmed diameters, exhaust velocities, and volumetric flow rates compiled from the STDSs; and
- confirmed diameters obtained from engineering drawings.

The STDS log notebook that was examined included measurements from 1983 through 1990, although the majority of the measurements were made from 1984 through 1988. Many stacks had more than one sampling episode, up to a maximum of six during this time period. For Table B-6, values of stack diameter, exhaust velocity, and volume flow rate were averaged if more than one sampling episode occurred. In addition to these averaged values in the STDS column of Table B-6, the low and high values are given in parentheses if sampling was done more than once.

In a number of instances, the STDS measurements were performed for special flow testing, during which the flow rates apparently were varied. These data have been ignored for this report, because the operational flow rates were not noted, and we are not interested in flow rates used for testing.

It was not feasible to incorporate all of the data from the STDSs into the compilation given in Table B-6. For some measurement episodes, not enough information was given on the STDS for precise identification of the stack that had to be sampled. For other measurement episodes, sampling was performed in ducts that fed the actual exhaust duct and thus was not representative of the conditions in the exhaust stack. These data have not been used in Table B-6 to confirm data from the FMPC-2082 report.

For the G5-248 stack, the measured stack diameter changed from 16 inches in June 1987 to 30 to 32 inches in April 1990. This large change in diameter suggests that the duct work was probably changed sometime between these two sampling episodes. For this confirmation of previous data, the 1990 data for this stack have been ignored.

The individual measurements of stack diameters do show slight variation, but in all cases the averages of the measurements from the STDSs are within two inches of the value reported in the FMPC-2082 report. The small differences in measured values for a given stack can probably be attributed to different measuring techniques and different personnel making the measurements.

From the STDSs, the exhaust velocity and volume flow rate data vary considerably. For many stacks, the measurements are closely grouped, differing by less than ten percent. However, for other stacks, the velocity and flow rate measurements made in different years vary by factors of two and more.

In a number of cases, the exhaust velocities obtained from the STDSs were the same as the velocities given in the FMPC-2082 report, although some were based on a single measurement. This observation confirms the verbal references indicating that the STDSs were used for preparation of Table 1 of the FMPC-2082 report. However, it also indicates that the FMPC-2082 stack diameter and exhaust velocity data were based, in some cases, on a single measurement. Thus, the exhaust velocity data given in the FMPC-2082 report should only be considered representative of the time when the measurement was performed. For many of the stacks, the exhaust velocity measurements are varied enough that even an average value cannot be considered an adequate characterization of the stack's flow for long periods of time.

If it is considered necessary for purposes of the dispersion modeling, a more detailed assessment of the stack diameters and exhaust velocities will be performed. Discussions with FMPC personnel indicated that earlier STDSs (prior to the current log notebook) have been archived in the FMPC Central Files. Also, the FMPC drafting files are likely to contain additional engineering drawings that will provide more confirmatory stack diameter information.

3.2.5 Rain Caps

Historical information obtained from the FMPC-2082 report indicates that when originally installed, all stacks included conical rain caps (Boback et al. 1987). During a site visit, we located two engineering drawings, 08X-H-02312 and 08X-H-02313, which showed the planned installation of a new scrubber system for the box furnace in Plant 8 (FMPC 1968). Drawing 08X-H-02313 shows the stack for this new scrubber, but without a rain cap. The drawing does show an adjacent dust collector stack with a rain cap. Some evidence suggests that the Plant 2/3 and Plant 8 scrubber stacks may not have had rain caps (Schmidt 1990).

In another engineering drawing, 08X-H-02315, the Plant 8 dust collector G43-44C stack is drawn without a rain cap (FMPC 1969). This dust collector was on the southeast roof of Plant 8 with the stack adjacent to the dust collector and should be identified easily on aerial photos showing Plant 8. Historical aerial photographs of the site taken from the 1950s up to the present may provide help in locating rain caps on these stacks. The FMPC-2082 report also stated that there had been plans to remove the rain caps, so that stack discharges could be calculated with the computer program required for the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations. It is then stated that the removal plans were dropped, and that the rain caps were retained.

These rain caps would prevent momentum-based plume rise of stack emissions. Accordingly, with rain caps in place, the effective stack height for the atmospheric releases would be no greater than the physical height of the stack mouth in each case. The released stack gases would emanate from a circular area around the stack rather than from a point source at the stack mouth.

Another important effect of the rain caps may result from impingement of particulates on the underside of the caps. Reflection of particulates downward could result in an effective release height that is lower than the physical height. The probable importance of this effect will be investigated. If it is a significant factor in the atmospheric transport simulations, the existence of rain caps will be verified.

During the site visit to the FMPC, discussions were initiated with members of the maintenance staff regarding the existence of stack rain caps and plans to remove the caps (Moore 1990). Maintenance supervisors at the FMPC have confirmed that all stacks were originally fitted with rain caps. They have also provided additional details regarding the proposed replacements of stack rain caps. They stated that there was a management decision made during 1984 or 1985 to replace the original process stacks. The replacement stacks consisted of an inner duct to transmit process emissions to the atmosphere, and a concentric, outer duct extending above the inner duct. Momentum-based plume rise would not be inhibited by this newer type of stack, but rain protection would still be afforded by the outer duct. The decision to replace the stacks was made because the existing conditions, with rain caps, were believed not to fit the computer code mandated by the Environmental Protection Agency for the NESHAP calculations.

A knowledge of the specific process stacks which were replaced, along with replacement dates, is important for modeling atmospheric dispersion from 1985 to the present time. We located the Project Authorization #PA 00-85397, dated 9-4-85, for the rain cap removal project through a keyword search of the NLO database (NL0 1985). This document indicated that the existing deflector-type weather caps would be replaced with vertical discharge caps on stacks G4-2, G4-12, G4-14, G4-5, G5-249, G5-250, G5-251, G5-253, G5-260, and G5-261. Recently, we have located additional documentation at FMPC regarding the removal of stack rain caps in the mid eighties (Schmidt 1990).

On January 22, 1985, the Department of Energy, Oak Ridge Operations (DOE-ORO), asked NLO to study the impacts of removing existing rain caps and stated that rain caps were not acceptable for new stacks (Fayne 1985). Robert Weidner of NLO confirmed the DOE-ORO request with Vincent Fayne on January 24, 1985 (Weidner 1985). Boback and Nutter of NLO then sent an Idea Letter suggesting the replacement of the rain caps (Boback and Nutter 1985). Individuals from the Production Division, Engineering Divisions, and PA Review Committee exchanged ideas on the topic (Leist 1985; Nutter 1985).

The monthly rain cap project record, initiated in August 1985, shows that the Project Authorization was approved by NLO management on September 28, 1985, and that work on drawings and subcontract specifications proceeded in November and December 1985 (Berzins 1985). C.C. Gleason, the engineer assigned to the project in August 1985 (Gleason 1985), was replaced by A.O. Berzins in January 1986 (Berzins 1986). A subcontractor was to have performed the replacement work (FMPC 1985c), but by May 1986 the project was cancelled (Berzins 1985).

Since Gleason and Berzins are no longer at FMPC, L.W. Bunk, the designated construction supervisor for the project (FMPC 1985c), was contacted (Schmidt 1990). He did not recall the project being cancelled but did confirm that the work was originally planned to be performed by a subcontractor. Subsequently, it was decided to have the Maintenance Division at FMPC do the work.

The design of the new weather cap involved a duct extension to the stack with a diameter one inch greater than the stack, and with the resultant gap between the extension and the stack to remain open (FMPC 1983). The rain cap project files include six engineering drawings that had been revised in November 1985 to show the new rain caps installed on the ten designated stacks (FMPC 1985a; FMPC 1985b; FMPC 1988). These drawings, however, were not titled "as built" drawings, and thus it was still not certain that the work had been completed.

A maintenance job order was located in the FMPC Central Files for the installation of a new stack on the G4-4 dust collector with a "new style rain hood" (Pennix 1986). The job order did not specify removal of an existing rain cap. In addition, a "close out" date was given for the order but no "job started" or "job finished" dates were noted.

3.3 Other Release Points

3.3.1 Identification of Release Points

This section describes the other, non-stack release points of radioactivity to air. This "other" category generally includes area releases and groups of many point source releases, which will likely be modeled as area releases. These release points have been broadly described in the FMPC-2082 report and its Addenda (Boback et al. 1987; Dolan and Hill 1988; Clark et al. 1989).

These other release points include building exhausts, laboratory emissions, the K-65 storage silos, and fugitive dust emissions from the waste pits. The identified release points are shown in Table B-7, in Appendix B, along with the previous reference and confirmatory references.

The building exhausts are either passive or forced ventilation exhaust points for the building ventilation systems. These release points were identified, in general terms only, in the 1989 Addendum to the FMPC-2082 report (Clark et al. 1989). Additional information is contained in the backup letter report that served as a reference to the Addendum (Hill 13 Mar 1989). In most cases, the exhausts consist of various wall exhaust fans and roof ventilation fans. It is noted that the Addendum and its reference did not include building exhausts from Plant 7 as a release point. Although Plant 7 only operated for a short period in 1954 through 1956, it is assumed that it did have building exhausts which should be considered release points.

The laboratory emissions are exhausts from laboratory fume hoods in the Laboratory Building 15 and the Occupational Safety and Health Building 53. These release points were generally identified in the 1989 Addendum (Clark et al. 1989). Additional information is contained in the backup letter report that served as a reference to the Addendum (Hill 15 Mar 1989). The emission points included 55 hood vents in the Laboratory building and 7 hood vents in the Occupational Safety and Health building.

The K-65 storage silos are large concrete silos that have been used to store the K-65 residues, which are the waste residues from the processing of very high grade Belgian Congo uranium ores in the 1950s. These silos were identified in the FMPC-2082 report (Boback et al. 1987). Additional reference documents were reviewed, including an evaluation of radon emissions from the silos (Borak 1985) and a recent engineering evaluation for the Remedial Investigation and Feasibility Study for the silos (BNI 1990). These references indicate that historical ^{222}Rn releases from these silos occurred through diffusion of radon through the silo walls and roof, and through exchange of contaminated air from within the silos.

The six waste pits at the FMPC have been used for the disposal of waste materials containing radioactivity, and for the settling of waste solids, also containing radioactivity, from process waste water. The 1989 Addendum to the FMPC-2082 report identified the waste pits as sources of fugitive dust emissions to the air (Clark et al. 1989). Dust was released to the air during the loading of material into the waste pits and from wind erosion of the material stored in the pits. Additional information is contained in the backup letter report that served as a reference to the Addendum (Kispert 1988).

