2984 G-000-1001.36

REQUEST FOR INFORMATION ON THE FEED MATERIALS PRODUCTION CENTER (FMPC) FERNALD, OHIO

02/04/1987

DOE METZENBAUM
~~2~~ 417
LETTER

[redacted]

1,725 2984

Department of Energy
Oak Ridge Operations
P. O. Box E
Oak Ridge, Tennessee 37831

February 4, 1987

The Honorable Howard M. Metzenbaum
10411 Federal Building
Cincinnati, Ohio 45202

Attn: Patricia Phelan

Dear Ms. Phelan:

REQUEST FOR INFORMATION ON THE FEED MATERIALS PRODUCTION CENTER (FMPC) - FERNALD, OHIO

Reference is made to your December 24, 1986, letter to the Department of Energy (DOE) regarding the above subject.

Item 1 of your letter requested "any reports completed as a result of investigations into the leak of radioactive dust from the Fernald Plant." As a result of clarification discussions between yourself and Rick Collier of my staff, we are providing you a copy of DOE-ORO-855 "Investigation of September-December 1984 Plant 9 Excessive Uranium Emissions, FMPC." This investigation centers around an incident of continued higher than normal air pollutant emissions which occurred in Plant 9 of the FMPC from approximately mid-September 1984 to December 7, 1984. This is the specific report you requested.

Existing plant records were researched to determine if additional significant incidents involving higher than expected stack losses of uranium occurred. This research indicated three releases as follows:

DATE	URANIUM LOSS IN KILOGRAMS
June 1981	59
September 1981	238
June 1982	103

All of the above releases resulted from malfunctions of the dust collector/filter system. These are the only releases between the period 1980 to present in which more than 20 kilograms of uranium are involved in a release.

I trust this information will better help you respond to to Ms. Angela Wessels inquiry. If DOE can be of additional assistance, please let me know.

Sincerely,

Signed By

James A. Reafsnyder
Site Manager

Enclosure:
As stated above

cc w/o encl:
Al Knight, CP-35, FORS

bcc w/o encl:
Bill Bibb, DP-80, ORO
Betsy Jordan, DP-122, ORO

[redacted]

2984 —

United States Government | Department of E

memorandum

Oak Ridge O

[redacted]

DATE: February 7, 1985

REPLY TO ATTN OF: SE-334, SE-34, DP-81

SUBJECT: INVESTIGATION OF ENRICHED URANIUM RELEASE AT THE FEED MATERIALS PRODUCTION CENTER - SEPTEMBER 4 TO DECEMBER 7, 1984

TO: Joe La Grone, Manager, Oak Ridge Operations Office

As instructed by your letter dated December 10, 1984, a Type B investigation of the September to December 1984 uranium release from Plant 9 was performed during the period December 11, 1984, to January 18, 1985. Due to the position taken by the Fernald Atomic Trades and Labor Council, the maintenance workers (millwrights) were not available for interview until January 17 and hence a delay was necessary to complete the draft.

On December 15 and 19, 1984, and January 18, 1985, briefings were held with the Plant Manager and/or the Assistant Manager to advise them of the pertinent facts discovered in the investigation. Attached for review and approval are the final draft of the investigation report and the recommendations of the board.

John R. Martin, Chairman

Patrick L. Slattery, Member

Gabriel J. Marciante, Member

Attachments:
1. Recommendations
2. Report

12-

ATTACHMENT 1

[redacted]

RECOMMENDATIONS OF INVESTIGATION BOARD

Investigation of September-December 1984
Plant 9 Excessive Uranium
Emissions at the Feed Materials Production Center (FMPC)

The Investigation Board recommends the following:

1. The National Lead of Ohio Corporation should:

   a. Continue to implement the recommendations of the supplementary technical report entitled, "Inspection and Review of Air Pollution Control Systems at the NLO Fernald Plant." All "near-term recommendations" should be inplace prior to restart of dust collection systems at Plants 9 and 5. Secondary air seals and retainers should be installed in a manner which will provide unimpeded blow-ring movement. All bag-house collectors currently in service should be subject to effective inspection/evaluations at a frequency and in a manner to abate uranium emissions. Action plans and milestones should be developed to implement "near-term and long-term recommendations" in a timely manner. The U.S. Environmental Protection Agency, Method 5, should be used as a benchmark for evaluation of stack sampling methodologies.

   b. Orient key staff at FMPC in the provisions of all applicable reporting requirements of DOE Orders and other Federal Regulations including the Comprehensive Environmental Response Compensation and Liability Act. Setup an effective internal and external reporting system to assure that such reports and notifications are issued as necessary.

   c. Establish an aggressive, performance oriented environmental ALARA program under the direction and personal supervision of a qualified health physicist. The applied scope should provide for control and monitoring technology to eliminate excessive releases while maintaining routine emissions as low as reasonably achievable. In addition, the program should provide for timely radiological evaluations and action plans to minimize personnel exposure potentials resulting from excessive uranium releases.

   d. Implement a dynamic internal audit system to systematically evaluate the NLO environmental protection program.

2. All DOE/ORO contractors operating with bag-house collection systems should be provided with the investigation findings and requested to report similar conditions and corrective actions taken.

3. DOE/ORO should accelerate NLO restoration programs and funding requests to upgrade uranium emissions control technologies, i.e., high efficiency particulate filtration systems and stack monitoring/inspection improvements recommended by this report.

4. DOE/ORO should conduct a comprehensive review of the NLO management system. The lack of environmental, safety, and health staff representation in daily management meetings, absence of clear-cut guidance pertaining to minor event reporting, poorly developed procedures and inadequate or nonexistent internal audits in these areas when viewed together suggest a widespread lack of management control. The total management of environmental, safety, health, and quality assurance programs at FMPC should be scrutinized carefully and changed accordingly to reflect a more equitable balance between production needs and environmental, safety, and health concerns.

5. DOE/ORO should evaluate its own appraisal programs and make corrections as necessary to assure that the scope, depth, quality, and followup are sufficient to identify and resolve significant environmental problems. Previous DOE/ORO environmental and quality assurance appraisals of NLO failed to identify programmatic or technical problems which led to this emission.

[redacted] 2984 —

ORO - 855

[redacted]

INVESTIGATION OF SEPTEMBER-DECEMBER 1984 PLANT 9 EXCESSIVE URANIUM EMISSIONS

FEED MATERIALS PRODUCTION CENTER

BY

INCIDENT INVESTIGATION BOARD

FEBRUARY 6, 1985

[redacted] 6

[redacted]

TABLE OF CONTENTS

APPENDIX B

FIGURES

APPENDIX C

PHOTO

I. SCOPE OF INVESTIGATION

As a result of an excessive release of slightly enriched uranium from the Feed Material Production Center, Plant 9 dust collection system during September-December 1984, a type B investigation was initiated in accordance with DOE Order 5484.1. The investigation board was charged with assessing the situation and determining causal factors which contributed significantly to the release (Exhibit 1).

The board assembled facts and findings by conducting interviews, inspecting plant facilities, consulting with a team of baghouse experts, and conducting physical tests on site. The data was analyzed in part by utilizing the Management Oversight and Risk Tree (MORT) Chart, identifying causal factors, and using change analysis. Based upon these investigative techniques, judgment of needs were prepared.

II. SUMMARY

On December 7, 1984, NLO, Inc., contract manager of the Feed Materials Production Center (FMPC), reported to the Department of Energy's Oak Ridge Operation Office (DOE/ORO) that there had been an excessive and unanticipated amount of uranium emissions to the air. The loss was reported to have occurred from the Plant 9 operations from approximately mid-September to December 6, 1984.

DOE/ORO made reports to the National Response Center and several State of Ohio health and environmental protection agencies, pursuant to the provisions of the Comprehensive Environmental Response, Compensation and Liability Act on December 7, 1984. The loss has been determined to have been 123.9 kilograms of slightly enriched uranium, emitted from some time after September 11, 1984 through the early morning of December 7, 1984.

The excess emissions caused no discernable impacts offsite. An intensive in-vivo whole body count of Plant 9 workers indicates that none have incorporated an amount of uranium in their lungs in excess of allowable standards. Apparently much of the uranium and other released particulate matter was deposited on the roof of Plant 9 or in the one to two thousand foot wide buffer area which surrounds the FMPC process buildings.

During the incident, stack sampler results and radiation detector readings told NLO operating personnel and environmental protection professionals that the dust collector system was not operating properly. NLO personnel repeatedly opened the baghouse and from a very limited outside vantage point, looked for excessive dust. They did not see excessive dust, discounted the stack sampler results and radiation detectors, and continued to operate. Evidence suggests that a bag was loose in a difficult to see area in the baghouse during this time allowing excessive emissions to escape.

NLO does not have an effective program from which to closely monitor and control uranium emissions to as low as reasonably achievable (ALARA). The results of stack sampling and radiation detector excursions were not supported with professional assessments of the consequences of continued operations in a manner to facilitate sound management decisions.

