CONCEPTUAL DECOMMISSIONING PLAN FOR THE LONDON ROAD FACILITY

Revision 1

Submitted by:

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August 29, 1996

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INTRODUCTION

Background

Advanced Medical Systems, Inc. (AMS) manufactured and fabricated sealed sources of ^{60}Co for teletherapy and radiography machines at its facility at 1020 London Road, Cleveland, Ohio. Under the provisions of U. S. Nuclear Regulatory Commission (USNRC) license No. 34-19089-01, AMS used to possess up to 300,000 curies of ^{60}Co, and 2,200 kilograms of depleted uranium (nickel plated) for use as shielding material. However, the types and quantities of all licensed materials that are currently in the AMS inventory are shown in Table 1.

Purpose/Scope

Recently, AMS submitted an application to renew license No. 34-19089-01. As part of the renewal process, and pursuant to 10 CFR 40.36, a decommissioning funding plan is required. A conceptual decommissioning plan was submitted as a supplement to the renewal application tc describes the AMS plan to decommission the London Road facility after licensed activities are terminated.[1] Prior to USNRC approval of this plan, a Building Recovery Project was completed.[2] This project reduced the radioactive materials inventory at the London Road facility from approximately 60,000 curies in the form of sealed sources, bulk cobalt, packaged radioactive waste and residual contamination at the start of the project, to less than 10,000 curies in the form of sealed sources and residual contamination only at the end of the project. Therefore, Revision 1 of the conceptual decommissioning plan was prepared.

The extent of the decommissioning efforts described herein is intended to ensure that short- and long-term radiation exposures to workers and members of the general population after license termination are as low as reasonably achievable, and that the volume of radioactive waste to be disposed of is minimized. Included in this report is a description of the decommissioning objective for the AMS facility, the conceptual plan for decommissioning the site, an ALARA analysis to demonstrate that the preferred decommissioning methodology is consistent with the requirements of 10 CFR 20.1101, and a conservative estimate of the cost for achieving the decommissioning objective. The decommissioning funding plan for AMS, submitted under separate cover, is based upon the findings of this report.

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[1] Integrated Environmental Management, Inc., Report No. 94009/G-3114, "Conceptual Decommissioning Plan for the London Road Facility", October 20, 1995.

[2] Integrated Environmental Management, Inc., Report No. 94009/G-6125, "Building Recovery Project", June 10, 1996.

ITEMS TO BE DECOMMISSIONED

AMS operations that involve licensed radioactive materials occupy approximately 25% of an 80,000 square foot warehouse and manufacturing building at the London Road address. The main floor of this three-story area includes an office area, the Isotope Shop area, a hot cell, a source storage area and irradiation facility, a shielded work room, and miscellaneous unoccupied areas. The second floor contains additional unoccupied office space, a mechanical equipment room, and the ventilation system equipment room. The basement contains a waste storage area, additional unoccupied space, and a liquid waste holdup tank room (WHUT Room). The majority of the 6.3-acre property is covered with asphalt or concrete.

The AMS facility was built specifically for the manufacture and distribution of sealed sources. Licensed radioactive materials are located in specific areas within the AMS building. The following is a description of the various areas of the building, along with conservative estimates of the quantity of radioactive material that exists in each area as of the date of this report. This information is also summarized in Table 2.

Hot Cell

The Hot Cell was designed and equipped to encapsulate sources of radioactive material used for medical therapy and industrial radiography. The cell is six (6) feet square, has 5.5-foot thick concrete walls, and a four-foot thick floor and ceiling. There is a stainless steel floor pan in the cell, and 0.25-inch (thick) by 11 foot tall steel wall plates. The cell has a six (6) foot wide, 42-ton hinged door at the rear, and a 60-inch (thick) viewing window at the cell front.

Remote handling is accomplished with a pair of manipulators and a two-ton overhead crane. Every item of equipment in the cell and every item in the cell structure is removable. The location of the Hot Cell on the first floor of the AMS building.

The Hot Cell is a "Restricted Area". It currently contains approximately 4,000 curies of ^{60}Co and less than one (1) curie of residual surface contamination.[3] Because of the structural integrity of the hot cell, this radioactivity would not disperse in the event of a fire, flood or building damage.[4]

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[3] These sources are located under a cell plug that has become affixed to the point that it cannot be removed without incurring damage to the cell.