3.3.2 Physical Features of Release Points

The important physical features of these other air release points were not compiled in the previously recognized documents, the FMPC-2082 report and its Addenda (Boback et al. 1987; Dolan and Hill 1988; Clark et al. 1989). Some of these features, such as areas of release, flow rates (for exhausts and hood vents), exhaust air temperature, and heights of release are more complicated to describe than similar information for stacks. These data have not been collected at this time. If it is determined that this information is necessary for the dispersion modeling, it will be developed concurrently with the appropriate task of the Project.

The coordinate locations of the release points have been determined, based on the approximate center of the release point area or release point building. The coordinate locations of the building exhausts for the various buildings are assumed to be the same as those presented earlier, in Table B-2, in Appendix B, for the centers of the production plants.

Coordinates for the remaining release points are given in Table B-8, also in Appendix B. The coordinates are given in both latitude and longitude and in the Ohio state plane coordinate system. The latitude and longitude coordinates were scaled from figures in the FMPC-2082 report and the dose assessment report prepared by IT Corporation (Boback et al. 1987; IT 1989). The Ohio state plane coordinates were obtained by translating the latitude and longitude coordinates, using a computer program from the U.S. Geological Survey (USGS 1985).

3.4 Release Points Due to Accidents or Unusual Events

This section discusses the identification of points of accidental release of radionuclides to air. It is difficult to determine release points for unusual or accidental events until we have thoroughly investigated these occurrences for Task 2, Verification of Source Term Data. For accidental liquid releases, the surface water and groundwater points of release would be the same as those identified in Sections 4.0 and 5.0 of this report. For accidental atmospheric events that occurred inside the Plants, much of the released material would go out stacks and vents already tabulated in Sections 3.2.1 and 3.3.1.

RAC will continue to pursue the identification of unvented processes where accidental or unusual releases could have occurred. In addition, we will search the literature thoroughly for documents related to accidents and unusual occurrences in order to have as complete a record as possible of the major accidents and unusual events that released large quantities of materials. If additional atmospheric release points are discovered during our investigation of accidents for Task 2, then Task 1 will be modified at that time to include these points.

Table B-9, in Appendix B, presents accidental release events that were identified in FMPC documents (Boback et al. 1987; Clark et al. 1989; Vaaler and Nuhfer 1989). A major uranium hexafluoride (UF_6) release occurred in 1966 at the Pilot Plant, when a valve was inadvertently removed from a heated cylinder of UF_6 (Boback et al. 1987). The other accidental releases have been categorized as uranium fires, solid spills, other UF_6 leaks, and releases of uranyl nitrate (Clark et al. 1989; Vaaler and Nuhfer 1989).

3.5 Nearby Structures

The FMPC-2082 report presented only the dimensions and roof peak heights of the major plant buildings. For purposes of modeling building wake effects, it may be necessary to present similar information for all buildings on the plant for various time periods.

Historical aerial photos of FMPC are available for the years 1954, 1965, 1968, and 1987 and will be published in an addendum to this report. These photos show that major changes in building locations or sizes did not occur throughout this time period. In comparison with Plants 4 and 7, which are located toward the center of the site, Plants 5 and 9 are relatively low structures. Although Plant 7 was used actively only from 1954 through 1956, the structure has remained. The building for Plant 9 does not appear in 1954 photos but is present in 1965 and 1987 photographs. Uranium discharge data in FMPC-2082 are recorded for the first time in 1957 for Plant 9. Thus, it appears that the construction of this low building to the north of Plant 6 began after 1954 and was completed by 1957.

Topographic maps from 1988 of the production area show elevations for some of the building roofs, and will be useful in determining heights and dimensions of nearby structures for modeling purposes.

4.0 POINTS OF RELEASE TO SURFACE WATERS

4.1 Introduction

This section covers the identification of areas and points of release of radioactivity to surface waters around the FMPC. Surface water evaluation is included for completeness in order to reconstruct radiation doses to the general public living downstream from the FMPC.

As with other sections of this report, information gathered about surface water releases were obtained by interviewing consultants and staff at the FMPC. This effort was followed by reviewing the following key documents, which verify interviews:

- the FMPC-2082 report (Boback et al. 1987);
- an engineering evaluation for the Remedial Investigation and Feasibility Study for the South Plume (ASI/IT 1990);
- a report of a radiological characterization of soils on the FMPC site (Solow and Phoenix 1987); and
- a report of the investigation of above-background concentrations of uranium in groundwater (Dames and Moore 1985).

Finally, an observation of release points was conducted where applicable.

4.2 Surface Water Release Points

There are a few release points and areas that eventually can contribute to above background uranium concentrations in surface waters. These sources include

- surface water runoff over soils contaminated with uranium deposited from airborne effluents (Section 2.0);
- waters flowing into storm sewers and overflow waters which eventually enter Paddy's Run, carrying uranium contaminated sediments;
- sump waters from the plant production area;
- waters which flowed through the waste (pit) storage area;
- waters which originate in the fly ash and suspected waste disposal area; and

- waters that originate from the scrap metal pit area.

Above-background levels of uranium in surface waters and sediments can originate from the contaminated surface soils. These runoff waters eventually leave the FMPC via Paddy's Run as surface runoff or by storm sewers that empty through the main effluent line into the Great Miami River. During periods of high flow, excess water that overflows the storm sewer system eventually enters Paddy's Run in a natural drainage located in the southwest corner of the site.

Uranium leaves the FMPC production area by the main effluent line to the Miami River. Principal contributors to the source of above background uranium radioactivity include storm runoff, water from the general sump in the production area, and treated effluent from the sanitary sewage treatment plant. The main effluent line discharges at the bottom of the Great Miami River below the lowest recorded river water level.

Runoff through the waste storage area is a source of above-background uranium concentration. Most of the storm runoff waters from the area flow directly into Paddy's Run. In general, surface water runoff from the waste storage area and the fly ash piles, which are located along the western and southwestern sides of the FMPC, respectively, enters directly into Paddy's Run. Runoff waters that originate in the scrap metal pile, along the northern part of the production area, appear to be collected in the storm sewer system.

5.0 POINTS OF RELEASE TO GROUNDWATER

5.1 Introduction

This section identifies known releases to groundwater. For completeness, the Project requires assessing potential radiation doses through the groundwater pathway.

Assessment of groundwater pathways involved interviewing consultants and staff at the FMPC. This was followed by a thorough review of the following documents:

- The FMPC-2082 report;
- An engineering evaluation for the Remedial Investigation and Feasibility Study for the South Plume (ASI/IT 1990); and
- A report of the investigation of above-background concentrations of uranium in groundwater (Dames and Moore 1985).

5.2 Release Points To Groundwater

Off-site groundwater contamination was discovered in 1982 when the first off-site groundwater samples were analyzed. Since the discovery of off-site groundwater contamination, the above reports have indicated uranium has been transported towards the off-site wells by the following mechanisms:

- Runoff water from the plant production and waste storage area flowed through natural and man-made channels and into Paddy's Run, where it was diluted by upstream waters;
- Percolation of surface water through the permeable sand and gravel in the Paddy's Run channel forms the line source of above background uranium radioactivity in the groundwater south of the FMPC; and
- The north-south groundwater flow pattern led to the above background concentration in the three off-site wells.

Based on current mapping, groundwater studies have shown that the plume is expected to enter the Great Miami River just upstream of the Paddy's Run mouth and downstream of New Baltimore.

6.0 CONCLUSIONS

The Task 1 study has established the identity of the major release points to air and water. Our ongoing review of records and relevant documents, discussions with staff and former employees, and examination of drawings and photographs up to this time have confirmed the identity, physical features, and locations of release points tabulated previously in FMPC documents. In general, the study has found that the information provided in the FMPC-related documents and records is accurate. It is recognized, however, that there are minimal or missing data regarding some of the release points in the FMPC documents that must be uncovered and evaluated. We will continue to do this throughout the project. If other significant release points are identified during our research, Task 1 will be modified to include the new information.

In general, historic aerial photographs, engineering drawings, and review of records suggest that major structural changes to the process buildings or their locations have not occurred from the 1950s onward. Although Plant 7 was used actively only from 1954 through 1956, the structure has remained. The building for Plant 9 was not present in the early years of operation, but construction was completed by 1957.

No obvious or gross errors have been discovered up to this point in the identity and locations of stack release points listed in FMPC-related documents. Of 131 stack release points identified in this report, 59 have been confirmed in another reference. It is clear, however, that information is negligible or incomplete for some release points such as non-routine or accidental releases. Release points grouped together as Other Release Points in this report were only broadly described in the FMPC-2082 report and its addenda. Building exhausts from Plant 7 were not listed as release points, although the plant did operate from 1954 through 1956.

Physical features that may play an important role in source-term estimation are being verified. Stack heights from the engineering drawings of stack G1-252 (Plant 5), G4-2 and G4-5 (Plant 4), G4-7, G43-44C (Plant B), Plant 9 stacks, and exhaust stacks of building 39A, the liquid organic waste incinerator, agreed well with those given in the FMPC-2082 report. For a scrubber stack in Plant 8, there was a difference of 9 feet between the stack height given in FMPC-2082 and that taken from a drawing.

For stack diameters, individual measurements of stack diameter recorded in the Stack Traverse Data Sheets (STDSs) do show slight variation, but in all cases the averages of the measurements from the STDSs are within two inches of the value reported in the FMPC-2082 report. It appears that most major stacks were originally fitted with rain caps, although evidence suggests that Plant 2/3 and Plant 8 scrubber stacks may not have had them. By 1986, the existing deflector-type weather caps were to have been replaced with the vertical discharge caps on ten stacks.

The exhaust velocity and volume flow rate measurements taken from the STDSs from August 1983 through April 1990 vary considerably. For many stacks, the STDS data and the FMPC-2082 measurements differ by less than ten percent, although some were based on a single measurement. On the other hand, the exhaust velocity measurements vary by a factor of two or more for stacks G2-1 and G2-171 in Plant 1, G4-13 and G4-4 in Plant 4, the Mid ESP stack in Plant 6, and stack 735-13-7050 in the Pilot Plant. Therefore, for many of the stacks, the exhaust velocity given in the FMPC-2082 document cannot be considered an adequate characterization of the stack's flow rate for long periods of time.