Analysis of investigative data pertaining to the NLO uranium release reveals the following conditions as probable causal factors in the incident:

1. The lack of adequate bag procurement specifications and receipt inspections to assure proper bag length requirements and shrinkage tolerances. This oversight proved critical since wool baghouse fabric, subject to shrinkage, was used to filter effluents from uranium casting support operations with high moisture content.

[redacted]

2. The deteriorated condition of the baghouse with holes in inlet ductwork, worn gaskets on flanges and maintenance ports, and flanges not completely bolted up resulted in significant air and moisture inleakage, thereby contributing to wool bag shrinkage, fabric clogging (blinding) and general loss of efficiency.

3. The blow ring assembly contacts the bags when operating. This abrasive contact contributes to bag failures. The contact of the blow ring nozzle assembly with improperly installed air seals may tear seals and rip off retainers. The seal retainer as acted upon by the moving blow ring may then dislodge or rip bags.

4. The bag connectors depend exclusively upon the tension provided by steel springs sewn into the bags and stretched over supportive flanges without an external steel hose clamp band.

5. Over reliance upon a limited, visual inspection from a single port to ascertain uranium breakthrough and bag failures for a large, close pack 45 bag array.

6. Failure to restrict baghouse operations based upon available stack sample and radiation detector results.

7. The lack of an effective program from which to closely monitor and control uranium emissions to as low as reasonably achievable (ALARA).

8. The absence of minor event reports or effective communications to middle and upper NLO management regarding the uranium emissions as they occurred.

9. The lack of proper bags and air seals, together with the short allowable time (stay times) to work in the radiation zone created by the bags, with very little working space may have resulted in bags coming loose during and after maintenance.

10. The safety analysis program has not yet evaluated baghouse failure in sufficient detail to ferret out problems which contributed to this uranium release.

11. The failure of the DOE Oak Ridge functional appraisal program to ferret out and assure that such causal factors were eliminated.

[redacted]

III. FACTS

A. BACKGROUND INFORMATION

The Feed Materials Production Center (FMPC) is an industrial facility owned by the United States Department of Energy (DOE). The facility is located on a 1,050-acre site about 20 miles northwest of downtown Cincinnati, Ohio. Several rural communities are 1-3 miles away. Figure 1 is a map of the area.

The Feed Materials Production Center was constructed in the early 1950s to convert uranium ore concentrates and recycle materials to either uranium oxides or uranium ingots and billets for machining or extrusion into tubular form for production reactor fuel cores and target fuel element fabrication. Following the initial $117 million construction project, an approximate $60 million expansion occurred in the mid-1950s. Metal deliveries peaked in 1960 at approximately 10,000 metric tons uranium (MTU) and then in 1964 began to decline to a low in 1975 of about 1,230 MTU.* It was during the 1970s that consideration was given to closing the FMPC, so capital improvements and staffing were minimized. From 1972 through 1979, the average annual operating and capital funds authorized, in FY 1983 dollars, were $27.5 million and $0.7 million, respectively. The staffing level, which peaked at 2,891 in 1956, slowly declined over the same period from 662 in 1972 to 538 in 1979. Then in FY 1981, direction was given to plan the Center's restoration to accommodate projected product requirements that were to grow to near the Center's originally installed capacity. What followed was significantly increased production levels, rapid staff buildup in many areas and implementation of a major facilities restoration program. As of this date, accomplishments include production output of 3 times the 1979 level, a staff increase from 538 to about 1000, and the initiation of over $70 million of capital facility improvements.

NLO, Inc. (NLO) is a subsidiary of NL Industries, New York, New York, and has been the contract manager of the FMPC, for the DOE and its predecessor agencies, since construction and production began in 1951.

In recognition of the revitalized mission of the FMPC, the Manager, Oak Ridge Operations, chartered a Task Force on Review of Operations at the FMPC. The Task Force reviewed the current operations and planning of NLO to meet its future responsibilities. Among the areas examined were:

---

* A metric ton is 1000 kilograms (Kgs) or 2200 pounds.

[redacted]

- Environmental Protection
- Radiation Protection and Employee Exposure
- Management's Commitment to Aggressively Implement Required Changes

The Task Force report of June 1984 resulted in several environmental assessments and judgments of need relating to NLO initiative, regulatory compliance, internal and external communication, and training.

In addition, DOE Oak Ridge Operations conducts periodic appraisals in such functional areas as Envrionmental Protection and Quality Assurance. Reviews of the most recent appraisals in these functional areas, however, reveal essentially no findings pertaining to the programmatic deficiencies leading to this incident.

Today, the principal product from FMPC operations is uranium metal in various physical forms having several standard isotopic assays and purity controlled at a high level. Although some metal is shipped directly to DOE facilities at Oak Ridge, Tennessee, and Rocky Flats, Colorado, most of the production stream metal is cast into ingots, which are center-drilled and surface-machined for extrusion into tubes on the DOE extrusion press facilities located at the RMI Company, Ashtabula, Ohio. Some extrusions are returned to the FMPC, where tube blanks undergo heat treating and fabrication into target element cores for DOE reactors at the Savannah River Plant (SRP), Aiken, South Carolina. Other extruded material is further processed into fuel billets, via an upset forge operation at RMI, for shipment to the Richland, Washington, site. Both fuel cores and target elements are used in government reactors for the generation of electricity and the production of plutonium.

This investigation centers around an incident of continued higher than normal air pollutant emissions which occurred in Plant 9 of the FMPC from approximately mid-September 1984 to December 7, 1984. Plant 9, also known as the Special Products Plant, is a one and a half story building with a ground floor area of 48,500 square feet. Its principal capabilities are:

- the machining of as-cast ingots and billets prior to extrusion
- the remelting and casting of uranium metal into large diameter ingots
- the chemical decladding of unirradiated fuel elements

[redacted]

- miscellaneous specialized operations to satisfy non-routine requests.

Currently, operations in Plant 9 primarily involve machining uranium metal pieces and casting large ingots up to 13 inches in diameter, 25 inches in length and weighing up to 900 kilograms of uranium. All ingots cast in Plant 9 are for supplying the enriched N-reactor core requirement for the Richland, Washington, plutonium production reactor. The average enrichment of the ingots is about 0.98 percent in uranium-235 content. Natural uranium is 0.72 percent in the 235 isotope.

The organization of NLO directly pertinent to the Plant 9 excess emissions is shown in Figures 2, 3, 4, 5, and 6. Figure 2 is the "Executive Group", including the Plant Manager. Figure 3 is the "Health and Safety" organization. Figures 4 and 5 trace the management control through to the Plant 9 area and shift supervisors. Figure 6 is the "Quality Control" organization.

The operation in Plant 9 which is of interest in this investigation involves the two uranium remelt furnaces and their associated support operations including crucible loading, crucible burnout, and ingot separation. A schematic drawing is provided as Figure 7. The two remelt furnaces are also known as the N-reactor furnaces. They are vacuum induction furnaces which melt uranium metal through the action of an electrically generated magnetic field. The burnout facility consists of a number of work stations at which empty graphite crucibles from the N-reactor furnaces are subjected to a natural gas flame which burns out impurities such as stray uranium dust and loose graphite. An ingot separation process is nearby to the furnaces to separate the furnace castings from their molds. For most of calendar year 1984, the production rate of the above operations was 1,400 to 1,500 metric tons of uranium per year, consisting of three shifts per day, five days per week, fifty weeks per year (6000 hours). The two furnaces produce from eight to nine castings per twenty-four hours. About 907 Kg (2000 pounds) of material are charged to the furnaces per heat.

Air pollutants are generated, with varying degrees, from all of the processes associated with the N-reactor furnaces. In order to minimize or eliminate the potential for exposure of these pollutants to the work force which operates the furnaces and their support facilities, the processes are either enclosed, hooded or occur in ventilated, closed-in booths. These measures draw the air pollutants into a central duct towards the outside of the building for cleaning by a dust

[redacted]

collector. The nature of the emissions is that of: (a) a fine uranium metal fume which quickly oxidizes to a fine black powder, U_3O_8, ("black oxide"); (b) small uranium metal chips struck loose from crucible cleaning or ingot separation; (c) graphite, (a black solid), from the "burnout" operation; and (d) nitrogen oxides, water and carbon dioxide from the combustion of natural gas used in burnout. It should be noted that small pieces or fine particles of uranium metal tend to be pyrophoric. That is, they will spontaneously spark and burn in a chemical reaction in air to form the black oxide. The various particulate pollutants described above and conveyed to the dust collector are generated at an approximate rate of 59 Kgs (130 lbs) per twenty-four hour day. The material that eventually reaches the ambient air has been measured in recent months, to consist of about 55 percent uranium. A substantial amount of the particulates generated, therefore, are not uranium oxide.

