Buckman Laboratories International, Inc.

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November 6, 1991

Neutron Products, Inc.
22301 Mt. Ephraim Road
Dickerson, MD 20842

Attention: Mr. Frank Schwoerer

Dear Mr. Schwoerer,

Enclosed is the final report on work done with the swab samples taken from the storage pool. The results confirm that the slime is definitely microbiological in origin. We were able to isolate two different encapsulated (slime-forming) bacteria. The coccus form is most likely Siderocapsa sp., a metal oxidizing bacterium that is often found in low nutrient ultrapure water systems. It obtains it's energy source nutrients from the metal surfaces such as stainless steel. As it develops a biofilm through the production of metabolic by-products, it provides an organic nutrient source for other bacteria such as the slime-forming bacillus type also isolated from the swabs. The combined growth of these microorganisms can produce a substantial slime mass and can raise the dissolved solids in ultrapure waters to a significant level. Long term, the Siderocapsa can contribute to the microbiologically influenced corrosion of the stainless steel and perhaps of the aluminum storage canisters.

I will call you after you have had a chance to review the report. At that time we can discuss what the next step should be.

We appreciate the opportunity to be of service, and your interest in the products and services of Buckman Laboratories.

Sincerely yours,

Richard W. Lutey, Ph.D.
Senior Consultant

Buckman Laboratories International, Inc.

Technical Service Laboratory Report

Reported By: MBH:R W LUTEY Date: 11/1/91

Company and Location: NEUTRON PRODUCTS, DICKERSON, MD

Reference: RLW DATED 10/30/91 Control No: 101940
Sample Received: 10/30/91

Identification of Sample(s): SAMPLE LABELED #1-#6

Statement of Problem: NONE STATED

Work Requested: STANDARD MICRO ANALYSIS

Report on Work Done:

The sample was analyzed as requested.

Microscopic examination of the cultured samples revealed the following:

1. bacillus and slime-forming bacillus bacteria
2. bacillus, coccoid, and slime-forming bacteria
3. bacillus and coccoid bacteria
4. bacillus and coccoid bacteria
5. bacillus and slime-forming bacillus bacteria
6. bacillus and coccoid bacteria. Also noted were slime-forming coccoid bacteria

If further technical assistance is needed, please advise.

TECHNICAL SERVICES -- THE CUSTOMER'S CHOICE

NEUTRON PRODUCTS, INC.

22301 Mt. Ephraim Road
Dickerson, MD 20842

MICROBIOLOGICAL SURVEY

November 18, 1991

BUCKMAN LABORATORIES INTERNATIONAL, INC
MEMPHIS, TN U.S.A.

INTRODUCTION

The following is a report and comments related to the microbiological survey made by Buckman Laboratories of the "Make-up Water and Pool Purification Systems" in limited access areas of Neutron Products, Inc. plant, Dickerson, MD. On November 18, 1991, visual inspection and sample collections were made of various sites in the system which included :

1. Swab samples taken from the backwash discharge line of the sand filters
2. Water sample taken from the backwash discharge line of the sand filters
3. Water sample taken from inlet to the RO unit
4. Water sample taken from the outlet of the RO unit
5. Swab samples taken from the wall of the 200 gal. holding tank
6. Water sample taken from the 200 gal. holding tank
7. Water sample taken from a line delivering water to production
8. Slime/biofouling deposit taken from production water holding tank
9. Swab samples from the south canal

The objective of this survey was to determine the possible source and path of contamination through the make-up water system to the main storage pool which contributes to the formation of slime found on the walls of the south canal and main storage pool. The slime deposit was characterized as microbiological in origin by previous examination of microflora isolated from swab samples taken 10/29/91 and results reported 11/6/91 in TSLR No. 101940.

In addition to determining the inoculum source for slime deposits, the survey should provide data on the characteristics of the microflora, specifically if it is potentially related to microbiologically influenced corrosion of stainless steel and/or aluminum.

The data and observations from this work will be used to develop a procedure for cleaning/sanitizing the system, and perhaps developing a means to prevent reoccurrence of the deposits.

VISUAL EXAMINATION

It was not possible to visually inspect each sampling site listed above. However, each water sample was inspected to determine the presence of suspended solids or flocs of biomass in the bulk water. The walls of the 200 gal. holding tank, the production water tank, the south canal, and the main storage pool were visually inspected. The following observations were made:

1. Water samples taken from the filter backwash discharge line (No. 2) and RO discharge lines (No. 4) contained a minimal amount of biomass flocs. No inorganic suspended solids were observed in these samples.