Above-background levels of uranium in surface water, sediments, and groundwater in the FMPC area can originate from similar sources. These sources include surface water runoff over soils contaminated with uranium from airborne sources, from waters flowing into storm sewers and overflow waters that eventually enter Paddy's Run, sump water from the plant production area, and waters that flow through the waste pit storage and the scrap metal pit area. Uranium leaves the FMPC production area by the main effluent line and is discharged to the Great Miami River as a surface water release point. The known releases to groundwater result from runoff water from the plant production and waste storage area flowing into natural man-made channels and into Paddy's Run. Percolation of surface water through the permeable sand and gravel forms a line source of above-background uranium concentration in the groundwater south of the FMPC. Studies based on current mapping have shown that the groundwater plume is expected to enter the Great Miami River just upstream of the Paddy's Run mouth and downstream of New Baltimore.

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APPENDICES

APPENDIX A

This appendix contains additional details regarding the searches of FMPC engineering drawings performed. Table A-1 contains information on the keyword searches performed, the drawings obtained from the microfilm files, and whether the drawing was copied to paper for later use. Table A-2 provides complete reference information for the drawings that were copied for further use.

The drawing numbers used in this report are actually the drawing index codes, with the originator code deleted. Thus, a code such as 04A-H-01072 refers to plant and area 4A, classification H, and drawing number 1072. These shortened index codes are still unique identifiers.

Table A-1. Results of the Engineering Drawing Database Searches

		Potentially Useful Drawings	
Plant	Title Keyword Searched[a]	Drawing Index Code[b]	Disposition
2	..DUST..	02A-E-02623	Disregarded.
		02A-H-02633	Obtained copy.
		02A-H-03333	Disregarded.
		02A-M-02591	Disregarded.
		02G-M-01290	Not found.
2	..GULP..	02C-E-00846	Disregarded.
		02C-E-00847	Disregarded.
		02C-E-02539	Disregarded.
		02C-F-02393	Obtained copy.
		02C-F-02503	Disregarded.
		02C-M-01890	Not found.
		02C-N-00879	Disregarded.
		02C-P-00889	Disregarded.
2	..SCRUBBER..	02C-F-02393	Duplicate.
4	..HVAC..	none	
4	..HEAT..	04A-F-00417	Obtained copy.
		04A-F-00420	Obtained copy.
		04A-H-00416	Obtained copy.
		04A-H-00419	Obtained copy.
		04A-H-01072	Obtained copy.
		04A-H-01073	Disregarded.
		04X-H-00418	Obtained copy.
		04X-H-00421	Disregarded.
		04X-H-00422	Disregarded.
		04X-H-00423	Disregarded.
		04X-H-00424	Disregarded.
		04X-H-00425	Disregarded.
		04X-H-00426	Disregarded.
		04X-H-00427	Disregarded.
		04X-H-00428	Disregarded.
		04X-H-00429	Disregarded.
		04X-H-00430	Disregarded.
		04X-H-00431	Disregarded.
		04X-H-00432	Disregarded.
		04X-H-00433	Disregarded.

4	..STACK..	04A-H-00629	Not found.
		04A-H-00827	Not found.
		04A-H-00828	Not found.
		04A-H-00829	Not found.
		04A-H-01072	Duplicate.
		04A-H-01476	Obtained copy.
		04A-S-01345	Disregarded.
		04X-N-01908	Obtained copy.
		04X-P-01874	Obtained copy.
4	..EXHAUST..	04A-H-00657	Disregarded.
		04A-H-00658	Disregarded.
		04A-H-00681	Not found.
		04A-H-00682	Obtained copy.
		04A-H-00685	Disregarded.
		04A-H-00689	Obtained copy.
		04A-H-00690	Obtained copy.
		04A-H-00691	Obtained copy.
		04A-H-00820	Obtained copy.
		04A-H-01072	Duplicate.
		04A-S-00656	Disregarded.
		04A-S-00659	Disregarded.
		04X-H-01803	Not found.
4	..DUST..	04A-F-01496	Disregarded.
		04A-H-00657	Duplicate.
		04A-H-00658	Duplicate.
		04A-H-00691	Duplicate.
		04A-H-00976	Disregarded.
		04A-H-01497	Obtained copy.
		04A-H-01498	Obtained copy.
		04A-H-01524	Obtained copy.
		04A-H-01540	Obtained copy.
		04A-H-01541	Obtained copy.
		04A-H-01542	Obtained copy.
		04A-H-01543	Obtained copy.
		04A-S-00656	Duplicate.
		04A-S-00659	Duplicate.
		04H-M-02350	Not found.
		04H-M-02351	Not found.
		04H-M-02352	Not found.
		04H-M-02353	Not found.
		04H-M-02354	Not found.
		04H-M-02355	Not found.
		04H-M-02356	Not found.
		04H-M-02357	Not found.

		04H-M-02358	Not found.
		04H-M-02359	Not found.
		04H-M-02360	Not found.
		04H-M-02361	Not found.
		04H-M-02362	Not found.
		04X-F-00306	Disregarded.
		04X-F-00562	Obtained copy.
		04X-H-00418	Duplicate.
		04X-N-02231	Obtained copy.
4	..G4-2..	04A-H-00689	Duplicate.
4	..BAG..	04A-H-00970	Not found.
		04X-M-01778	Obtained copy.
		04X-M-01779	Obtained copy.
		04X-M-01780	Obtained copy.
		04X-M-01781	Obtained copy.
8	..SCRUBBER..	08X-H-02312	Obtained copy.
		08X-H-02313	Obtained copy.

a A keyword listed as "..dust.." indicates that "dust" had to be part of the keyword found.

b The index codes shown are shortened, using only the plant and area code, classification code, and drawing number.

Table A-2. Summary of Engineering Drawings Copied and Reviewed

Drawing Index Code[a]	Drawing Title	Drawing Date[b]	Comments
02A-H-02633	Plant 2, Digestion Area, Reduction of Airborne Dust, Relocated Dust Collector No. G-252, General Arrangement	03/30/73	Diagram and location for G-252 in plant 2.
02C-F-00826	Plant No. 3, Denitration, Fume Scrubbing System, Piping Diagram	03/22/55 06/20/55 07/20/55 12/09/55	Piping diagram.
02C-F-02393	Plant 2, Denitration Area, Process Piping Diagram, UO_3 Gulping System	12/09/67 04/19/69	UO3 gulping diagram.
02F-A-00957 39A-A-00054	(Raffinate Calciner Bldg.), Incinerator Bldg., Plans - Elevations	04/11/56 04/30/56 03/31/82 12/03/86	Stack height and location.
04A-H-00416 04A-F-00417	Engineering Flow Diagram, Heating & Ventilation, General Vacuum Cleaning System, Green Salt Plant	03/07/52 04/16/52	Duct flow diagram.
04A-H-00419 04A-F-00420	Engineering Flow Diagram, Heating & Ventilation, Vacuum Conveying System, Green Salt Plant	03/07/52 04/23/52 06/16-52	Duct flow diagram.
04A-H-00682	Green Salt Plant, Exhaust Ducts through Roof	06/23/52	Stack locations.
04A-H-00689	Local Exhaust Ducts to G4-2 & G4-5, Upper Plan Columns 7-8/B-C Elev 629'-6", Green Salt Plant 3004	02/27/53 03/18/53	Ductwork for dust collectors to stacks.

04A-H-00690	Green Salt Plant Bldg #3004, Exhaust Ducts - Unit G4-706 - Col's 4 to 5 & E to G - El. 619'-6" to 588'-6"	12/24/52 03/26/53	Ductwork.
04A-H-00691	Final Connections to Dust Collectors G4-3 & G4-7, Green Salt Plant - Bldg #3004	12/29/52 03/21/53	Dust collectors, ductwork, and stacks.
04A-H-00820	Changes in Pipe Sizes Required to Add G4-805 to Exhaust System G4-4 (Bldg. 3004)	12/05/52	Duct sizes.
04A-H-01072	Exhaust Stack, Dust Collectors G4-3 & G4-7	04/21/61	Stack with rain cap.
04A-H-01476	Plant 4, Reactor Area, Fluid Bed Conversion, Layout of New Fan & Stack for Collector G-4-7, Plans, Elevation, Sections & View	07/14/58 10/27/58	Fan and stack.
04A-H-01497 04A-F-01496	Plant 4, South End, Dust Collection Alterations, Flow Diagram	10/03/58 07/29/59	Dust collectors G4-2, G4-4, G4-5, G4-11, and new G4A-1.
04A-H-01498	Plant 4, South End, Dust Collection Alterations, Plans & Elevation	10/30/58	Dust collectors, ductwork, stacks.
04A-H-01524	Plant 4, Packaging Area, Dust Collection Alterations, Demolition of Existing Duct Work, Plans & Elevation	09/28/59	Ducts to be removed for changes.
04A-H-01540	Plant 4, Dust Collection Alterations, East Side Duct Work, Elevations	04/15/59	Changes related to collector G4-4.

04A-H-01541	Plant 4, Packaging Area, Dust Collection Alterations, West Side Duct Work, Plans	07/10/59 12/18/59	Changes related to collectors G4-2, G4-5, and new G4A-1.
04A-H-01542	Plant 4, Packaging Area, Dust Collection Alterations, West Side Duct Work, Plan & Sections	06/27/59	Changes related to collectors G4-2, G4-5, G4-11, and new G4A-1.
04A-H-01543	Plant 4, Packaging Area, Dust Collection Alterations, West Side Duct Work, Elevations	06/27/59	Changes related to collectors G4-2, G4-5, and new G4A-1.
04X-F-00434	Process Flow Diagram, Green Salt Plant, Sump Recovery System	07/24/52	Sump system for plant 4.
04X-F-00562	Process Flow Sheet, Green Salt Plant, Dust Collection System	02/19/51	Flow diagram, prior to construction.
04X-H-00418	Engineering Flow Diagram, Heating & Ventilation, Dust Control Process Heating & Ventilation, Green Salt Plant	04/16/52 08/06/52	Heating, exhausts, dust collectors.
04X-M-01778		07/26/57	Specification for filter bags.
04X-M-01779		unknown	Specification for filter bags, collectors G4-2 to G4-7.
04X-M-01780		07/22/57	Specification for filter bags, collector G4-11.
04X-M-01781		03/25/58	Specification for filter bags, Hoffman unit GS-5-247.