Associated with the Plant 9 remelt furnace operations is a Hoffman brand High Vacuum Generator which produces a vacuum in and around most of the industrial processes serving the remelt furnaces and their related unit operations. This vacuum collects secondary emissions and stray dust that might be generated and serves much the same purpose as a vacuum cleaner in the home. About 44 Kgs (97 lbs) of uranium, as U_3O_8, is collected in an average 24 hours by the Hoffman unit.

As described above, the primary process operations generate air contaminants which are drawn into a duct. This duct leads outside the building to an American Air Filter brand Model 8 "Amerjet" dust collector (See Photo 1). This collector and its emission stack is known as source G9N1-1039, at the FMPC, as well.

The dust collector serving the FMPC Plant 9 remelt furnaces is a baghouse-type dust collector which captures particulate matter generated as the result of the operation of the remelt furnaces and their associated support operations. The Plant 9 dust collector consists of 45 wool felt bags of approximately 10 inches in diameter and 22 feet in length, each, in a very tight array, which severely limits the ease of inspection of each bag's surface. The bags are cleaned periodically, when a jet of air is applied on their clean side, which dislodges the collected dust on the bags and allows it to fall into a collection hopper. The jet of air is applied by a device called a blow ring which, when actuated, travels the length of the bags and dislodges the collected dust. The Plant 9 dust collector was installed at the FMPC in the early 1960s, and as such, represents a technological design which is about thirty years old. See Figures 8 and 9.

[redacted]

[redacted]

United States Environmental Protection Agency (USEPA) handbooks indicate that a baghouse, when properly maintained and in good operational order, should be able to capture as much as 99.3 to 99.9 percent, by weight, of the particulate matter to which it is subjected. Since a baghouse is not one hundred percent efficient, there is a small emission of particulates, over time from an operation like the Plant 9 remelt furnaces. For example, given 99.9 percent efficiency, for a three shift per day operation, the Plant 9 baghouse might be expected to emit about 0.032 Kg uranium per day (approximately 0.07 pounds uranium per day, about 0.13 pounds of total particulates per day). For a 24-hour, 5 days per week, 50 weeks per year operation, that would be 8.0 Kg uranium per year (approximately 17.5 pounds uranium per year, about 32.5 pounds of total particulates per year).

For information, the Ohio air pollution emissions control code would allow, for a nominal throughput of 1,500 metric tons in a 6000 hour year, an average total particulate rate of 1.73 pounds per hour or 42 pounds per day. There are no specific numerical emission limits established by Federal or State regulations for radioactivity for this facility. The DOE limits emissions from its facilities so as to limit doses to the general public below 500 millirems to the whole body. Based upon annual NLO Environmental Monitoring Reports, doses to the general public from FMPC operations, in recent years, have been less than 100 millirems.

The baghouse exhausts to a stack which is approximately sixty feet in height. The stack is equipped with a continuous stack sampler which indicates the quantitative amount of emissions released over time by the baghouse. The stack sampler consists of one probe (a small diameter tube) which faces into the baghouse discharge air stream and draws a small sample of air to a filter housed outside of the stack. See photos 1, 2, and 3. Suction for this sampler is supplied by the operation of the Hoffman High Vacuum Unit.

Ideally, the proper suction is applied to the sampler such that the face velocity of the sample tube's opening, matches the velocity of the gases in the stack at the location of the sample tube and "isokinetically" draws in a representative concentration of particle sizes in the gas. It has been the practice of NLO to have its Industrial Hygiene and Radiation (IH&R) Department inspect the sampler once a month. The inspection consists of looking at the filter to see if it has been "soiled" by the operation, indicating that a measurable amount of uranium has been deposited. If sampling filters do not have visual dust, they are left in the sampler, usually until the next monthly inspection, unless some process incident warrants reinspection of the filter for evidence of a significant release.

[redacted] 17

During the monthly inspection, NLO personnel take a flow measurement gauging of the sampler to insure it is operating properly (See Photo 2). If necessary, an adjustment is made to the flow rate.

Mounted behind the filter is a thin window, beta particle sensing Geiger-Meuller detector. The detector provides a qualitative real time indication of the amount of emission deposited on the sample filter. The radiation detector was an innovation of the IH&R Department and has been installed for two years. The purpose of the system is to detect the rapid deposition of radioactive particles on the filter, which would be indicative of a sudden, significant baghouse failure, usually caused by a sudden bag rip or bag becoming loose or disconnected from its mounting. The detector is connected to a visual and audible alarm located in an out-of-the-way position in Plant 9 near the baghouse central controller. See photos 3, 4, and 5. It was intended that the system would give a rapid indication that a baghouse was malfunctioning, well in advance of the monthly check of stack samplers for "soil", and, therefore, result in rapid shutdown of the pollution generating devices and repair of the dust collection system.

B. CHRONOLOGY

The chronology begins in September 1984, the last time the baghouse underwent major servicing. It had been determined that the blow ring drive cable required significant repair. Also, some bags looked old and worn. Note that it is the practice at the FMPC to remove and replace with all new bags, the bags in the Plant 9 baghouse, during major servicing, to allow more easy access to the blow ring and because such servicing, itself, tends to dislodge bags. The major repair job to the Plant 9 baghouse occurred during the Labor Day weekend of 1984.

<u>September 4, 1984 (Tuesday)</u>

The Plant 9 dust collector resumed operations with 45 new bags and ring blower repaired. Interviews indicate that rubber seals on the northwest, west, and southwest blowring air supply columns were installed in multiple sections instead of single units. The seal retainers for the southwest air column as installed failed to provide complete support for rubber seals. (Figure 9, item 14) In addition, several bags which were installed appeared to be short. See photographs 6, 7, 8, 9, and 15.

September 11, 1984 (Tuesday)

Sample filter number 1120 was put into service in the continuous stack sampler.

October 10, 1984 (Wednesday)

The monthly visual check of the stack sampler indicated a very slight accumulation of material, indicating small stack losses. The filter was kept in service.

November 5, 1984 (Monday)

Remelt furnace operation switched from a fifteen to twenty-one shift per week schedule.

November 7, 1984 (Wednesday)

The differential pressure gauge recorder had readings higher than normal, indicating that the collector bags were heavily laden with particulates. (See photographs 5 and 13 for recorder.) The blow ring drive was running continuously, yet with the differential pressure remaining high, there was clear reason to believe that the bags were not being cleaned by the blow ring action. The baghouse was shut down and inspected from the outside by an operator and a supervisor. The blow ring was put on manual operation to check for proper alignment and suspension and the bags were inspected. No problems were noted.

The Plant 9 Area Supervisor requested the Maintenance Department to inspect the baghouse because of the high differential pressure problem. The rubber seals (item 13, Figure 9) were found to be torn loose, thereby reducing the effectiveness of the reverse air flow through the bags.

November 8, 1984 (Thursday)

The IH&R Department, inspected the stack sampler filter. Although it was soiled with what looked like more than one gram of material, it was not taken out of the sampler for analysis, as required per IH&R procedure 1.4.

November 9, 1984 (Friday)

The Maintenance Department obtained an entry permit to enter the confined dusty interior of the baghouse in order to repair the blow ring rubber seals. The entry permit required that the millwright craftpersons work for no more than 24 minutes per person per week in the baghouse because of the radiation levels from residual dust on the bags, which were left hanging in the baghouse. The millwrights were to wear individual "airline" type respirators which require trailing an airhose out of the baghouse to a source of clean air. Most of the millwrights were used in relay crews to fix the baghouse between November 9 and November 12. The bags in the baghouse had not been removed, as in normal practice, which would have allowed for more repair (stay) time per crew, because Stores did not at that time have a full complement of 45 replacement bags.

The maintenance crew discovered five air column seal retainers laying on the west floor of the baghouse. Two of the retainers were bent. In addition, rubber seals were torn in the same areas. (See photos 11 and 12.)

The maintenance repair crews also found that a bag was loose in a hard to see section of the baghouse at its top connection. During the inspection, two bags were knocked off in the northeast corner of the baghouse. There was an accumulation of dust in the bottom of the baghouse, and this was vacuumed up. The loose bag and several additional bags were removed to facilitate repairs to the blow ring assembly.

November 12, 1984 (Monday)

Rubber seal and retainer replacements were completed and new bags were withdrawn from Stores to replace the bags which had been removed. It was found that the new bags were too short, so the bags which were removed during servicing were re-installed. The baghouse was returned to operation in the afternoon. At that time, instruments indicated normal operation. Interviews reveal that at least five bags were inadvertently knocked off during November 9-12 maintenance activities. Reportedly, these bags were all reconnected prior to resuming operation.