2. No biomass flocs were observed in samples No. 3, 6, and 7.

3. A small amount of brown suspended solids were contained in sample No. 7. However the amount was insufficient to determine if it was microbiological or inorganic in composition.

4. A thin film of biomass was observed on the walls of the 200 gal.holding tank. The film was easily removed by rubbing with the swab, and a dark brown residue remained on the swab after it was rubbed over the surface of the tank wall. It was not possible to readily see the brown residue when looking at the wall from the top of the tank. It was not possible to collect sufficient residue for further examination.

5. Sample No. 8, collected prior to the survey, was composed of a gray viscous supernate containing dispersed flocs white, brown, and light brown in color. The components of this sample were examined microscopically and observations are reported later.

6. A heavy biomass was observed on the walls and corners of the walls of the south canal. The biomass was colorless, approximately 1/8 inch thick, and extended from the water level to several inches below the water level. The biomass was readily removed from the surface by rubbing with the swabs. The residue on the swabs after rubbing the canal walls was colorless. The mass of the deposit was typical to that produced by slime forming bacteria.

7. Although not clearly seen, a biomass similar to that observed in the south canal, was observed on the walls of the main storage pool. Samples of this biomass were not retrieved for further examination or culturing.

MICROSCOPIC EXAMINATION

Samples of deposits collected from the swabs described earlier were examined using a compound light microscope at 1000 X with selective biological stains. The deposits examined included those collected from the inside of the backwash discharge line of the sand filters and the zeolite softeners, the walls of the 200 gal. holding tank, from the walls of the south canal, and the slime deposit collected from the process water system. Photomicrographs of the microscopic examinations are shown in the attachments.

1. Slime forming bacillus and coccus bacteria were present in the deposit collected from the surface of the sand filter backwash line (No. 1). These were similar to those found in the original swab sampling reported in TSLR No. 101940.

2. Both slime forming and non-slime forming bacillus bacteria, slime forming coccus bacteria, and scattered fragments of fungi hyphae were found in the brown residue rubbed from the surface of the 200 gal. holding tank(No. 5). A small amount of amorphous inorganic/organic non-microbiological material was also observed but in insufficient quantity to analyze chemically.

3. Slime forming bacillus and coccus bacteria were present in the deposit collected from the surface of the south canal (No. 9). These were similar to those found at the sand filter discharge and those collected from the original swab samplings.

4. Dense fungal mycelia were the primary composition of the microbiological flocs suspended in the viscous supernate of the deposit collected from the process water system (No. 8). The white and light brown flocs were similar in microbiological material as well as the dense fungal mycelia. The supernate contained significant levels of the slime forming bacillus and coccus bacteria found in all of the other samples.

MICROBIOLOGICAL CULTURE TESTS

Microbiological culturing tests were made from swab samples and bulk water

samples collected from the various locations listed earlier. Selective media culturing procedures were used to detect and characterize the presence of those microorganisms typically associated with the development of biomass (slime) deposition and microbiologically influenced corrosion (MIC). The procedures included :

Citrimide media for slime forming metal oxidizing bacilli and cocci (SMOB)

A.P.I. media for sulfate reducing bacteria (SRB) Note: requires 14 days incubation

Nutrient agar media for aerobic bacteria (ANA)

Nitrite media for acid producing bacteria (APB)

Nitrate media for ammonia producing bacteria (CPB)

Mycophil media for filamentous fungi (MFF)

All microbiological tests were made within 24 hours of sample collection. Streak cultures were made from the swab samples and results are reported as positive or negative. Dilution plate cultures were made from the water samples and results are reported as total colony forming units (in 1000s) per mL of sample.

Results after 48 hours incubation at 37 C.