04X-N-01908 00X-N-01368	General Stack Sampler Assembly & Detail	01/11/83 01/23/85 06/08/85 06/27/87	Tubing, connections, filter holder, radiation detector.
04X-N-02231	Plant 4, Green Salt Plant, High Vacuum System, G4-2 & G4-14 Dust Collectors, Piping & Instrumentation Diagram	11/17/87	Schematic.
04X-N-02232	Plant 4, Green Salt Plant, High Vacuum System, G4-4 & G4-9 Dust Collector, Piping & Instrumentation Diagram	11/17/87	Schematic.
04X-P-01874	Plant 4, Packaging Area, Vacuum Pump for Stack Sampler for Dust Collectors, Piping (Typical), Plans, Elevations & Schematic	03/19/73 01/11-82	Vacuum pump and tubing for samplers.
08X-H-02307	Plant 8, Area C, Replacement of Box Furnace Dust Collector	11/22/68	Diagram of dust collector system.
08X-H-02312	Plant 8, Area C, Scrubber for Box Furnace, Plan	12/05/68	New scrubber installation.
08X-H-02313	Plant 8, Area C, Scrubber for Box Furnace, Sections "A-A" &"B-B"	12/05/68	New scrubber installation.
08X-H-02315	Plant 8, Crusher Area, Outside Crusher Dust Collector Replacement, Demolition Plans and Section	11/19/58 07/21/59 12/19/66 01/16/69	Location of dust collector G43-44C, stack, etc.

09X-H-00275	Location and Detail of Exhaust Stacks through Roof - New Material Feed Production Building #3542	11/04/52	Stack locations, heights, and diameters.
18X-X-00658	1985 Site Runoff Characterization Study	09/16/85	Text regarding runoff calculations.
25A-F-00033	Sewage Treatment Plant Expansion, Plot Plan	05/26/55 07/29/55 07/14/60	"As built" of expansion.
39X-E-00041	Bldg 39, Liquid Waste Incinerator, Conduit and Cable Layout	06/10/82	
39X-G-00009	Sewage Treatment Area, Incinerator, Modifications to Plant Incinerator	04/24/69	Proposed changes.
39X-M-00012	Incinerator Plan and Sections	09/21/72 09/28/76	Shows after modifications.
39X-S-00003 39X-S-00004	Foundation Plan, Details, Incinerator	02/18/54 10/15/54	Incinerator and its dock.
39X-X-00002	Preliminary Dwg., Incinerator	10/02/53	Location, cross-section of incinerator.
75X-G-00112	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 1 0f 17.
75X-G-00113	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 2 0f 17.
75X-G-00114	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 3 0f 17.
75X-G-00115	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 4 0f 17.

75X-G-00116	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 5 0f 17.
75X-G-00117	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 6 0f 17.
75X-G-00118	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 7 0f 17.
75X-G-00119	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 8 0f 17.
75X-G-00120	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 9 0f 17.
75X-G-00121	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 10 0f 17.
75X-G-00122	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 11 0f 17.
75X-G-00123	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 12 0f 17.
75X-G-00124	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 13 0f 17.
75X-G-00125	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 14 0f 17.
75X-G-00126	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 15 0f 17.

75X-G-00127	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 16 0f 17.
75X-G-00128	Fernald Facility, Department of Energy, Fernald, Ohio	12/04/88	Topography of site, 17 0f 17.

a The index codes shown are shortened, using only the plant and area code, classification code, and drawing number. When two index codes are listed, the drawing includes both index codes.

b Dates used are typically the "drawing date" listed, or, secondarily, an approval date. Multiple dates listed are for the original drawing and for subsequent revisions.

APPENDIX B

Release Point Information Tables

TABLE B-1. IDENTIFICATION OF STACK AIR RELEASE POINTS

STACK RELEASE POINTS, PLANT 1

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G2-1	UO3 packaging station	FMPC-2082	
G2-2	Titan mill drum dump	FMPC-2082	
G2-63		FMPC-2082	NLCO 1959
G2-64	Williams Titan mill	FMPC-2082	NLCO 1959
G2-67		FMPC-2082	NLCO 1959
G2-68	Sample preparation	FMPC-2082	NLCO 1959
G2-76	Bucket elevators, drum dumper, Titan mill packout	FMPC-2082	NLCO 1959
G2-77		FMPC-2082	NLCO 1959
G2-171		FMPC-2082	
G2-172	Sheathed auger, sample area	FMPC-2082	NLCO 1959
G2-174	Pulsaire dust collector, Zenith mill	FMPC-2082	NLCO 1959
G2-235	Hoffman hi-vac	FMPC-2082	
G2-6014	Shotblaster, drum reconditioning	FMPC-2082	
G2-6015	Copper shredder, drum reconditioning	FMPC-2082	
G2-6042	Fitz mill, pin cut, laboratory hoods	FMPC-2082	NLCO 1959

STACK RELEASE POINTS, PLANT 2/3

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G1-94	Digestion systems and ore handling	FMPC-2082	NLCO 1959
G1-252	dumper	FMPC-2082	
G1-754		FMPC-2082	NLCO 1959
G1-856	dumping station	FMPC-2082	NLCO 1959
3-N	UO3 packaging, north Buffalo dust collector	FMPC-2082	
3-S	UO3 packaging, south Buffalo dust collector	FMPC-2082	
UO3 Gulping Scrubber - North		Clark et al. 1989	Semones and Sverdrup 1988
UO3 Gulping Scrubber - South		Clark et al. 1989	Semones and Sverdrup 1988
N.A.R. Tower	"Unmonitored"	Clark et al. 1989	Hill 21 Mar 1989
Test Process	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989

STACK RELEASE POINTS, PLANT 4

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G4-1	UO3 and UF4 dumping station	FMPC-2082	
G4-2	West packaging station	FMPC-2082	NLCO 1959
G4-3	West bank H2 offgas burners	FMPC-2082	NLCO 1959
G4-4	Seal hopper, hopper stations, east side	FMPC-2082	NLCO 1959
G4-5	G4-11 Hoffman and surge hopper	FMPC-2082	NLCO 1959
G4-7	East bank H2 offgas burners	FMPC-2082	NLCO 1959
G4-8	East UF4 packaging station	FMPC-2082	
G4-12	number 3 packaging station	FMPC-2082	
G4-13	bank 8 packaging	FMPC-2082	
G4-14	number 1 packaging station	FMPC-2082	
G4-15	bank 7 packaging	FMPC-2082	
G4-7001		FMPC-2082	NLCO 1959
ThF4 Scrubbers	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
ThF4 Dust Collectors	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989

STACK RELEASE POINTS, PLANT 5

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G2-67	west breakout	FMPC-2082	
G5-247	west jolters	FMPC-2082	NLCO 1959
G5-248	east jolters	FMPC-2082	NLCO 1959
G5-249	number 4 "F" machine	FMPC-2082	NLCO 1959
G5-250	number 5 "F" machine and west capping station	FMPC-2082	NLCO 1959
G5-251	number 1 "F" machine	FMPC-2082	NLCO 1959
G5-252	number 2 "F" machine	FMPC-2082	NLCO 1959
G5-253	number 3 "F" machine and east capping station	FMPC-2082	NLCO 1959
G5-254	west derby breakout	FMPC-2082	NLCO 1959
G5-256	east derby breakout	FMPC-2082	NLCO 1959
G5-258	casting furnaces and cover cleaners	FMPC-2082	NLCO 1959
G5-259	west burnout	FMPC-2082	NLCO 1959
G5-260	casting furnaces	FMPC-2082	NLCO 1959
G5-261	east burnout and east separation booth	FMPC-2082	NLCO 1959
G5-262	graphite machine shop	FMPC-2082	
G5A-100	west separation booth	FMPC-2082	
G5A-101	east derby breakout	FMPC-2082	
G55-E-100	Building 55. MgF2 slag	FMPC-2082	NLCO 1959

STACK RELEASE POINTS, PLANT 6

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G6-86	straighteners and cooling bed	FMPC-2082	NLCO 1959
G6-88	straighteners and cooling bed	FMPC-2082	NLCO 1959
G6-6057	drill, lathes	FMPC-2082	NLCO 1959
North ESP	north electrostatic precipitator. machining	FMPC-2082	NLCO 1959
Mid ESP	middle electrostatic precipitator. machining	FMPC-2082	
South ESP	south electrostatic precipitator. machining	FMPC-2082	NLCO 1959
Plant 6 Briquetting	"Unmonitored"	Clark et al. 1989	Hill 21 Mar 1989
Plant 6 Pickling	"Unmonitored"	Clark et al. 1989	Hill 21 Mar 1989

STACK RELEASE POINTS, PLANT 7

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G4-2507		FMPC-2082	NLCO 1959
G4-2508		FMPC-2082	NLCO 1959
G4-2509		FMPC-2082	NLCO 1959
G4-2510		FMPC-2082	NLCO 1959

STACK RELEASE POINTS, PLANT 8

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G3A-2		FMPC-2082	
G8-1		FMPC-2082	
G8-2		FMPC-2082	
G8-3		FMPC-2082	
G8-4		FMPC-2082	
G8-7	number 2 oxidation furnace	FMPC-2082	
G8N1-1000		FMPC-2082	
G43-27	kiln and calciner	FMPC-2082	NLCO 1959
G43-29	Rotex	FMPC-2082	NLCO 1959
G43-44C		FMPC-2082	
6018		FMPC-2082	NLCO 1959
6019		FMPC-2082	NLCO 1959
8002		FMPC-2082	
8021	muffle furnace dumping station	FMPC-2082	NLCO 1959
8024	muffle furnace dumping station	FMPC-2082	NLCO 1959
8035	number 1 oxidation furnace	FMPC-2082	NLCO 1959
8057	digester dumping station	FMPC-2082	NLCO 1959
8083	leach tank	FMPC-2082	NLCO 1959
8102		FMPC-2082	NLCO 1959

STACK RELEASE POINTS, PLANT 8

Release Point Designation	Description	Previous Reference	Confirmatory Reference
Rotary kiln scrubber		FMPC-2082	
Number 1 oxid furnace scrubber		FMPC-2082	
Number 2 oxid furnace scrubber		FMPC-2082	
Box furnace scrubber		FMPC-2082	
Muffle furnace scrubber		FMPC-2082	
Hydroxide Scrubber	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Hydroxide Dust Collector	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Oxalate Scrubbers	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Oxalate Dust Collectors	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989