[redacted]

November 16, 1984 (Friday)

The IH&R Department inspected stack filter number 1120. It was laden with material and was removed for analysis and replaced with stack filter number 1134. At that time, the IH&R Department informed Plant 9 supervision that there had been a stack loss. The operator inspection of the baghouse on November 17 at 8:00 a.m. showed no excessive dusting in the baghouse; operations, therefore, continued. Sample 1120 was analyzed. NLO's laboratory data sheet shows that a gravimetric and chemical analysis of the filter was completed on November 16, 1984. The analysis, when put into a conversion equation, would indicate a loss to the environment of 38 Kg of uranium from September 11 through November 16, 1984.

November 19, 1984 (Monday)

The Geiger counter stack monitor alarm indicated a possible loss. An IH&R Department technician inspected and removed sampling filter 1134 and inserted new filter number 1138. Sample 1134 was gravimetrically and chemically analyzed on November 21, 1984 (Wednesday). It had measured a loss to the environment of 24.7 Kg of uranium from the period November 16 through November 19. Operator routine morning inspection of the baghouse indicated no stray dust in the baghouse which would be indicative of a bag failure. The Geiger counter's alarm sensitivity was decreased by a factor of 10 so that it would not alarm.

The Plant 9 Area Supervisor was informed of the November 16 and 19 filter changes by the IH&R Department. However, he was given no guidance on the significance of the actions.

The Plant 6 and 9 General Supervisor was aware of the stack alarm and the need for sample filter changing as well, although he did not see numerical results until December 3. The Plant 6 and 9 General Supervisor has indicated that shortly after November 19, he discussed the facts as he knew them with the Department Superintendent of Plants 5, 6, and 9. It was understood that the Plants 5, 6 and 9 Department Superintendent was going to speak to the chief IH&R field representative.

November 21 through November 26, 1984 (Wednesday through Monday)

The chief IH&R field representative took several days off from work.

[redacted]

November 26, 1984 (Monday)

Inspection by IH&R of the stack sampler filter number 1138 indicated continued loss and was removed for analyses. However, no abnormal condition was indicated through inspection of the dust collector by an operator and a supervisor. Later, the loss indicated above was determined to be 22.4 Kg of uranium. NLO records do not indicate when this analysis was completed. Although instruments showed continued, above average losses, visual inspection of the baghouse from an outside access door did not reveal excessive dusting within the baghouse, which would be indicative of a loose bag or other significant malfunction. NLO, Inc. operational personnel, therefore, continued operation. The new sample filter which was installed was number 1140.

November 27, 1984 (Tuesday)

At approximately 6:30 a.m., a fire occurred in the cyclone of the Hoffman High Vacuum Generator. An additional inspection of the stack sampler filter by IH&R indicated continued loss. The Plant 9 Area Supervisor and the IH&R representative inspected the dust collector together and nothing unusual was found. Later, the loss indicated for the period from November 26 through 27 was determined to be 12.6 Kg of uranium. Operations of the remelt furnace continued despite the fact that the emissions monitoring capability for the system was lost, while the Hoffman High Vacuum Generator was inoperable. To permit repair of damage caused by the fire and by water, the dust collector was used without the High Vacuum Generator from November 27 until December 2. NLO made no report to ORO regarding the fire nor the loss of sampling capability.

November 29, 1984 (Thursday)

At approximately 6:00 p.m., while repairing the High Vacuum system, five hourly workers were exposed to a puff of approximately four pounds of U_3O_8. The vacuum system was thought to be free of uranium oxide before the dismantlement and the puff was unanticipated. Consequently, the workers were not wearing respirators during the repair activities. Urinalysis tests were not performed following the exposure. No report was made to NLO management concerning the exposure at this time. These workers were subsequently analyzed about 2 weeks later in a radioactivity whole-body counter. It was determined that their lung burden had not increased over previous levels.

On November 29, 1984, the IH&R Department completed its November stack sampling report. This report was reviewed by the chief IH&R field representative and the Head of the IH&R Department.

November 30, 1984 (Friday)

A stack sampler analysis report was reviewed by the FMPC Plant Manager. It indicated the 9-11-84 to 11-16-84 loss of 38.0 Kg uranium and the 11-16-84 to 11-19-84 loss of 24.7 Kg uranium. Apparently prior to the Plant Manager's review of the report, neither the IH&R Department nor other reviewers had recognized the significance of the data or issued a special report to upper management. The Plant Manager indicated that, on November 30, he was not aware that the problem was continuing (See Exhibit 2).

The Plant Manager was interested in knowing how to prevent a recurrence and he asked the Production Division General Superintendent to provide an explanation of the 63 Kg loss of uranium.

December 3, 1984 (Monday)

When the stack sampler results, through the sample of November 19, were brought to the attention of Plants 5, 6, and 9 Department Superintendent, who reports to the Production Division General Superintendent, he contacted the IH&R Department about shutting down the dust collector and casting operation. Reportedly, the IH&R representative suggested that operations wait for laboratory results on the samples of November 26, November 27, and December 3.

December 6, 1984 (Thursday)

The additional stack sampler results were received, indicating a total loss of 117.4 Kg emitted since mid-September 1984 through December 3. These results were given to the Plant 6 and 9 General Supervisor in terms of pounds of emission and he discussed the results with the Plants 5, 6, and 9 Department Superintendent who made a decision to shutdown at 8:00 a.m. on December 7. Operations were allowed until December 7 since the furnaces were in operation. Shutdown with the charge in the operating furnaces would require a loss of approximately $5,000, according to the Plants 5, 6, and 9 Department Superintendent.

December 7, 1984 (Friday)

NLO management was given a report on the losses, which at that point totaled to 117.4 kilograms of uranium. The DOE/ORO Weapons Division manager, then in Washington, D. C., was informed during a telephone call placed to the plant. DOE/ORO staff was also informed by NLO management. DOE/ORO staff was told that potentially 180 kilograms of uranium had been lost as excess emissions during the period from approximately mid-September to December 6, 1984. This information and other facts were reported to the National Response Center pursuant to the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) by the DOE/ORO Environmental Protection staff. CERCLA requires that excess or unanticipated emissions of radioactivity greater than 1 pound per day be reported. Reports were also made to the Ohio Environmental Protection Agency, the Ohio Department of Health, and the Ohio Disaster Services Agency. NLO was told to prepare a press release for December 10, in accordance with standing ORO policy to keep the public informed about unusual occurrences at its facilities.

DOE/ORO staff had been given the estimate of 180 kilograms of uranium which is more representative of the total year's loss of uranium from the Plant 9 baghouse rather than the loss during the upset condition period. The losses from mid-September 1984 through December 7, 1984, inclusive of the December 3 through December 7, 1984 sample, totaled to 123.9 kilograms of uranium, according to information given to the Board. (123.9 kg = 273 pounds)

It was later found that one of the 45 bags (located in the obscure southeastern area) was loose from its bottom flange. The bag was too short to be reattached at the bottom flange. Entry into the baghouse, itself, did reveal the presence of dust accumulations.

Subsequent to the remelt furnace operation shutdown, the following measures were pursued:

1. The baghouse was vacuum cleaned.

2. A bag was replaced.

3. New gaskets were installed on the units' access doors on Monday, December 10.

4. A visolite dye test was administered on Tuesday, December 11. Visolite is a brand name for fluorscein and has a face powder texture. It is a black-light sensitive phosphor. An inspection of the clean side of the baghouse was conducted with a black light. No leaks were detected. A bag was loosened at the bottom, purposely, to check the inside of one bag with the black light for the presence of the test dye. There was a significant amount of the test dye on the inside of the bag (dirty side) indicating that the dye had been dispersed to and had been captured by the bags.

[redacted]

The stack sample filter was removed and checked with the black light for presence of the test dye. None was found.

5. A dry run was conducted of the remelt furnace baghouse and related systems. The dust collector was turned on and allowed to operate for the second and third shift periods, approximately 16 hours on Tuesday, December 11.

<u>December 12, 1984 (Wednesday)</u>

The remelt furnace operations were restarted. Subsequent inspection of the stack sampler on December 13, 1984, at 8:00 a.m., revealed no evidence of any leaks. The Geiger counter monitor also indicated no evidence of a baghouse malfunction.

<u>December 14, 1984 (Friday)</u>

On December 14, the Geiger counter started to show an unexpectedly rapid rise in its readings. As a precaution, the remelt furnaces' operation was shut down. An analysis of the stack sampler filter indicated a loss to the atmosphere of 0.05 Kg uranium for a two-day period. This is an extremely small amount. However, the DOE decided to keep the furnaces shut down until the baghouse could be inspected by a team of experts.

<u>December 18, 1984 (Tuesday)</u>

As a result of an ongoing, intensified inspection of all major process ventilation systems at the FMPC, Plant Management made a decision to temporarily shut down a portion of a second processing facility (Building 5) because of marginal performance of the facility's bag filtration system. The malfunctioning of the system, involving two bag filtration units and associated stacks, had resulted in slightly more uranium dust being discharged to the atmosphere than would be expected for the operating period involved. Approximately 5.5 Kg of uranium are estimated to have been discharged from one stack at Building 5 from December 11 through December 17, and approximately 7 Kg of uranium dust are estimated to have been released from the second stack between November 10 and December 11.