Sample	SMOB	SRB	ANA	APB	CPB	MFF
No. 1 Swab filter backwash	pos.	N/A	pos.	pos.	neg.	neg.
No. 5 Swab 200 gal.tank	pos.	N/A	pos.	pos.	neg.	pos.
No. 9 Swab South canal	pos.	N/A	pos.	neg.	neg.	neg.
No. 8 Slime process water	pos.	N/A	pos.	pos.	pos.	pos.
No. 2 Filter backwash water	>100	N/A	>100	>10	<10	<10
No. 3 Inlet RO water	15	N/A	55	<10	<10	<10
No. 4 Outlet RO water	22	N/A	36	<10	<10	<10
No. 6 200 gal. tank water	87	N/A	>100	<10	<10	<10
No. 7 Process water	>100	N/A	>100	<10	<10	<10

Note: SRB data will be available 12/10/91

DISCUSSION AND CONCLUSIONS

The visual examinations, microscopic examinations, and microbiological culturing tests confirm the conclusion that the deposits found in the south canal and main storage pool are microbiological in origin. These results further indicate that the massive biofouling deposits found in the process water system also are microbiological in origin.

The deposits found on the walls of the water holding tanks located in the pretreatment sites and the process water sites were composed of a microflora that was dominantly fungal. Typically these types of deposits develop over an extended period of time, usually in succession after the deposition of a biomass produced by slime forming bacteria.

The deposits collected at the south canal were composed of a microflora that was dominantly slime forming bacteria. Typically these types of microorganisms have a more rapid reproduction rate and can produce a biomass in a relatively short time. The data indicate also that the slime forming coccus bacteria may be metal oxidizing (SMOB). This would account for the initial establishment of the microflora in a relatively nutrient free environment. Subsequent progression of the mixed microflora may be a result of the nutrients provided by the growth of the SMOB microorganisms.

Although the microorganisms isolated from the system included those potentially involved with MIC, no conclusions regarding this concern can be made at this time. Further investigations are required to determine the relationship of the microflora to any alleged MIC.

Tracking the path of the contamination from the incoming water to the pretreatmant sites of the system, through the pretreatment process, and to the points of treated water use confirm that the entire system has been contaminated with the slime forming bacteria. The total population of the microflora in the bulk water samples was relatively low. This indicated that primary source of the existing contamination is the surfaces of the system itself rather than the bulk water. This is not unexpected since the microorganisms involved with the deposits are sessile colonizing and exist in the bulk water as planktonic microorganisms only in low numbers.

It appears as if the objective of the survey has been achieved. The next step would be to implement a program to clean the system from the inlet to the pretreatment sites and extend through to the sites where the treated water is used. The program will require the following:

1. Mechanically remove as much of the existing deposits as possible.

2. Divide the cleaning process into three steps, starting at the inlet to the pretreatment to the point of separation of water going to process use and water going to limited access area use. The second step would include cleaning the process system, and the third step cleaning the limited access area.

3. Remove components of the system that potentially could contribute to high levels of RAD waste when cleaning and "sanitizing" the system, e.g. resins in the demineralization units and filters in the LAA.

4. Make provisions for recirculating, flushing, and disposing of water from the non-LAA segments of the system.

5. Apply an oxidizing biocide that would degrade in a short time without leaving residual dissolved solids in the system, particularly the main storage pool. Hydrogen peroxide may be the most suited option. It should be noted however, that even with extensive mechanical removal of existing organic deposits, high levels of the peroxide will be required to "sanitize" the surfaces where existing deposits are present.

6. Make provision for recirculating peroxide treated water through the LAA sites and filtering the solids removed from the surfaces during the cleaning and "sanitizing" steps. An estimate of time required for recirculation through the filters would be approximately that required to turn over the volume of the system 4 times.

7. Make provisions for concentrating and disposing of the solids filtered from the circulating water contained in the LAA system.

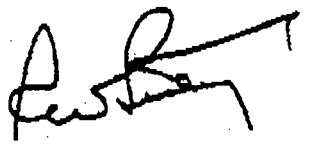
8. Carry out a complete microbiological survey and visual inspection of the system following the cleaning procedure. Complete all repairs and component replacements required.

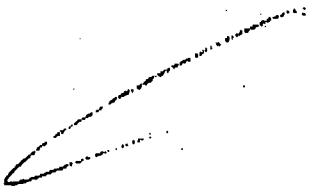
9. Make provisions for a routine maintenance treatment with peroxide and a routine " housekeeping " procedure to prevent the re-establishment of the sessile microflora in the system following cleaning.

These comments and discussion are provided for consideration based on the information available at this time. It is suggested this report be reviewed and then a proposed plan be developed for the mitigation of existing conditions. If there are any questions or if further information is required feel free to contact the writer.