STACK RELEASE POINTS, PLANT 9

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G9N1-1039	NPR casting: burnout, separation booth	FMPC-2082	
G9E2-400	machining	FMPC-2082	
G42-615	Reduction: jolters, "F" machine, breakout	FMPC-2082	NLCO 1959
G42A-100	I & E casting: burnout, separation booth	FMPC-2082	
Rotoclone		Not previously considered	NLCO 1959, NLCO 1962
Plant 9 Briquetting	"Unmonitored"	Clark et al. 1989	Hill 21 Mar 1989
Plant 9 Pickling	"Unmonitored"	Clark et al. 1989	Hill 21 Mar 1989
Metal Scrubbers	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Metal Dust Collectors	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Briquetting Scrubbers	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Briquetting Dust Collectors	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989

STACK RELEASE POINTS, PILOT PLANT

Release Point Designation	Description	Previous Reference	Confirmatory Reference
G-1	6 to 4 packaging	FMPC-2082	
G-2	6 to 4 packaging	FMPC-2082	
G20-20	3620 area, UF6 to UF4 reactor	FMPC-2082	NLCO 1959
G6-93A		FMPC-2082	
G37-5011	3037 area, metals	FMPC-2082	NLCO 1959
735-13-7041	annex equipment	FMPC-2082	
735-13-7050	Rotoblast	FMPC-2082	
108843	wet area equipment	FMPC-2082	
Oxidation furnace		FMPC-2082	
Burnout		FMPC-2082	
Hoffman		FMPC-2082	
Boildown		FMPC-2082	
Chip furnace		FMPC-2082	
Extraction Process	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Gel Scrubbers	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Gel Dust Collector	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
TNT Crystals Scrubber	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Metal Scrubbers	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Metal Dust Collectors	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989

STACK RELEASE POINTS, PILOT PLANT

Release Point Designation	Description	Previous Reference	Confirmatory Reference
Oxalate Scrubber	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989
Oxalate Dust Collector	Thorium emission point	Clark et al. 1989	Hill 8 Mar 1989

STACK RELEASE POINTS, NON-PRODUCTION

Release Point Designation	Description	Previous Reference	Confirmatory Reference
Graphite Burner		FMPC-2082	
Oil Burner		FMPC-2082	
Old solid Waste Incinerator	in sewage treatment plant area	FMPC-2082	
New Solid Waste Incinerator		FMPC-2082	
Liquid Organic Incinerator		FMPC-2082	
Cooling Towers	"Unmonitored"	Clark et al. 1989	Hill 21 Mar 1989

Table B-2. Approximate Centers of Production Plant and Non-Production Points of Stack Releases to Air.

Release Points	North Latitude	West Longitude	Ohio State Plane Coordinates (ft) East	Ohio State Plane Coordinates (ft) North
Plant 1	39°18'5"	84°41'27"	1380080	481500
Plant 2/3	39°18'1"	84°41'24"	1380310	481090
Plant 4	39°17'59"	84°41'16"	1380930	480870
Plant 5	39°18'0"	84°41'13"	1381170	480960
Plant 6	39°18'0"	84°41'8"	1381570	480960
Plant 7	39°17'58"	84°41'17"	1380850	480770
Plant 8	39°17'58"	84°41'23"	1380380	480780
Plant 9	39°18'5"	84°41'8"	1381580	481460
Pilot Plant	39°17'55"	84°41'28"	1379980	480490
Old Incinerator	39°17'59"	84°40'50"	1382980	480820
Graphite Burner	39°18'11"	84°41'15"	1381040	482080
Oil Burner	39°18'11"	84°41'15"	1381040	482080
New Incinerator	39°18'0"	84°41'25"	1380230	480990
Liquid Incinerator	39°18'0"	84°41'25"	1380230	480990

TABLE B-3. RELEASE HEIGHTS OF STACK AIR RELEASE POINTS

RELEASE HEIGHTS, PLANT 1

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G2-1	10		
G2-2	67		
G2-63	67		
G2-64	67		
G2-67	67		
G2-68	67		
G2-76	67		
G2-77	67		
G2-171	65		
G2-172	40		
G2-174	65		
G2-235	67		
G2-6014	25		
G2-6015	25		
G2-6042	67		

RELEASE HEIGHTS, PLANT 2/3

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G1-94	72		
G1-252	72	70	02A-H-02633
G1-754	72		
G1-856	72		
3-N	72		
3-S	72		
UO3 Gulping Scrubber - North			
UO3 Gulping Scrubber - South			
N.A.R. Tower			
Test Process			

RELEASE HEIGHTS, PLANT 4

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G4-1	97		
G4-2	97	98	04A-H-00682, 04A-H-01498
G4-3	97		
G4-4	97		
G4-5	97	98	04A-H-00682, 04A-H-01498
G4-7	97	102	04A-H-01476, 04A-H-01498
G4-8	97		
G4-12	97		
G4-13	97		
G4-14	105		
G4-15	97		
G4-7001	97		
ThF4 Scrubbers			
ThF4 Dust Collectors			

RELEASE HEIGHTS, PLANT 5

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G2-67	48		
G5-247	57		
G5-248	57		
G5-249	57		
G5-250	57		
G5-251	57		
G5-252	57		
G5-253	57		
G5-254	57		
G5-256	57		
G5-258	57		
G5-259	57		
G5-260	57		
G5-261	57		
G5-262	57		
G5A-100	57		
G5A-101	52		
G55-E-100	62		

RELEASE HEIGHTS, PLANT 6

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G6-86	53		
G6-88	53		
G6-6057	53		
North ESP	25		
Mid ESP	25		
South ESP	25		
Plant 6 Briquetting			
Plant 6 Pickling			

RELEASE HEIGHTS, PLANT 7

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G4-2507	120		
G4-2508	120		
G4-2509	120		
G4-2510	120		

RELEASE HEIGHTS, PLANT 8

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G3A-2	55		
G8-1	53		
G8-2	53		
G8-3	53		
G8-4	53		
G8-7	45		
G8N1-1000	53		
G43-27	45		
G43-29	45		
G43-44C	53	49	08X-H-02315
6018	53		
6019	53		
8002	53		
8021	45		
8024	45		
8035	45		
8057	53		
8083	53		
8102	53		

RELEASE HEIGHTS, PLANT 8

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
Rotary kiln scrubber	53		
Number 1 oxid furnace scrubber	53		
Number 2 oxid furnace scrubber	53		
Box furnace scrubber	53	44	08X-H-02312, 08X-H-02313
Muffle furnace scrubber	53		
Hydroxide Scrubber			
Hydroxide Dust Collector			
Oxalate Scrubbers			
Oxalate Dust Collectors			

RELEASE HEIGHTS, PLANT 9

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G9N1-1039	44	43	09X-H-00275
G9E2-400	44	43	09X-H-00275
G42-615	44	43	09X-H-00275
G42A-100	44	43	09X-H-00275
Rotoclone			
Plant 9 Briquetting			
Plant 9 Pickling			
Metal Scrubbers			
Metal Dust Collectors			
Briquetting Scrubbers			
Briquetting Dust Collectors			

RELEASE HEIGHTS, PILOT PLANT

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
G-1	50		
G-2	50		
G20-20	52		
G6-93A	52		
G37-5011	52		
735-13-7041	52		
735-13-7050	52		
108843	52		
Oxidation furnace	52		
Burnout			
Hoffman			
Boildown			
Chip furnace			
Extraction Process			
Gel Scrubbers			
Gel Dust Collector			
TNT Crystals Scrubber			
Metal Scrubbers			

RELEASE HEIGHTS, PILOT PLANT

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
Metal Dust Collectors			
Oxalate Scrubber			
Oxalate Dust Collector			

RELEASE HEIGHTS, NON-PRODUCTION

Release Point Designation	Stack Height from FMPC-2082 (feet)	Confirmed Height (feet)	Confirmatory Reference
Graphite Burner			
Oil Burner			
Old solid Waste Incinerator		45	39X-M-00012
New Solid Waste Incinerator		51	39A-A-00054
Liquid Organic Incinerator		51	39A-A-00054
Cooling Towers			

Table B-4
STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
1	G2-235	6	0.196	10-17-85	1506	296	0.49	17
				10-24-85	1475		0.50	16
				8-27-87	1874	368	0.55	19
				11-7-89	1726	338.7	0.50	19.3
	G2-6014	14 x 15	1.458	10-31-85	2648	3582	3.80	28
				8-27-87	2134	3111	4.09	22
				11-7-89	2660	3879	3.95	27.5
					2596	3789		
	G2-172	18	1.767	10-24-85	2858	5051	4.71	30
				11-7-89	2532	4456	2.99	42.3
	G2-64	24	3.142	10-24-85	2448			21
				8-27-87	2005	6299	12.3	14.5
	G2-76	24	3.142	10-24-85	1308			
				8-27-87	1725	5419	9.10	16.9
	G2-6015W	18 x 14	1.750	10-31-85	4469	2716	4.77	46
	SLY	10	0.545	10-17-85	4481	2444	1.5	46
	G2-2 (Draco)	14	1.069	11-1-85	2651	2834	3.2	25
	G2-171	12	0.785	1-14-86	1534	1205	2.3	15
	G2-1 (Micropulsair)	8	0.349	1-14-86	5823	2033	1.02	56.6
	G2-6042	10	0.545	8-27-87	2778	1515	1.51	28
				9-2-88	3414	1862		

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
2/3	Feed Line for NAR Stack	8	0.349	5-25-89	4079 4099 4143	1423 1431 1446		
	Denitration	12	0.785	7-11-88	1612	1266	SP:VC 0.008, VO 0.016	
	Pot Scrubber			7-12-88	1683	1322	SP: VC 6.9, VO 5.3	
	G1-94	16	1.396	3-26-86	3387	4729	3.61	37
	G1-856	17	1.576	3-26-86	1971	3106	4.30	20
	North Buffalo	20	2.182	10-16-85	2202	4805	5.88	23
	South Buffalo	20	2.182	10-16-85	2059	4493	6.24	20

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
4	G4-5	11	0.660	3-5-84	2824	1864		
				3-5-84	2823	1863		
				10-17-85	2697		1.73	29
				11-7-89	2906		1.74	31.2
	G4-14	22	2.640	3-5-84	1322			
		24	3.142	10-11-85	1413		9.41	13
				8-6-87	1518		9.33	14
	G4-2	18	1.767	3-5-84	3926			
				10-11-85	3280		6.09	33
				2-12-86	3384		5.46	38
				2-3-88	3563		4.24	38
	G4-1	10	0.545	10-17-85	2994		1.50	31
		11	0.660	10-7-86	2220			
	G4-15 (New North)	10	0.545	8-19-83	2456	1085		24
					2411	1065		
	G4-13	8	0.349	11-6-85	2275		1.03	22
	G4-4	12	0.785	11-6-85	2968		2.20	30
	G4-12	12	0.785	10-11-85	3470		2.63	29
	G4-7	27	3.976	2-5-86	1342		11.30	12.9
	Talcum Rx Cooling Vent	27	3.976	5-22-86 Sampler Installed	1237		3.69	14