A team of baghouse experts examined the Plant 9 dust collection system. The team examined Plant 5 on December 19. The technical report is attached as an Exhibit. (No. 3)

The DOE investigating board was told that on this day, NLO upper management first learned of the previous exposure of 5 hourly workers to U_3O_8 dust which occurred on November 29.

[redacted]

[redacted]

C. SUPPORTIVE TECHNICAL DATA

1. Collector Housing System

- The housing of the baghouse provides inspection/access doors only on the north side of the collector. Two doors are provided at the lower level and one door is provided at the upper level of the collector. For the daily inspection, only the lower level doors are utilized.

- The physical arrangement of the housing does not allow physical accessibility within the collector for a thorough inspection. (The photographs 7 and 14 illustrate the limited field of view available to an inspector. Several bag rows cannot be observed from the doors.)

- No permanent lighting is within the collector nor is utilization of temporary lighting required by procedure.

- The filtering system operates on a vacuum and in-leakage would definitely decrease the efficiency of operation. Several in-leakage areas were noted by the investigation team and also by the special bag house expert task team. In-leakage of moist wet air can cause wetting of the bags and the collected particles on them which can lead to blinding of oxide on the dust bags as well as providing potential dust bag problems discussed below.

2. Dust Bags

- The wool bags connect to upper and lower flanges by a spring tension device designed into each end of the bags. The device is strictly tension, such as a rubber band, and not adjustable. (See photographs 15 and 16 for flanges.)

- The bags pass through a blow ring assembly. Tolerances between the bag and blow ring are very close and rubbing does occur from time to time during operation which can cause pinholes. This is noted since all bags removed from the collector over December 14 weekend were found to have pinholes in them. (See photographs 7, 17, 18, and 19.)

[redacted]

[redacted]

- The blow ring makes contact with the six air supply columns by six elliptical nozzle assemblies which must extend through the rubber seals and extract air within the pressurized column. The rubber seals, which are about 23 feet in height, should be installed in a single top to bottom piece so that the metal nozzle lip will get an adequate seal. (See photos 8, 9, and 10.)

- The last procurement and receipt of bags for the Plant 9 collector prior to this investigation occurred in 1979. No records were provided to indicate any receipt inspection took place.

- There is no receipt inspection procedure used for Plant 9 dust bags.

- Presently there is a Quality Control (QC) group, which for approximately two years, has performed dimensional checks on dust bags on a sample basis. Checklists are utilized and were available from the QC group.

- No vendor certification or utilization of an independent lab on requirements of the procurement specification (shrinkage, bag strength, material, etc.) has been required.

- No preoperational test(s) is required by procedures for the Plant 9 collector.

- All bags removed after the Plant 9 shutdown on December 14, 1984 were measured. The 45 removed bags ranged in size from 21 feet, 9 inches to 21 feet 11 1/2 inches. Measurement of all bags is provided as Exhibit No. 4.

- The bag found loose on December 7, 1984 was also measured and found to be 21 feet, 8 1/4 inches.

- The bags that had been pulled from storage for replacement in November 10-12, 1984 time frame were not used because they were too short. These bags were later measured to be 21 feet, 5 inches to 21 feet, 9 1/2 inches.

- The procurement specification requires the Plant 9 bags to be 21 feet, 10 inches, but provided no tolerances. Measurement by the bag house expert task force team indicated 21 feet, 10 1/4 inch from upper flange to lower flange. For proper connection, the task team estimated a bag should probably range in size from 21 feet, 11 3/4 inches to 22 feet, 1 to 2 inches.

[redacted]

- The bag procurement specification also required preshrunk material be used.

- The investigation team requested that a bag be removed from stores, wetted and then dried. A bag was wetted and dried in the NLO laundry and shrunk from 22 feet, 2 inches to 20 feet, 4 inches, a total shrinkage of 22 inches. Operation with moist/wet in-leakage together with the moisture inherent from natural gas usage in upstream processes and the heat produced by the industrial process could result in some bag shrinkage. (See photographs 20-22 for in-leakage source examples.)

- The team of baghouse experts indicated that some bag stretching during installation may occur.

- The wording of the bag procurement specification requires a spring at one end of the bag. However, the drawing of the bag, which is part of the procurement package, and actual physical installation requires springs at both ends.

- The QC group presently is using a check mark (✓) to indicate an acceptable dimension on a checklist in lieu of putting the actual measurement. QC supervisory acceptance and bag acceptance (by another organization) is based on these check marks.

- Any deviation approval of the procurement bag specification is requested from maintenance personnel in lieu of the procurement specification preparer and operations.

- Stores attempts to keep one set of bags for a complete changeout. Bags in storage on December 14, 1984 were measured and found to range in size from 22 feet, 1 inch to 22 feet, 2 3/8 inches.

3. <u>Visual Inspection and Differential Pressure Recorder Chart</u>

- The differential pressure recorder (photo 13) records the difference in air pressure between the process side of the baghouse and the clean side. The differential pressure recorder is to be read once per shift. (High differential pressure would be indicative of restriction to air flow, such as dust buildup on the bags. Low differential would be indicative of less restrictions, such as loose bags or new bags.

- Discussions revealed that accepted practice was to operate if visual inspection revealed no bag problems.

- Discussions indicated that management did not believe one loose bag would be detected on the differential recorder but did not have an idea as to how many bags would have to be disconnected before a noticeable change on the recorder was seen.

- The NLO Standard Operating Procedure (SOP) indicates the desired range for the AMERJET baghouse is 3 to 4 inches. However, the procedure provides for flexibility by allowing plant supervision to adjust the range when new bags are installed or older bags become blinded. Plant 9 supervision did adjust setpoints between 1 and 3 on December 5, 1984 to have the ring blower operate more.

- Review of recorder charts prior to bags being found loose do <u>not</u> indicate any sudden unexplained drop of differential pressure.

4. <u>Stack Filter Sampler</u>

- The stack filter sampler inspection requirement and filter change procedure is described in Industrial Hygiene and Radiation Department (IH&R) Procedure Number 1.4 (Exhibit <u>4</u>).

- The filter sampler was to be inspected within the first two weeks of each month. If the filter shows evidence of significant accumulation of material (i.e., estimated at greater than one gram) the filter is to be changed and analyzed. Per the chief IH&R field representative, one gram on the filter is representative of 20.75 Kg of particulate up the stack.

- Per IH&R procedure 1.4, if deficiencies are noted, the IH&R must notify the Plant Supervisor before leaving the plant and make suggestions for correcting any deficiencies.

- The filter in use is a Staplex Type TFAS pleated cellulose filter, 4 inches in diameter, which is mounted in a fixed housing drawing an effluent sample stream from an isokinetic stack probe. (Photo 3 and Figure 10)

- The evaluation of uranium emissions relies upon a gravimetric and chemical analysis of the filter and its contents, together with a proportionality factor to assess effluent emissions by comparing the volume of effluent sampled with the total stack throughput. The evaluation, however, is without a filter collection efficiency factor which will account for that small fraction of the particulate sample stream which passes through the filter.

- DWYER Rotameters with a 0-60 liter per minute range are used to test the stack sampler flow rate monthly. The Rotameter used during the uranium emission episode was calibrated on October 4, 1984 using a wet test meter, however, calibration of rotameters at NLO is ad hoc with no required frequency.

- The standard operating procedure for collector systems does not address the sampler or require the sampler for dust collector bag operation. The sampler in Plant 9 relies on the Hoffman High Vacuum Generator to be operating to obtain adequate flow rate across the sampler. Commencing November 27 and for approximately six days thereafter, operation of the dust collector continued with the Hoffman down for repairs.

- The IH&R Department issues a monthly Stack Discharge Report reflecting filter analyses results.

5. <u>Geiger Mueller Stack Monitor</u>

- The Ludlum Rate meter and Geiger Mueller detectors (See Exhibit 6) were installed upon seven stacks about two years ago to provide more sensitive indications of uranium losses as they occurred. Presently, 53 stacks exist without such detection systems. The plan was to judge the effectiveness of the radiation detection systems upon the seven stacks known to have higher emission rates and then extend usage to the remaining stacks if warranted.

- The Ludlum Model 177 Alarm Rate Meter has an audible and visual alarm which may be set on any of four scales, 0-500, 0-5000, 0-50,000, or 0-500,000 counts per minute. The physical location of the rate meter is in an area with industrial noise and removed from office spaces which make it difficult to recognize alarms when they occur.

- The alarm settings and scale positions are easily changed and could be adjusted by unauthorized personnel.

- The Ludlum Model 44-9 Pancake Geiger Mueller detector is positioned in the stack sample assembly to detect uranium beta/gama radiation from the sample filters (Photo 3).