Submitted By: Richard W. Lutey, Ph.D.
Senior Consultant
Buckman Laboratories International, Inc.

November 25, 1991





RADIOLOGICAL HEALTH PROJECTS - STATUS AND ACCOMPLISHMENTS

September 1991

This section of the monthly report deals with ongoing projects related to radiological health protection.

Cleanup of the Pools and Canals in the Limited Access Area

Inventory of cobalt-60 encapsulations:

Old sources, source components, and stainless steel waste tubes stored in the main pool were inventoried during the month. There are approximately 1,350 old sources and source components and 750 waste tubes. The inventory has categorized these items by size, but not, as yet, by their cobalt-60 activity or cladding integrity. Some of the items are almost certainly leakers because, as calculated from the pool activity and the flow and cobalt-removal efficiency of the pool purification system, about 0.05 curies of cobalt-60 per day are being leaked (or leached) into the pool water. A program is under development for identifying and reencapsulating leaking items, along with further categorizing and consolidating them into fewer encapsulations to facilitate periodic leak testing.

Water conditions:

During the entire month the radioactivity level in the main pool was above the level requiring RSO notification. Radioactivity concentrations were as follows:

	On 9/3/91	Max (date)	On 9/30/91
North canal	6.3E-5	8.3E-5 (9/04)	4.2E-5
South canal	1.7E-4	1.9E-4 (9/06)	1.0E-4
Main pool	1.8E-3	3.1E-3 (9/06)	9.5E-4

The ranges of pH and conductivity of the water in the canals and main pool remained essentially the same as during the preceding month. The instrument for measuring conductivity required replacement, and the new instrument indicated slightly lower values, particularly below about 15 umho/cm. The south canal and main pool temperatures were slightly higher because approximately 500,000 curies of cobalt-60 were added to the in-pool inventory early in the month.

	pH	Conductivity	Temperature
North canal	7.0-7.2	2-10 umho/cm	78-89F
Main pool & south canal	7.2-7.5	38-45 umho/cm	83-96F

We are continuing to observe a slimy substance on the walls, filters, and long-handled tools in the main pool and south canal. The substance is believed to be a product of biological growth in the water. The slime makes long-handled tools slippery to use and clogs the filters, thereby reducing the flow rate of the pool cooling and purification system. Additionally, local corrosion (e.g., pitting) is known to result from the presence of some types of biological growth. Treating the water with hydrogen peroxide or ozone has been successful in eliminating biological growth at nuclear power plants. We have attempted to grow a culture in the laboratory in water removed from the main pool, in order to test remedial measures in the laboratory. To date the program has been unsuccessful. An alternative action plan is being considered.

Radwaste Management

Discussions continued with MDR/RHP about our plans for temporary onsite storage from late-1992 through mid-1997, but without resolution. Although it appears that progress is being made towards agreement on the conceptual plan, discussions to date have been inconclusive.

Self-Contained Irradiators

The other two self-contained irradiators that have been in storage at Neutron Products, were disassembled and the shielded sources were put into the new ocean-type container for storage until the sources can be removed for long term storage pending disposal. The source strengths as of May 1, 1991 were (b)(4) (b)(4) respectively.

Storage and Inventory of Depleted Uranium Metal Parts

On August 29, 1991, we submitted to MDR the notifications required by regulation for the possession of depleted uranium metal parts and commercial products under the General License designed for that purpose. In September, we initiated the modification of an existing room that will serve as the facility for storing and controlling said parts and products; and notified RHP that we would welcome its inspection and comments at its convenience.

FS:12

RADIOLOGICAL HEALTH PROJECTS - STATUS AND ACCOMPLISHMENTS

August 1991

This section of the monthly report deals with ongoing projects related to radiological health protection.

Cleanup of the Pools and Canals in the Limited Access Area

Leak testing of old sources:

In August two new leak testing fixtures were put into operation and leak testing of old sources and waste tubes, stored in the main pool, was begun. During the month, 40 clad coils were tested for leakage. Three coils were found to have cladding defects, which allowed leaching of cobalt-60 into the pool water. These coils were moved to the hot cell and encapsulated in 9/16" diameter by 24" long stainless steel tubing. The activities of the encapsulated coils were too low to be measured by the in-cell calibrator, but were inferred as 100 to 200 curies each by noting the readings of the in-cell monitor with the sources at various distances from it.