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
5	G2-67	24	3.142	10-16-85	3473	10912	10.32	30
				5-8-86	3720	11687	9.81	33.8
					3735	11734(CL V-bar=3503 fpm)		
	G5-101	22	2.640	10-22-85	2253	5948	7.47	23
	G5A-101	22	2.640	8-12-87	3073	8111	7.10	32
	G5-247	16	1.396	10-15-85	3377	4715	3.74	36
				8-12-87	3311	4622	3.83	34
	G5-248	16	1.396	10-15-85	4340	6058	3.49	49
				6-4-87	4333	6050	3.72	46
		30	4.909	4-2-90	1112	5457	(Top, by sampler)	
		32	5.585	4-2-90	1019	5690	(Top, by sampler)	
	(Above fan, 15')	31	5.241	4-4-90	2140	11214	16.77	18.94
	G5-249	23	2.885	3-6-84	2829	8162		
		24	3.142	10-15-85	2622	8239	8.39	28
		23	2.885	6-10-87	3036	8760	8.15	30.4
	G5-250	24	3.142	10-14-85	3631	11409	9.07	36
				6-10-87	3667	11520	9.74	33.5
	G5-251	24	3.142	10-15-85	2864	8998	9.96	26
				10-4-88	2354	7397	(At inlet to fan)	
					2776	8721	(At inlet to fan)	
				9-27-88	3618	11367	9.08	35.4
	G5-253	24	3.142	10-15-85	3229	10144	9.03	32
				9-27-88	4147	13028	8.56	43.1
	Replacement Dust Collectors for G5-251 and G5-253, Exhaust Flow Comparisons							
		34	6.305	8-19-88	3562	22458	Kurz M F	25500
					2958	18651	Kurz M F	21700
					1807	11395	Kurz M F	11500
	G5-254	22	2.640	10-16-85	3153	8323	7.41	32
		24	3.142	10-4-88	3171	9962	(At inlet to fan)	
					2904	9124	(At inlet to fan)	
				8-6-87	3384	8933	7.51	34

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
5	G5-256	22	2.640	10-16-85	3132	8268	7.06	33
	G5-260	22	2.640	3-6-84	2264	5977		
				10-16-85	1886	4979	6.89	20
				3-20-89	2104	5554		
	G5-261	30	4.909	3-6-84	4110	20176		
				10-10-85	3968	19476	13.96	39
				3-6-86	4238	20806 (Measurements for		
					4182	20529 design of isokinetic		
					4139	20318 sampling rack)		
					4177	20504		
				5-7-86	3663	17982	14.26	35.4
					3594	17643(CL V-bar=3664 fpm)		
				6-4-87	3530	17329	13.85	35
				3-20-89	4500	22089		
	G5-262	22	2.640	5-17-84	1543		5.19	21
	(Before Installing Sampler)				1470		(based on mean?)	
				10-20-85	1779	4697	7.69	17
		23	2.885	6-4-87	2441	7042	7.22	28
		24	3.142	6-29-88	2350	7383 (DC & high vac on)		
		24	3.142	6-30-88	2332	7327 (DC operating)		
					2476	7780 (DC high vac.)		
	G5A-100,SLY	30	4.909	10-20-85	2654	13028	12.12	30
				5-8-86	2012	9877	11.01	24.3
					1842	9042(CL V-bar=2520 fpm)		
				7-9-87	2996	14706	13.26	31
	G5-267	24	3.142	7-9-87	3507	11020	9.38	33
	Reduction Pot Cooling Exhaust Stacks–Selection of Sampling Points						**VBAR (fpm)**	
	East	28	4.276	1-7-88	3244	13885	3560	34.4
	West	28	4.276	1-7-88	2937	12572	3254	31.4

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
5	"F" Machine Ventilation Exhaust Ducts							
	#1 Bottom	13	0.922	5-7-86	3751	3458		
	#3 Bottom	13	0.922	5-7-86	4153	3828		
	#4 Bottom	13	0.922	5-7-86	3568	3289		
	#5 Bottom	13	0.922	5-7-86	3344	3082		
	East Cooling Booth Exhaust Stack							
		18	1.767	3-31-86	3450	6096		
		17.5	1.670	5-6-86	3217	5373	Dwyer Incline Manom	
		17.5	1.670	5-6-86	3190	5328	Alnor Electro-Manom	
		17.5	1.670	5-6-86	3209	5360	Alnor Electro-Manom	
	Graphite Breakup Booth Exhaust, Maint. Shop Roof							
		22	2.640	7-7-88	6599	17421		
					6579	17369		
				1-18-89	6279	16577	8.20	57.2
	East Mold Cooling Booth Exhaust Stack							
		18	1.767	1-18-89	3108	5492	4.74	32.8
	Exhaust from Bin 4 in Building 55							
		3.5	0.067	3-20-89	2498	167		
				3-31-89	5098	341		
	Building 55 Hoffman							
		6	0.196	2-6-85	9257	2314		
	"Plant 55"	13	0.922	11-6-85	2371	2186		
	Building 55 Replacement Dust Collector Stack Exhaust, Flow Rate Comparisons							
		18	1.767	8-18-88	1451	2564	Kurz M F	3030
					1225	2165	Kurz M F	2500
					2838	5014	Kurz M F	6200
			NW above hnycomb		2702	4774	Kurz M F	6200
			SW above hnycomb		2710	4788	Kurz M F	6200
		18	1.767	10-4-88	3134	5537	South Port	
					3047	5384	North Port	

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
5	G55E-100	12	0.785	1-28-87	2718	2134		
				8-6-87	2774	2178	2.13	29
	G55E-100 Replacement Dust Collector Exhaust, Fan at 60%							
		18	1.767	9-27-88	2783	4918	4.90	28.4

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
6	**Tool Room Tool Grinders**							
		19	1.969	6-28-84	2900	5710		
	Tool Room Cyclone Collector							
		20	2.182	10-14-87	3091	6744	6.33	30
	North ESP Exhaust							
		46	11.541	7-9-87	2254	16011	32.68	23
	South ESP Exhaust							
		46	11.541	6-10-87	2697	31126	32.20	26
	Middle ESP Exhaust							
		32	5.585	2-3-86	3508	19592	16.04	33.8
	G6-6057	47	12.048	10-25-85	2053		33.17	21
	Slug Cleaning Line							
		24	3.142	6-5-84	1391	4371		
	Trench	20	2.182	6-5-84	1217	2654		
	Middle Stack							
	Slug Dry S	10	0.545	6-5-84	2598	1417		
	Slug Dry N	10	0.545	6-5-84	2748	1499		
	Chip Pickling Scrubber							
		11.75	0.753	6-5-84	3746	2479		
					3732	2463		

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
8	G8-7	11	0.660	6-10-85	3134	2069	1.92	30
					3119	2058		
	G43-27	28	4.276	10-16-85	3432	14675	11.36	37
				1-24-86	1923	8223	11.38	21
				4-15-87	2733	11688	12.28	27
					2787	11920		
		30	4.909	3-22-89	1315	6454	11.82	15
	G43-29	16	1.396	10-28-85	2289	3195	4.01	23
				1-30-89	2410	3364	3.80	25
	8038	13	0.922	10-23-85	4416	4070	2.66	43
				1-24-86	3703		2.24	37
				4-15-87	1907	1758	2.57	19.5
					1938	1786		
	8057	14	1.069	11-1-85	3848	4114	3.14	37
	Drum Washing Station							
		24	3.142	6-14-89	974	3061		
	Caustic Exhauster for Primary Calciner							
		14	1.069	10-29-85	2552		2.95	
				4-11-89	1540?	Correction Factor=0.85; mult/div?		
	Scrubber Exhaust for Oxidation Furnace #1							
		10	0.545	5-9-84	809	Plugged Possibly		
					1069			
					1179			
				5-10-84	690			
					1265			
					1089			
				7-14-89	1596	870		
					1599	872		
	Scrubber Exhaust for Oxidation Furnace #2							
		12	0.785	5-15-84	2796			
	Scrubber Exhaust for Kiln							
		12	0.785	5-15-84	2720			

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
9	G9E2-400	46	11.541	8-29-85	2140	24696	34.28	21
				2-3-86	1856			
			ESP	5-6-86	2291	26440	38.91	19.2
					2293	26463		
	Hoffman G42A-100	5.5	0.165	1-31-86	4735	781		
	G9-1015	34	6.305	3-11-87	3444	21714		
		Velocity Profile for DOP Testing			3207	20220		
		32	5.585	3-11-87	3980	22228	Air Monitor Reading	
					3954	22083	22800–23100	
	G9N1-1039	36	7.069	10-13-85	3107	21965	19.70	
		29	4.587	12-2-85	4185	19198	11.88	45
		36	7.069	3-19-86	2807	19845	18.20	31
	G9-1039	32	5.585	12-16-86	5532	31000		
					5575	31100		
	Feeders to G9N1-1039							
	#16	14	1.069	10-20-88	3272	3497		
	#18	5	0.136	10-20-88	7731	1055		
	#21	7	0.267	10-20-88	5148	1376		
	#23A	20	2.182	10-20-88	4430	9666		
	#9	14	1.069	10-20-88	3511	3753		
	#11	14	1.069	10-20-88	3312	3540		
	#12	14	1.069	10-20-88	3415	3650		
	#14	14	1.069	10-20-88	3184	3404		
	#4	20	2.182	10-20-88	2699	5889		
	#5	20	2.182	10-20-88	2825	6164		
	#6	20	2.182	10-20-88	2804	6119		
	#7	20	2.182	10-20-88	2824	6162		
	#1	32	5.585	10-20-88	4185	23371		
	#3	34	6.305	10-20-88				
	#17	28	4.276	10-20-88	5446	23285		
	#19	27	3.976	10-20-88	5330	21193		
	#23B	18	1.767	10-20-88	5294	9354		
	#24	8	0.349	10-20-88	883	308		
	#25	6	0.196	10-20-88	954	187		
	#26	6	0.196	10-20-88	1139	224		

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
9	Feeders to G9N1-1039							
	#20	8	0.349	10-20-88	8011	2797		
	#27	6	0.196	10-20-88	6010	1180		
	#28	6	0.196	10-20-88	9495	1865		
	#29	5	0.136	10-20-88	8282	1130		
	#30	14	1.069	10-20-88	8048	8604		
	#31	8	0.349	10-20-88	6357	2219		
	#32	6	0.196	10-20-88	3605	708		
	#33	9	0.442	10-20-88	7815	3453		
	G-09-0015	34	6.305	4-14-87	3666	23117	18.56	36
					3604	22725		

STDS Diameter and Flow Velocity Data

Plant	Stack Identification	Internal Diameter of Duct (in)	Area (ft^2)	Testing Date	Meas. Mean Velocity (ft/min)	Meas. Flow Rate (ft^3/min)	Stack Factor (kg/g)	Stack Sampler Flow Rate (L/min)
Pilot	735-13-7051	34	6.305	3-27-89	778	4902	17.95	8
	7041	24	3.142	3-22-89	1819	5710	9.35	17.55
	G-1	12	0.785	8-12-87	2301	1807	2.12	24
	G-2	12	0.785	8-12-87	2007	1577	2.11	21
	7050	34	6.305	10-29-85	2807	17698	18.33	27
	DC-1	12	0.785	8-11-84	3149	2474		
	Set Up Continuous Stack Sampler			8-11-84	3095	2431		
				10-11-85	2567	2016	2.18	26
	DC-2	12	0.785	10-4-84	2636	2070	2.46	24
				10-11-85	2675	2101	2.38	25

Table B-5. Engineering Drawings Used to Confirm Stack Diameters.