- The rate meter and detector represent a sensitive indicator which, in addition to detecting major bag failures and pinhole leaks, also monitors the gradual buildup of uranium upon the filter as a consequence of nominal uranium penetration under design filtration conditions. As the filter loads normally, the rate meter will gradually increase, but usually remain below 50,000 counts per minute between filter changes, at Plant 9.

- The stack monitor was not addressed by any operating procedure or by an IH&R procedure.

- No permanent recordings nor slave alarms in manned areas are provided.

- No procedural setpoints were or have been established, nor any training provided for operator action if alarms were seen or heard.

- The IH&R Department has custody of the monitor operation and apparently on plant 9 had set the alarm at full range on the X100 scale when its alarm sounded on November 19, 1984. Changes between the X1000 and X100 scale took place several times during the September-December time frame (See Exhibit 7).

6. Administrative Controls

- The NLO Quality Assurance (QA) Program requires Quality Assurance Analyses (QAA) and Plans (QAP) to determine and prevent significant potential problems. The QAA and Plans are attached as Exhibits 8 and 9.

- The NLO QA program requires that a minor event report be written and submitted to the NLO Assistant Plant Manager within 24 hours after the event. Minor event is defined as: "Any unusual happening which did occur or might have taken place and caused a problem." Some examples are serious violations of operating procedures, a failure of emergency equipment, injuries if potentially serious, damage to equipment, etc. The supervisor must judge if the event is serious enough to require a report". No minor events were prepared on the plant 9 collector prior to commencement of the investigation. An example of a minor event is attached for information, Exhibit 10.

- NLO upper management holds daily meetings to discuss plant highlights. A listing of the highlights is typed and readied for the meeting which is held at 11:00 each day. During the September through December 7, 1984 time frame, the following entries concerned the Plant 9 collector:

  November 12: The N-Reactor Furnaces have lost seven shifts while Maintenance is repairing the dust collectors. They are still down this morning.

  November 13: The American Dust Collector was repaired at the end of the first shift yesterday, and we resumed operation on the second shift.

  November 27: We had a fire in the cyclone of the American Dust Collector (Hoffman High Vacuum Unit) in Plant 9 this morning. We plan to use the portable dust collector and continue to operate. Maintenance plans to replace the bottom cone of the cyclone.

  December 7: The N-Reactor Furnaces have been shut down to allow thorough inspection of the American Air Filter Dust Collector. Stack samples have indicated enriched uranium losses from this dust collector. N-Reactor casting will not be resumed until this problem is resolved.

- NLO has not established any plant action level, emissions tracking or control measures to be utilized to trigger a plant response, to reduce or eliminate excess emissions. An effective ALARA program from which to closely monitor and control uranium emissions has not been implemented.

- No internal QA audits specific to the plant 9 baghouse have been performed to evaluate the efficiency and effectiveness of the operation. Interviews would indicate that an internal appraisal system, to evaluate effectiveness and efficiency of management systems, is not in place but that all QAAs and QAPs are audited (i.e., reviewed) on an established frequency. An internal audit of the QAP-PROD-OG-5, Dust Collectors Systems in Production Plants was performed in May 1984. The audit included an item by item review of the plan and basically suggested several word changes which was reported in June 1984.

- The Assistant Manager indicated that it was standard practice of the various plants to maintain a shift log of the events that occur during operation, however, plant 9 was not maintaining such a log. This fact required reliance on the memories of several persons during the investigation.

- Plant 9 does maintain production logs and various operational checklists such as the operator's Dust Collector and Residue Report and Recorder Charts which were utilized during the investigation.

- Oak Ridge Order OR 5484.2 requires prompt notification of unusual occurrences to be made to DOE Contracting Officers/Contracting Officer' Representatives. The policy of the ORO order indicates that even events which do not qualify as unusual occurrences, yet are of interest to ORO, particularly as related to environment, safety, health, public information, security, quality, and programmatic matters should be informally communicated directly from the contractor to their ORO counterpart.

- DOE Order 5484.1 provides guidance for notification to DOE of occurrences which would give rise of inquiry by members of the press or public or where a press release is made.

- The Safety Analysis Report for Plant 9 has not been commenced and is scheduled for completion in the fourth quarter of fiscal year 1988. (Only a draft report for Plant 1 has been completed to date.)

7. Personnel

- There is no experienced, qualified staff health physicist working in the environmental area at the FMPC. The chief IH&R field representative and the chief of IH&R Department are experienced industrial hygienists.

[redacted]

- o Operational and the IH&R staff appear to be conditioned to tolerating large size releases because of the operational experiences of earlier years (1955-1972) when routine and upset losses were much higher than recent years.

- o Upper management has maintained the responsibility for reporting Unusual Occurrences to DOE and have relied on NLO administrative systems to kick up necessary reportable information. For this reason, management has not passed on specific DOE occurrence reporting requirements to lower levels.

- o A representative from the Safety Division is not a routine attendee at the daily plant meeting to discuss highlights.

8. <u>Health Physics Activities</u>

- o Routine health physics surveys performed at Plant 9 include quarterly ground floor and high platform alpha and beta/gamma surveys for both fixed and transferable uranium contamination. Comparisons of third and fourth quarter 1984 survey results (Exhibit 11) provide for a rough before and after incident contamination profile at Plant 9. No significant increase is noted in the general workplace.

- o About seventy personnel were reported by NLO to have been potentially exposed. This determination was completed about two weeks after the incident.

- o Routine breathing zone air samples for Plant 9 workers were compiled for the uranium release period September 4 - December 7, 1984 and compared with a comparable 1983 period which represents a minimal uranium emission period. The post incident samples appear to be slightly less than the 1983 results (Exhibit 12). The time weighted average exposures are well within DOE standards.

- o On December 14, 1984, special surveys were conducted in the vicinity of the baghouse on the south side of Plant 9, on and below the baghouse platforms near the stack, on the lower maintenance platform at the Hoffman Hi-vac unit, ground level underneath the baghouse and related plenums and on adjacent Plant 9 roof areas and drainage easements. Visual examination

[redacted]

revealed accumulations of wet, black residue in the roof drainage easement, the dyked area under the baghouse and on platforms near the stack. Uranium analyses of residue samples indicate uranium deposits upon the roof and high platform areas consistent with the uranium content identified in baghouse effluent (about 55% uranium) calculated to be about 9% of the total release. The ground level deposits appear to be associated with the elevated uranium content (62.6%) released during a minor fire that occurred in the Hoffman Hi-vac unit on November 27, 1984. Other uranium residue identified by this special survey are consistent with residual contamination levels generated from routine plant site operations.

o The most definitive health physics exposure data is the urinalysis and whole body analyses for the potentially exposed personnel. This data (Exhibit 12) yields no evidence of elevated exposure to the workers in the proximity of the Plant 9 baghouse.

9. Environmental Activities

- Seven permanent monitoring instruments located around the FMPC perimeter fence line did not detect any elevated levels of uranium during the timeframe of the recent accidental release, indicating that the uranium was primarily deposited on the plant site. This indicates that any off-site contamination from the recent accidental release was not readily discernable from that resulting from expected routine releases.

- As a result of the DOE CERCLA notification, the FMPC was visited on December 13, 1984, by representatives of the Ohio Environmental Protection Agency, the Ohio Disaster Services Agency, the Ohio Department of Health, the Southwestern Ohio Air Pollution Control Agency, and the Hamilton County Civil Defense Agency. Various environmental sampling collection methods and sampling data were reviewed with these representatives and feedback from the representatives did not indicate any concern regarding off-site contamination. Soil and milk samples have also been taken and results of their analysis were not available at the time of the report. Since the inhalation pathway is the most significant effective exposure pathway from U_3O_8 particles, the lack of effect to the ambient air is indicative that the levels of U_3O_8 in soil and milk, as a result of the Plant 9 excess emissions, will probably be within acceptable limits.

- During the past approximately thirty years of FMPC operation, uranium has been discharged to the environment via both the air and water pathways under both normal and upset operating conditions. The major discharges occurred during the 1950's and 1960's. During the past ten years, significant progress has been made in reducing both routine and accidental discharges of uranium to the environment. A comparison of discharges of uranium from baghouses during 1955 and 1984 is as follows:

	1955	1984
Total Loss, Kilograms Uranium	12,477	322
Uranium Metal Production, Metric Tons	6,500	5,400
Loss Per Metric Ton of Production, Kilograms Uranium	1.92	0.06
Number of Major Loss Incidents, Over 45 Kilograms Uranium	37	1

- Discharges of uranium from FMPC operations over the past 30 years have resulted in some accumulation of uranium in the soil, sediments, and groundwater in the area surrounding the plant. Current levels of uranium in these media are documented and evaluated in Environmental Monitoring Reports which are issued on an annual basis. The annual Environmental Monitoring Reports are furnished to such agencies as the U. S. Environmental Protection Agency, Region V, the Ohio Environmental Protection Agency, and Ohio Department of Health, and the Cincinnati Commission of Health.