Water conditions:

Radioactivity concentrations (uCi/cc) are listed below. The increase in main pool activity during the month probably resulted from stirring up sediment off the bottom in the course of source leak testing operations.

	On 8/1/91	Max (date)	On 8/30/91
North canal	7.3E-5	9.0E-5 (8/29)	6.9E-5
South canal	1.5E-4	2.5E-4 (8/27)	2.1E-4
Main pool	6.2E-4	4.3E-3 (8/27)	2.4E-3

The ranges of pH, conductivity, and temperature of the water in the canals and main pool remained essentially the same as during the last month.

	pH	Conductivity	Temperature
North canal	5.8-7.5	10-18 umho/cm	78-84 F
Main pool & south canal	7.2-7.5	42-60 umho/cm	84-88 F

Radwaste Management

A shipment of low-activity, bagged radwaste was made to SEG, Inc. on August 2, 1991. The shipment consisted of 550 cubic feet, containing about 100 mCi, in a lead shielded sea/land type container. Dose rate limits for shipping (ten mR/hour at two meters) prevented shipment of bags reading higher than 200 mR/hour at contact.

On August 8, the remaining bagged waste was put into nineteen 55-gallon drums, without being compacted. When we are again authorized to compact radwaste, additional waste can be put into these drums. Ten of the hotter drums (with contact rates ranging from 1 to 15 R/hour) were put into the drum vault. Subsequent measurements of radiation dose rates at the fence along Mt. Ephraim Road and in the second floor hallway above the receptionist showed reductions of approximately 40% from dose rates measured prior to August 8.

Self-Contained Irradiators

On August 13, 1991, two self-contained irradiators manufactured by Radiation Facilities, Inc., which have been in storage at Neutron Products, were disassembled. This consisted of: 1) securing the cobalt-60 source inside the shield; 2) removing the remainder of the irradiator, surveying the parts for contamination, and disposing of them as scrap; and, 3) putting the shielded source into the new ocean type container for storage until the source can be removed. Source strengths as of May 1, 1991 were [(b)(4)] curies, respectively. Two remaining irradiators of generally similar design are to be similarly disassembled and stored in September.

FS:12

RADIOLOGICAL HEALTH PROJECTS - STATUS AND ACCOMPLISHMENTS
October 1991

This section of the monthly report deals with ongoing projects related to radiological health protection.

Cleanup of the Pools and Canals in the Limited Access Area

Status of cobalt-60 capsules:

A program for identifying and reencapsulating leaking capsules is still under development. Attention during the month was given to development of a procedure for encapsulating bent and tangled clad coils, that are suspected of being leakers, into a 4-1/2" diameter by 18-20" long stainless steel waste tube.

Water conditions:

The radioactivity level in the main pool was above the level requiring RSO notification throughout the month. This indicates that activity is leaking and/or leaching into the pool at a rate of about three curies per month (1.5E-3 uCi/cc * 3785 cc/gallon * 12 gallons/minute * 1440 minutes/day * 30.5 days/month). Radioactivity concentrations in the main pool and north and south canals were as follows:

	On 10/1/91	Max (date)	On 10/31/91
North canal	3.9E-5	5.6E-5 (10/22)	1.9E-5
South canal	1.0E-4	1.7E-4 (10/28)	1.5E-4
Main pool	1.4E-3	2.3E-3 (10/28)	1.7E-3

The ranges of pH and conductivity of the water in the canals and main pool remained essentially the same as during the preceding month.

	pH	Conductivity	Temperature
North canal	6.3-7.2	2 umho/cm	80-86F
Main pool	7.0-7.4	38-45 umho/cm	86-96F
South canal	7.0-7.4	38-45 umho/cm	76-88F

During the month, a mixed-bed polishing demineralizer was installed between the plant water supply and the storage tank in the limited access area, from which makeup water is supplied to the LAA pools and the irradiator pools. The effect has been to reduce the conductivity of the makeup water from about 40 to about 2 umho/cm. This will result in better quality water in the pools and will substitute depletion of nonradioactive resin (in the new demineralizer) for depletion of radioactive resin in the pool circulating water systems.