Stack Designation	Diameter (in)	Reference Drawing[a]
G1-252	23	02A-H-02633
G4-2	20	04A-H-00689
G4-3	28	04A-H-00691
	28	04A-H-01072
G4-4	12	04X-N-02232
G4-5	11	04A-H-00689
G4-7	28	04A-H-01072
	28	04A-H-01476
G4-14	24	04X-N-02231
G8N1-1000	18	08X-H-02307
Old Solid Waste Incinerator	26x70[b]	39X-M-00012
Liquid Organic Waste Incinerator	24	02F-A-00957
New Solid Waste Incinerator	24	02F-A-00957

a The full references are given in Table A-2, Appendix A.

b This stack is oval shaped, with short and long axis dimensions as listed.

TABLE B-6. DIAMETERS AND FLOW VELOCITIES OF STACK AIR RELEASE POINTS

DIAMETERS AND FLOW VELOCITIES, PLANT 1

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G2-1	8	8		1600	5823	2033
G2-2	14	14		2651	2651	2834
G2-63	24			1910		
G2-64	24	24		2448	2226 (2005-2448)	6299
G2-67	24			2610		
G2-68	18			3221		
G2-76	24	24		1308	1516 (1308-1725)	5419
G2-77	18x22			1018		
G2-171	10	12		4884	1534	1205
G2-172	18	18		2858	2695 (2532-2858)	4754
G2-174	8			5730		
G2-235	6	6		1475	1645 (1475-1874)	334
G2-6014	14x15	14x15		2648	2470 (2134-2660)	3509
G2-6015	19x15	18x14		4469	4469	2716 *
G2-6042	10	10		4481	3558 (2778-4481)	1940

* The value shown is from the data sheet. This value does not correspond to what we calculate from the measured stack diameter and the measured exhaust velocity

DIAMETERS AND FLOW VELOCITIES, PLANT 2/3

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G1-94	16	16		2078	3387	4729
G1-252	23		23	3118		
G1-754	17			3938		
G1-856	17	17		2855	1971	3106
3-N	20	20		2202	2202	4805
3-S	20	20		2059	2059	4493
UO3 Gulping Scrubber - North						
UO3 Gulping Scrubber - South						
N.A.R. Tower						
Test Process						

DIAMETERS AND FLOW VELOCITIES, PLANT 4

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G4-1	10	10		2994	2607 (2220-2994)	
G4-2	20	18	20	3280	3538 (3280-3926)	
G4-3	28		28	2590		
G4-4	12	12	12	908	2968	
G4-5	11	11	11	2697	2809 (2697-2906)	1864
G4-7	28	27	28	935	1342	
G4-8	21			3100		
G4-12	12	12		3470	3470	
G4-13	8	8		388	2275	
G4-14	24	23	24	1413	1418 (1322-1518)	
G4-15	9	10		2434	2434 (2411-2456)	1075
G4-7001	11			2380		
ThF4 Scrubbers						
ThF4 Dust Collectors						

DIAMETERS AND FLOW VELOCITIES, PLANT 5

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G2-67	24	24		3473	3569 (3473-3735)	11214
G5-247	16	16		3377	3344 (3311-3377)	4668
G5-248	16	16 *		4340	4336 * (4333-4340)	6054 *
G5-249	24	23		2622	2829 (2622-3036)	8387
G5-250	24	24		3631	3649 (3631-3667)	11464
G5-251	24	24		2863	3016 (2354-3618)	9475
G5-252	22			2500		
G5-253	24	24		3229	3688 (3229-4147)	11586
G5-254	22	23		3153	3192 (2904-3384)	8933
G5-256	22	22		3132	3132	8268
G5-258	22			2447		
G5-259	30			2811		
G5-260	22	22		1886	2085 (1886-2264)	5503
G5-261	30	30		3968	3987 (3530-4500)	19570
G5-262	23	23		1779	2028 (1470-2476)	6412
G5A-100	30	30		2654	2526 (1842-2996)	12398
G5A-101	22	22		2253	2663 (2253-3073)	7030
G55-E-100	13	12		4365	2621 (2371-2774)	2166

* Based only on data prior to 1990.

DIAMETERS AND FLOW VELOCITIES, PLANT 6

Release Point Designation	Stack Diameter (in) FMPC-2082	Stack Diameter (in) STDS	Stack Diameter (in) Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	Exhaust Velocity (fpm) STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G6-86	17			3534		
G6-88	17			3222		
G6-6057	47	47		2053	2053	
North ESP	47	46		2500	2254	16011
Mid ESP	32	32		6547	3508	19592
South ESP	47	46		2761	2697	31126
Plant 6 Briquetting						
Plant 6 Pickling						

DIAMETERS AND FLOW VELOCITIES, PLANT 7

Release Point Designation	Stack Diameter (in) FMPC-2082	Stack Diameter (in) STDS	Stack Diameter (in) Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	Exhaust Velocity (fpm) STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G4-2507	22			1733		
G4-2508	22			1733		
G4-2509	18			2123		
G4-2510	18			2123		

DIAMETERS AND FLOW VELOCITIES, PLANT 8

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G3A-2	16			1725		
G8-1	13			2585		
G8-2	23			3761		
G8-3	19			1821		
G8-4	19			3850		
G8-7	11	11		3119	3126 (3119-3134)	2064
G8N1-1000	18		18	1180		
G43-27	28	28		3432	2358 (1315-3432)	10289
G43-29	16	16		1725	2350 (2289-2410)	3280
G43-44C	14			3600		
6018	9.5x9.5					
6019	9.5x9.5			3350		
8002	10x10			2592		
8021	10			4700		
8024	10			4750		
8035	13	13		4416	3347 (1907-4416)	2921
8057	12	14		3685	3848	4114
8083	10x10			2592		

DIAMETERS AND FLOW VELOCITIES, PLANT 8

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
8102	10x10			2592		
Rotary kiln scrubber	12	12		2720	2720	
Number 1 oxid furnace scrubber	10	10		1265	1307 (690-1599)	871
Number 2 oxid furnace scrubber	12	12		2796	2796	
Box furnace scrubber	11.5			1145		
Muffle furnace scrubber	14			2552		
Hydroxide Scrubber						
Hydroxide Dust Collector						
Oxalate Scrubbers						
Oxalate Dust Collectors						

DIAMETERS AND FLOW VELOCITIES, PLANT 9

Release Point Designation	Stack Diameter (in) FMPC-2082	Stack Diameter (in) STDS	Stack Diameter (in) Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	Exhaust Velocity (fpm) STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G9N1-1039	36	34		3107	3913 (2807-5575)	23014
G9E2-400	46	46		2140	2145 (1856-2293)	25574
G42-615	30			4085		
G42A-100	26			3300		
Rotoclone						
Plant 9 Briquetting						
Plant 9 Pickling						
Metal Scrubbers						
Metal Dust Collectors						
Briquetting Scrubbers						
Briquetting Dust Collectors						

DIAMETERS AND FLOW VELOCITIES, PILOT PLANT

Release Point Designation	Stack Diameter (in) FMPC-2082	Stack Diameter (in) STDS	Stack Diameter (in) Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	Exhaust Velocity (fpm) STDS Average (min-max)	STDS Volume Flow Rate (cfm)
G-1	12	12		2567	2663 (2301-3149)	2092
G-2	12	12		2675	2439 (2007-2675)	1916
G20-20	20			2350		
G6-93A	24			3118		
G37-5011	17			4053		
735-13-7041	24	24		1975	1819	5710
735-13-7050	34	34		1098	2807	17698
108843	30			2030		
Oxidation furnace	12			3118		
Burnout						
Hoffman						
Boildown						
Chip furnace						
Extraction Process						
Gel Scrubbers						
Gel Dust Collector						
TNT Crystals Scrubber						
Metal Scrubbers						

DIAMETERS AND FLOW VELOCITIES, PILOT PLANT

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
Metal Dust Collectors						
Oxalate Scrubber						
Oxalate Dust Collector						

DIAMETERS AND FLOW VELOCITIES, NON-PRODUCTION

Release Point Designation	Stack Diameter (in) FMPC-2082	STDS	Eng. Drwg	Exhaust Velocity (fpm) FMPC-2082	STDS Average (min-max)	STDS Volume Flow Rate (cfm)
Graphite Burner						
Oil Burner						
Old solid Waste Incinerator			26x70			
New Solid Waste Incinerator			24			
Liquid Organic Incinerator			24			
Cooling Towers						

TABLE B-7. IDENTIFICATION OF OTHER RELEASE POINTS

Release Point Designation	Description	Previous Reference	Confirmatory Reference
	PLANT 1		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989
	PLANT 2/3		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989
	PLANT 4		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989
	PLANT 5		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989
	PLANT 6		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989
	PLANT 7		
Building Exhausts	Ventilation fan exhausts	Not previously considered	Assumed
	PLANT 8		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989
	PLANT 9		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989
	PILOT PLANT		
Building Exhausts	Ventilation fan exhausts	Clark et al. 1989	Hill 13 Mar 1989

Release Point Designation	Description	Previous Reference	Confirmatory Reference
	NON-PRODUCTION		
Laboratory Building 15	Exhausts from laboratory fume hoods	Clark et al. 1989	Hill 15 Mar 1989
O.S. & H. Building 53	Exhausts from laboratory fume hoods	Clark et al. 1989	Hill 15 Mar 1989
Waste Pit 1	Area Source of fugitive dust emissions	Clark et al. 1989	Kispert 1988
Waste Pit 2	Area source of fugitive dust emissions	Clark et al. 1989	Kispert 1988
Waste Pit 3	Area source of fugitive dust emissions	Clark et al. 1989	Kispert 1988
Waste Pit 4	Area source of fugitive dust emissions	Clark et al. 1989	Kispert 1988
Waste Pit 5	Area source of fugitive dust emissions	Clark et al. 1989	Kispert 1988
Waste Pit 6	Area source of fugitive dust emissions	Clark et al. 1989	Kispert 1988
K-65 Silo Number 1	South K-65 residue storage silo	Boback et al. 1987	BNI 1990
K-65 Silo Number 2	North K-65 residue storage silo	Boback et al. 1987	BNI 1990

Table B-8. Approximate Centers of Points of Other Releases to Air.