- The annual Environmental Monitoring Report for 1983 indicates, on pages 34 through 39, that the radiological doses to residents living near the FMPC, both from ongoing operations and the effects of accumulated uranium in the environment, are far below the DOE dose limit standards of 1500 millirem to critical organs (the lung) or 500 millirem to the whole body.

[redacted]

IV. ANALYSIS

A. PHYSICAL CONDITION OF EQUIPMENT

The age, exterior location of the plant baghouse collection facility, and past years' budgetary constraints have contributed, in part, to the deteriorated physical condition of the equipment involved. It also appears that successful meeting of schedules during former austere budgetary periods has brought about a pride of accomplishment which centers upon production. A combination of these conditions may have fostered the continuance of a minimal maintenance program when production goals have been increased in recent years and the equipment had been designated for replacement in the near future.

There is no record of the lengths of the bags prior to their installation in early September 1984. The bag manufacturing specification indicates the end to end length is to be 21 feet, 10 inches, however, the baghouse expert team measured the true distance between flanges to be 21 feet, 10 1/4 inches. In mid-December, measurement of the bags after several months in service showed that 32 of the 45 bags are now 21 feet, 10 inches or less. The bag found loose and removed on December 7, 1984, measured 21 feet, 8 1/4 inches and the unused bags that were measured from Stores ranged from 21 feet, 5 inches to 21 feet, 2 3/8 inches. Operation of the Plant 9 baghouse also provides all necessary conditions (moisture, heat, and wool material) for shrinkage. In the case of Plant 9, additional in-leakage sources for moisture and heat from exposure to direct sunlight exist.

Because of the above facts, the potential for several bags to barely make connection on the upper and lower flanges during installation existed, particularly if the bags just met the procurement specification of 21 feet, 10 inches prior to installation.

The presence of joints were reported in the three western column rubber seals during the September 4 maintenance due to the lack of appropriately sized rubber seals in NLO stores. On November 9, five retainer brackets, two being bent, were discovered on the baghouse floor (See Photos 11 and 12). The moving blow ring with extended nozzle edges could catch upon protruding rubber seal edges at a joint. This action may result in a ripping action which could tear seals and force off seal retainers. The bends in the seal retainers appear to be the result of force exerted by the blow ring which is the only moving part. The bag discovered to be loose was disconnected at the top. Forces such as those exerted by one

[redacted]

or more retainers being directed upon a bag by the moving blow ring may have dislodged the bag. The simple wedging action of the blow ring against seal retainers may be sufficient to force the horizontal blow ring off center. The off center blow ring movement may apply disruptive force to bags as well as remove additional seal retainers.

B. INSPECTION AND TESTING

The baghouse continued to be operated despite elevated stack samples and radiation detector alarms because it was an accepted practice to do so until such time as a visual inspection confirmed the presence of uranium oxide in the baghouse. The visual baghouse inspections were not adequate to identify uranium oxide at all locations within the baghouse.

The monthly stack sample check is also a visual inspection upon a pleated, convoluted filter matrix relying upon a trained eye to estimate significant oxide deposits in difficult to view filter folds (See Photo 3). The monthly filter inspections appear to be subject to considerable variability of detection limits among various IH&R personnel and, moreover, do not constitute a sensitive method from which to control emissions but rather represent, largely, an after the fact indicator to be firmed up by subsequent gravimetric and chemical analyses. The lack of a uniform, continuous flow across the filter and collection efficiency correction factor combine to diminish measurement precision in a manner which would likely underestimate the true uranium emission rates.

The differential pressure readout is primarily used to trigger bag cleaning and can only be considered a very crude indicator which would only detect a severe, multi-bag failure in a manner which would not permit timely actions to avert significant releases.

The Ludlum Rate Meter and Geiger-Mueller Detection System does appear to represent a sensitive indicator of stack losses in a timely manner which may permit effective emissions control. During routine operation conditions at design filtration, there is residual sample filter loading and, consequently, a gradual increase in count rates. Therefore, it is necessary to identify excess counts from those expected from normal build-up. This distinction is simplified when sudden bag failures, such as bag detachments occur, since the rate meter would rapidly increase and may alarm; however, for pinhole leaks and gradual failures, the increases may not be readily discernible and, hence, go unnoticed. Moreover, the lack of formal monitoring requirements, absence of readout recordings, and the difficult to view location selected for the rate meter combine to create circumstances whereby alarms might go unnoticed and certainly any gradual excess build-up of rate meter counts corresponding to a gradual failure such as worn bags with increasing numbers of pinholes would likely be unrecognized.

There appears to be a lack of coordinated, aggressive efforts to minimize uranium releases as evident from the casual visua inspection practices used for both the baghouse and stack samplers; the ad hoc manner in which the radiation detectors had been used for two years; lack of clear cut guidance for interpretation of results; or preset action plans to mitigate releases based upon knowledge of consequences.

C. MANAGEMENT CONTROL

1. Communications and Execution of Procedures

- NLO pursued a management system based on the expectation that each subsequent lower level, somehow knew what was the correct way to respond to unusual occurrences. Key people within the IH&R Department who were responsible for collecting the stack sampler data and providing interpretations of its significanc to operating management personnel had limited formal Health Physics training and did not aggressively appl ALARA philosophy. These people performed their dutie in an independent fashion and failed to take advantag of other Health Physics expertise.

- DOE orders, which provide some cogent examples of events which require reporting, were not disseminated to lower eschelons for fear of inducing "over reporting". NLO management expected its definition o "Minor Event" to elicit the proper response from NLO employees, in the event of an unusual occurrence, tha would fulfill DOE Order requirements.

- IH&R professionals continued to casually develop data which indicated that the environment was being insulted. The IH&R Department did not realize the significance of the data it generated and, therefore, could not properly advise the production management staff about the stack sampler readings nor recommend shutdown of operations. Despite evidence from two monitoring devices showing a baghouse problem, NLO operating and IH&R Department personnel allowed the operation which was causing the problem to continue. There was no perception of the need to consult with higher health and safety or production management at NLO or with DOE.

- First line IH&R Department and production personnel made statements to the Board to the effect that the losses indicated by the Plant 9 stack sampler were no significant when related to FMPC experience of twenty to thirty years ago. Although the executive management of NLO displayed a sensitivity to the incident's releases, this sensitivity was not widespread in the plant. Finally, late into the incident, it took an inquiry by the Plant Manager on November 30 to precipitate an investigation into the excess emissions reported as of that date. On December 3, the Plants 5, 6, and 9 Department Superintendent decided to continue to operate while the IH&R Department developed more data. Therefore, the incident continued for another seven days beyond November 30.

- o The Director of the Health and Safety Division is not a regular member of the daily meeting to review highlights of the plant. His presence could have contributed to upper management awareness of releases, fires, etc.

- o NLO failed to have procedures in place that would allow for compliance with DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Reporting Requirements" (See Chapter I, m. and n.). On November 30, the Plant management knew that NLO had measured two large, unanticipated releases yet NLO failed to notify the DOE.

- o NLO management became aware of the exposure of the Hoffman unit cyclone repair crew to U_3O_8 dust of November 29 over two weeks after the exposure. This late perception made the use of the quick urinalysis test procedure for assessing internal uptake moot.

- o NLO senior management believed that the Geiger counter monitors were routinely and effectively being utilized as an aid to controlling emissions.

2. Procedures

There were only two procedures (Exhibits 5 and 13) which describe the dust collector system equipment and the stack sampler. No procedure mentioned the two year old stack monitor. The two procedures were plantwide documents which provide great flexibility, while depending on subjective interpretations and judgments to accomplish goals. For example, the procedure covering the collector system lacks specificity to operators for the need for stack monitoring equipment to be functional prior to placing the dust collector system in operation. Actions to be taken if stack monitor equipment fail while in operation is not addressed. The sampler procedure requiring the IH&R technician to estimate weight of soiled material is also subjective.

3. Quality Assurance

Although both the dust collector and dust bags had an associated QA Analysis and Plan, these documents faile accomplish their objective, which was to prevent this of unacceptable situation by implementing preventive measures. During the review, several other QA programmatic failures were noted which occurred appare previously, and definitely during, the September to December time frame and contributed to this situation. Significant failures found were:

a. The bag procurement specification has not dictated proper bag size since issuance of the original specification in the 1960s.

b. No timely "minor event" reports were prepared, nor notified although items were encountered as followe

   i. Bags too short for installation were obtained f Stores.

   ii. Loose bags were found on two separate occasions

   iii. A fire occurred. This fire also resulted in th loss of the capability to measure emissions for approximately the next six days.

   iv. Blow ring maintenance was required in November after major repairs had recently been performed September.

   v. Personnel were exposed to oxide.

   vi. Sampler results of large emissions could not be correlated to a physical operational problem by visual inspection.

c. Acceptance of equipment (bags) continually being obtained without specific measurable criteria or certification.

d. Lack of procedures which addressed monitor alarm action although a specific action of the QA analysis was to be familiar with SOP on alarms.

e. A lack of a check and balance system which would provide management with objective feedback in the effectiveness and efficiency of the QA program.

f. Lack of procedures which require that a baghouse and associated facilities be shut down if the stack sampling capability is lost. The loss of the operation og the Hoffman High Vacuum Unit should have resulted in a shutdown of the Plant 9 baghouse.

g. Lack of procedures to designate personnel authorized to adjust radiation alarm set points.