A slimy substance continues to exist and to grow on the walls, filters, and long-handled tools in the main pool and south canal. The substance is believed to be a product of biological growth in the water. We are working with Dr. Richard W. Lutey of Buckman Laboratories, Memphis, Tennessee, to identify the organism(s) and develop a treatment program. Based on the symptoms we have observed, Dr. Lutey's initial guess was that the pool is infected with "sidero capsa," a metal oxidizing organism. Swab samples have been sent to Buckman Labs for culturing and analysis. A preliminary report on the identity of the organism(s) is expected during the first week in November. Development of the treatment program will follow.

Radwaste Management

During the course of an MDE/RHP audit of the -01 license activities, the auditors informed us their department has further questions about our plans for temporary onsite storage from late-1992 through mid-1997, and is writing us a letter. Activities are on hold until we receive that response.

Based on conversations with Chem-Nuclear and SEG, all type B radwaste casks are heavily scheduled for the balance of 1991. This probably precludes the possibility of our making a waste shipment of 100-150 curies until after January 1, 1992.

Radwaste Compaction

On October 9, MDE/RHP faxed a letter to us with detailed comments on our plan for compaction of radwaste, which was submitted in August 1989. A response to those comments and a revised plan for compaction are being prepared.

FS:12:RH-10-91

RADIOLOGICAL HEALTH PROJECTS - STATUS AND ACCOMPLISHMENTS

November 1991

This section of the monthly report deals with ongoing projects related to radiological health protection.

Cleanup of the Pools and Canals in the Limited Access Area

Status of cobalt-60 capsules:

No further identification and reencapsulation of leaking sources and capsules was accomplished during the month.

Water conditions:

The radioactivity level in the main pool continued above the level requiring RSO notification throughout the month. One of the factors contributing to the high specific activity was a reduced purification system flow rate (from 12-15 gpm down to 5-7 gpm), caused by collection of microbiological slime on the filters and the resin beds. Water conditions during the month were as follows:

Radioactivity concentrations (uCi/cc):

	On 11/1/91	Max (date)	On 11/27/91
North canal	2.8E-5	5.2E-5 (11/22)	3.8E-5
South canal	1.7E-4	2.7E-4 (11/23)	2.1E-4
Main pool	1.7E-3	2.3E-3 (11/22)	1.8E-3

Other conditions (range: min-max):

	pH	Conductivity	Temperature
North canal	6.8-6.9	2 umho/cm	74-82F
Main pool	7.0-7.4	44-46 umho/cm	84-93F
South canal	7.0-7.4	44-46 umho/cm	78-88F

The resin in the main pool was changed on November 27, 1991. In contrast to prior resin changes, the resin did not flow freely from the resin bottles. It appeared to be caked in the bottles, probably as a result of collection of slime on the resin, and it was necessary to dump the spent resin manually into the HIC. The aggregate radiation exposure for the resin change was approximately 1 man-rem

Following the resin change, the purification system flow rate returned to a normal value (14 gpm); the radioactivity concentration in the water

went to about half its previous value; and on December 4 the main pool conductivity was 2 umho/cm and the pH about 5.

Microbiological contamination:

Analysis of swab samples of slime from the walls of the main pool and south canal showed the presence of slime-forming and metal-oxidizing bacteria. Our consultant, Dr. Lutey of Buckman Laboratories, suspected that the plant water treatment system was the source of the microbiological organisms. On November 16 he came to Neutron Products and took swab and water samples from locations throughout the water treatment system. Analysis of the samples revealed the entire system to be contaminated with slime-forming bacteria. The system was flushed with about 1000 ppm hydrogen peroxide solution, which removed much of the microbiological contamination. In addition, the plant water treatment system is being upgraded.

Treatment of the water systems in the LAA will be more difficult because the water and slime are radioactive. We are developing a cleanup procedure that consists of mechanical removal of slime from the pool walls, followed by hydrogen peroxide treatment of the pools. Before initiating cleanup of the main pool and south canal, small-scale work will be done to ensure that we have effective procedures for collecting, treating, and disposing of the radioactive waste material that will be generated.

Radwaste Management

Our response to a letter from MDR/RHP, requesting further information about our plans for temporary on-site storage from late-1992 through mid-1997, has been drafted and is being reviewed internally.

Radwaste Compaction

Our response to the MDR/RHP letter of October 9 is still in the preparation stage. Meanwhile, small-scale R&D is being done on alternative methods of reducing the volume of low level radioactive waste.

Air Sampling System

Weekly measurements from our "mini-flow" system, in which a continuous flow of about 1 cfm is drawn off the exhaust duct and passed through a fiberglass