Release Points	North Latitude	West Longitude	Ohio State Plane Coordinates (ft) East	Ohio State Plane Coordinates (ft) North
K-65 Silos	39°18'0"	84°41'47"	1378500	481030
Waste Pits	39°18'11"	84°41'47"	1378530	482140
Lab Building 15	39°17'55"	84°41'23"	1380370	480480
OSH Building 53	39°17'55"	84°41'13"	1381160	480460

TABLE B-9. IDENTIFICATION OF NON-ROUTINE AIR RELEASE POINTS

Release Point Designation	Description	Previous Reference	Confirmatory Reference
	PILOT PLANT		
1966 UF6 Release	Inadvertent release of UF6 from a heated cylinder	FMPC-2082	
	MISCELLANEOUS		
Non-Routine Releases	U fires, solid spills, UF6 leaks, liquid UNH releases	Clark et al. 1989	Vaaler and Nuhfer 1989

APPENDIX C

List of Documents in RAC Repository

This appendix lists the FMPC-related documents, records and reports that RAC has gathered to date for the Fernald Dose Reconstruction Project. The documents listed here are those that will be useful in contributing to the particular Task at hand, and are grouped together by topic. Additional documents and records will be added regularly to the RAC Repository of Documents as the project proceeds.

APPENDIX C

AERIAL SURVEYS / PHOTOGRAPHS

Feimster, E. L., June 1979. An Aerial Radiological Survey of the Area Surrounding The Feed Materials Production Center, Fernald, Ohio, EGG-1183-1680. EG&G Energy Measurements Group. Date of survey: August 1976/May-June 1977.

Shipman, G. R., October 1985. An aerial Radiological Survey of the Feed Materials Production Center and Surrounding Area, Fernald, Ohio, EGG-10282-1084. EG&G Energy Measurements. Date of Survey, April 1985.

AIRBORNE DUST ONSITE/PERSONNEL EXPOSURE

Kessler, L. W., 17 February 1959. Air Contamination In Plant 8, Project No. P-23000-15, Short Order Completion Report for Production Engineering Department, NLO/ICN 2225348.

Starkey, R. H. to J. A. Quigley, P. G. DeFazio & C. R. Chapman, 20 October 1960. Compilation of High Air Dust Exposure Operations. National Lead Company of Ohio

Wing, J. F., K. N. Ross and R. G. Wissman, 30 November 1961. Exposure Study of Technical Laboratory personnel to Radioactive Airborne Dust. National Lead Company of Ohio.

Wing, J. F. to H. M. Beers, 1 August 1958. Air Dust Samples From Outside Mill, Plant 8, NLO/ICN 2225349. National Lead Company of Ohio.

ANALYTICAL DATA SHEETS

Stack, Surface Water, Miscellaneous. RAC has most early 60's data sheets for air and water. For other years, all available through NLO and Central Files at FMPC.

Water Sample Miami River	- 1961
Fluoride Pit (Pit 3)	- 1961 (daily, weekly)
Paddy's Run	- 1961, 1960 (daily, weekly)
Manhole 175	- 1961
Sewage Plant	- 1961 (daily, weekly)
Storm Sewer (Outfall, Lift Station, MH 66)	- 1961 (daily, weekly)
Miscellaneous (air, soil sludge, coolant, urine, oil)	- 1961

CP - CONSTRUCTION PROPOSALS

CP-59-65, 29 December 1959. Space Ventilation - Dintration Area- Plant 3 (After-the-fact), NLO/ICN 2214114. Authorized by J. H. Noyes. National Lead Company of Ohio.

COST STATEMENTS - PRODUCTION INVENTORIES

Cost Statements: Production Inventories and SS Material in Research, Feed Materials Prodcution Center, National Lead Company of Ohio. June 1967.

Cost Statements: Production Inventories and SS Material in Research, Feed Materials Production Center, National Lead Company of Ohio. June 1968.

Cost Statements: Production Inventories, Feed Materials Production Center, National Lead Company of Ohio. June 1969 through June 1973.

Cost Statements: Production Inventories, Feed Materials Production Center, National Lead Company of Ohio. June 1974 through June 1976.

Cost Statements: Production Inventories, Feed Materials Production Center, National Lead Company of Ohio, Fiscal Year Report. September 1976 through September 1983.

Cost Statements: 1611 Production Inventories and Fund 4A Cost, Feed Materials Production Center, National Lead Company of Ohio. September 1984 through September 1986.

Cost Statements: 1611 Production Inventories and Fund 4A Production Operations, Feed Materials Production Center, National Lead Company of Ohio. September 1987 & September 1988.

DUST COLLECTOR AND AIR FILTERS

Audia, S.F. to M.S. Nelson, 8 December 1955. Dust Collector Performance, (Re: letter Audia to Stewart dated 12/6/55, subject "Estimated Stack Losses for October"). National Lead Company of Ohio.

Chapman, C. R. to W. K. Benson, 15 August 1972. Stack Sampler filters and Air Sampler Solutions. NLO/ICN 2149686. National Lead Company of Ohio.

Connerton, J. F. to M. V. Carle, 12 Feb 1987. Plant 9 Dust Collector System, Spare Parts List. NLO/ICN 2149642. National Lead Company of Ohio.

Heatherton, R.C. to J. W. Mahaffey, 22 April 1957. Removal of Air Filters from Plant 5 Heating Units. National Lead Company of Ohio.

Inadequacy of FMPC Monitoring program (Title Page with author, date missing, 20 pages, incl. Dust Collector Replacement Schedule for all plants with collector number and manufacturer, air flow). NLO/ICN 2200675. 1983/4. National Lead Company of Ohio.

Nelson, M. S. to C.L. Karl, 17 Dec 1964. Dust Collector Stack Monitoring. NLO/ICN 2149709. National Lead Company of Ohio.

Podlipec, F. J. to G. R. Harr, 21 November 1955. Progress Report to Date on Dust Collector Improvement (P-20000-6). NLO/ICN 227791. National Lead Company of Ohio.

Ross, K. N. & M.W. Boback, 15 November 1971. The Control and Sampling of Airborne Contaminants from Uranium Production. NLCO-1087. Prepared for presentation at 101st Annual Meeting of American Institute of M,M,P Engineers, 1972.

Spenceley, R. M. to M. R. Thiesen, 6 March 1984. Request for Support for EPA Review of NESHAP for Radionuclides Data. National Lead Company of Ohio.

Starkey, R. H. to C. R. Chapman, 21 February 1956. Stack losses from Collector G4-3 (Re: Letter to R. H. Starkey from C. R. Chapman, on handling of stack loss sample from collector G4-3, dated 2/17/56). National Lead Company of Ohio.

FMPC Radionuclide Air Emission Source Compilation, 29 May 1990. From unknown document, 21 pages, lists FMPC Emission points by EP #, kg U per emission pt., source description and control equipment number. National Lead Company of Ohio.

ENVIRONMENTAL MONITORING REPORTS

US DOE, March 1987. Environmental Survey Preliminary Report Feed Materials Production Center, Fernald, Ohio, EH-24. U. S. Department of Energy, Environment, Safety and Health, Office of Environmental Audit.
FMPC Environmental Monitoring Annual Report for 1959. Health and Safety Division, National Lead of Ohio, Inc., 1 May 1960.

FMPC Environmental Monitoring Quarterly Report Jan - Feb - Mar 1960. Health and Safety Division, National Lead of Ohio, Inc., 1 May 1960.

FMPC Environmental Monitoring Quarterly Report Oct - Nov - Dec 1960 and Summary Report for 1960. Health and Safety Division, National Lead of Ohio, Inc., 10 January 1961.

FMPC Environmental Monitoring Quarterly Report Jan - Feb - Mar 1961. Health and Safety Division, National Lead of Ohio, Inc., 10 April 1961.

FMPC Environmental Monitoring Quarterly Report Apr - May - Jun 1961. Health and Safety Division, National Lead of Ohio, Inc., 10 July 1961.

FMPC Environmental Monitoring Quarterly Report Jul - Aug - Sep 1961. Health and Safety Division, National Lead of Ohio, Inc., 10 October 1961.

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FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1962, Summary Report for 1962. Health and Safety Division, National Lead of Ohio, Inc., 20 January 1963.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1963, Summary Report for 1963. Health and Safety Division, National Lead of Ohio, Inc., 20 January 1964.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1964, Summary Report for 1964, NLCO-939. Health and Safety Division, National Lead of Ohio, Inc., 20 January 1965.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1965, Summary Report for 1965, NLCO-972, Special. Health and Safety Division, National Lead of Ohio, Inc., 20 January 1966.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1966, Summary Report for 1966, NLCO-992, Special. Health and Safety Division, National Lead of Ohio, Inc., February 1967.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1967, Summary Report for 1967, NLCO-1013, Special. Health and Safety Division, National Lead of Ohio, Inc., February 1968.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1968, Summary Report for 1968, NLCO-1036, Special. Health and Safety Division, National Lead of Ohio, Inc., February 1969.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1969, Summary Report for 1969, NLCO-1055, Special. Health and Safety Division, National Lead of Ohio, Inc., February 1970.

FMPC Environmental Monitoring Semi-Annual Report for Second Half of 1970, Summary Report for 1970, NLCO-1079, Special. Health and Safety Division, National Lead of Ohio, Inc., February 1971.

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