It appears the existence of the above problems can continue unless a better communication and understanding occurs throughout all levels of the NLO organization on how all parts of its QA program is to be implemented and maintained.

D. REGULATORY ISSUES

Controversy surrounds the issue of CERCLA requirements as they pertain to FMPC operations. NLO upper management indicated that formal DOE guidance had not required full compliance with all CERCLA requirements. This guidance was later determined to be a 1981 letter (Exhibit 14) which only required ORO contractors to report accidental or episodic hazardous substance releases for which remedial action might be necessary. DOE staff members indicate that they verbally advised the NLO Director of Health and Safety as recently as the spring of 1984 to meet CERCLA requirements, but no written guidance which revises the 1981 memorandum have been issued. The DOE letter remained, forgotten, in the DOE files. NLO brought this letter to the attention of DOE after December 7, 1984. Nevertheless, the confusion as to CERCLA requirements did apparently prevent timely reporting by lower management of inadvertent discharges at the one pound per twenty-four hour level, pursuant to CERCLA.

Irrespective of parallel requirements to report under the Environmental Protection Agency CERCLA provisions, the releases were significant enough to be reported, as they occurred, to DOE per the DOE Unusual Occurrence Order. They were not reported to DOE until the incident was over.

o DOE Order 5480.1, "Environmental Protection, Safety and Health Protection Program for DOE Operations," requires that all DOE operating sites maintain a program to manage and reduce radioactive releases to as low as reasonably achievable (ALARA). NLO IH&R Department staff were not acquainted with the requirement to have an active ALARA program to manage emissions during the course of the year.

- The Ohio Air Pollution Control Code requires that malfunctions of air pollution control equipment which result in the violation of emission standards are to be reported to the Ohio Environmental Protection Agency. environmental oversight procedures did not provide for recognition and compliance with this regulatory requirement.

E. AMELIORATION

The Plant 9 baghouse was shut down on December 7 and tests conducted prior to restart. All baghouses and associated stacks were placed on a more frequent monitoring schedule. a result, the Plant 9 and Plant 5 baghouse operations were ceased on December 14 and 18th, respectively, by order of DC and NLO following timely identification of slightly higher than normal release rates. DOE and NLO actions were timely and decisive in preventing unnecessary uranium emissions. [has ordered that all the units in question shall remain shut down until it is determined they can operate in a normal manner.

The on-site radiation safety response to the incident was t(conduct a special contamination survey a week after the episode of excessive uranium releases. The survey (Exhibit 11) was confined in scope to surface contamination in the immediate vicinity. No air contamination surveys were conducted except for the routine breathing zone samples whic were fortunately ongoing during and after the episode of excessive uranium emission. Although there does not appear be significant exposures to personnel at Plant 9, there were total of some 70 personnel potentially exposed, including other contractor personnel involved in a ventilation survey Plant 9. NLO staff were slow to identify potentially expose personnel and evaluate exposures. This may have been due, part, to earlier experiences of IH&R personnel with evaluati of similar or even greater releases without apparent exposur problems.

The environmental assessment consisted of gathering air, soi well water, cistern, and milk samples at the end of the emission episode. The response appeared to be timely and effective in evaluating the environmental consequences. The results to date indicate no measurable environmental impact.

[redacted]

V. CONCLUSIONS

A. FINDINGS

1. The attitude of IH&R personnel, Plant 9 operators, and line management regarding inspection and monitoring of baghouse leakage was somewhat casual and reflected earlier operational regulatory requirements and philosophies which had tolerated larger uranium losses.

2. The daily visual inspection practices at the Plant 9 baghouse were not adequate to identify uranium oxide leakage.

3. The Geiger Mueller radiation detection systems were not researched and developed to provide credible, clearcut information to management.

4. The monthly visual inspection of stack filters is inadequate in frequency, scope, and quality to provide timely information in order to assure that stack releases are maintained as low as reasonably achievable.

5. Uranium control, monitoring equipment and practices have, in general, failed to keep pace with best available technology.

6. Bags can become loose at their flanges because of one or more of the following factors: improper sizing, weak bag attachments, shrinkage, blow ring forces exerted upon seal retainers and bags, vibration, restoring forces of a stretched bag, high differential pressure and/or being inadvertently knocked off during maintenance.

7. The bag procurement specifications and certification assurances required from vendors were less than adequate.

8. Many aspects of the NLO QA program were not adequately implemented (See Section IV.3.).

9. Significant omissions were present in the operation procedures (See Section IV.2.).

10. Subjective judgment instead of measurable criteria is utilized to accept and operate equipment.

11. The level of authority which approves deviations and variances has not been established. In the bag or air seal installation, deviation approval authority appears to be improperly accepted by the maintenance personnel installing such equipment.

[redacted]

12. Implementation of internal and external reporting on occurrences is less than adequate.

13. The management of NLO had failed to insure that its environmental protection professionals had established : maintained an effective excess emissions reduction and control program incorporating ALARA practices.

14. The DOE Oak Ridge functional appraisal program failed tc identify and assure correction for significant causal factors.

B. PROBABLE CAUSES

1. A casual and sometimes frustrated attitude towards contr of uranium emissions in accordance with increasingly restrictive contemporary standards and practices. This appears to be due, in part, to the difficulties encountered in operating a tightly budgeted uranium production plant with emissions control equipment which borders upon obsolescence.

2. Visual inspections were inadequate and knowledge of radiation monitoring systems was insufficient to provide timely, useful information to management regarding the extent of uranium emissions and, more importantly, the significance of those levels as compared with appropriat standards and reporting requirements.

3. The Plant 9 baghouse operated with undetected loose bags which were only visible during physical entry. The bags became loose due to reason(s) stated previously in Findi number 6. The bag discovered loose on November 9 most likely became dislodged during the blow ring malfunction which may have caused retainers to act as levers. The December 7 bag which apparently shrank below tolerable limits probably worked its way loose by vibration and bl ring actions.

4. Failure of the QA Program to identify and implement necessary preventative actions and also to provide timel proper corrective actions for known problems at lower levels.

5. The lack of an effective ALARA program from which to closely monitor and control uranium emissions.

C. JUDGMENT OF NEEDS

1. A critical need exists to assure that cognizant line management, operators and IH&R staff are knowledgeable in appropriate reporting requirements for inadvertent uranium emissions and are committed to effective control strategies which maintain uranium emissions as low as reasonably achievable.

2. A need exists for management control that provides clearcut implementation of procedures for abatement actions and operational curtailment whenever uranium releases may potentially exceed acceptable levels.

3. Inspection and monitoring programs for baghouse emissions should be upgraded to provide aggressive evaluative surveys of sufficient scope, frequency, and quality to assure that inadvertent releases and routine emissions are minimized.

4. NLO needs to promptly evaluate exposure potential during significant uranium releases and assure that exposures are minimized.

5. A need exists to improve and streamline communications regarding minor event reports and other significant occurrences, between NLO lower and upper management levels (See Exhibit 15).

6. Evaluation and implementation of the team of baghouse experts recommendations as they apply to all baghouses should be performed.

7. NLO should establish means to evaluate efficiency and the effectiveness of in-place management control systems. These reviews should include, but not be limited to, the QA program, procurement, inspection, maintenance, and the environmental protection program.

8. A need exist to assure measurable acceptance criteria and vendor certification requirements are included in procurement packages. NLO management should also designate the proper authority which must approve procured and installed equipment deviations.

9. NLO needs to conform fully with CERCLA and all other regulatory requirements cited in this report.

10. The DOE Oak Ridge appraisal programs need to be evaluated to assure that the overall scope and depth is adequate to identify significant needs in the NLO environmental protection and quality assurance programs.

[redacted]

VI. SIGNATURES OF BOARD MEMBERS

J. R. Martin, *Chairman
Health Physicist, Health Protection Branch
DOE - Oak Ridge Operations Office

G. J. Marciante
Industrial Engineer, Weapons Division
DOE - Oak Ridge Operations Office

P. L. Slattery
Quality Assurance Engineer, Quality and Reliability Division
DOE - Oak Ridge Operations Office

*This member of the Board is a DOE-Certified Accident/Incident Investigator.

[redacted] 47