[4] Meschter, Robert, Advanced Medical Systems, Inc., written communication to John Madera, U. S. Nuclear
(continued...)

The average ambient exposure rates within the cell are approximately 12 R per hour, with rates up to 200 R per hour on contact with certain surfaces.

Isotope Shop

The Isotope Shop is located on the first floor next to the Hot Cell. This area has a concrete floor, ceiling, and interior walls. The exterior walls are of painted brick. Cobalt-60 sources are transported around this area in shielded containers.[5] Within the Isotope Shop is the Source Garden. The Isotope Shop is a "Restricted Area", but it does not contain a significant inventory of licensed material.[6]

Source Garden

The Source Garden is located in the southwest corner of the building within the Isotope Shop area. This storage location houses 54 vertical tubes in a six-foot square well that extends from the first floor to the basement. An L-shaped shield around the well at the basement level is provided by two sand-filled compartments which, at one time, were accessible through manholes in the first floor.[7] The high-density concrete walls that hold the sand shield are two-feet thick.

The 54 storage tubes in the Source Garden are arranged in a nine-by-seven rectangular array. The nine center spaces of the array are open and fitted with an irradiation plug which accommodates objects up to 8.5 inches square by 12 inches high. The source tubes terminate in a metal container through which cooling air is drawn from the room to the high-efficiency particulate air- (HEPA-) filtered exhaust system.

The Source Garden is in a "Restricted Area", but it does not contain a significant quantity of licensed radioactive materials.[8] The contamination levels currently average about 5,000 disintegrations per minute (dpm) per 100 cm^2. If it is conservatively assumed that the flat surfaces in the Source Garden are uniformly contaminated at this level, and that the surface area is 38 m^2,

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[4] (...continued)
Regulatory Commission, June 7, 1996.

[5] One such container is the "transfer monster", which is used to move sources in and out of the Hot Cell.

[6] This area was decontaminated during the Building Recovery Project and all residual radioactivity was removed.

[7] These manholes have been sealed by multiple layers of paint that have been placed there over the years.

[8] All of the sources in the Source Garden were removed and the area was decontaminated during the Building Recovery Project.

there is a total of 8.54 microcuries (8.54×10^{-6} curies) of residual contamination currently in this area.

Decontamination Room

The Decontamination Room is located behind the Hot Cell and at the side of the Isotope Shop. This area has a concrete floor and walls. The room provides space enough for opening the Hot Cell door into the ventilation controlled space of the Decontamination Room. It is equipped with water outlets and a floor drain which was used during decontamination operations that were on-going prior to 1989.

The Decontamination Room is a "Restricted Area", but it does not contain a significant quantity of licensed radioactive materials.[9] The contamination levels in this 12 ft. by 12 ft. room are approximately 10,000 dpm per 100 cm^2. If it is conservatively assumed that the flat surfaces in the Decontamination Room are uniformly contaminated at this level, and that the surface area is 18 m^2, there is a total of 1.13 microcuries (1.13×10^{-6} curies) of residual contamination currently in this area.

High Level Waste Storage Room

The High Level Waste Storage Room is located next to the Hot Cell on the first floor. This room has a concrete floor, walls and ceiling. At one time there were drums of waste stored here, along with spent HEPA filters. The High Level Waste Storage Room is a "Restricted Area", but does not contain licensed radioactive materials.[10] Contamination levels are insignificant (e.g., below the RSP-009 release criteria).

Clean Equipment Room

The Clean Equipment Room is located on the second floor. This room has a concrete floor, walls and ceiling. It contains all of the facility service equipment with the exception of the HEPA ventilation equipment.

The Clean Equipment Room is a "Restricted Area" that does not contain licensable materials of significance. It currently has average ambient exposure rates of less than one (1) mR per hour. Contamination levels that are less than the RSP-009 criteria.

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[9] All of the materials in this room, including contaminated tools, lead blankets and solid waste from a previous Hot Cell decontamination effort were removed, and gross area decontamination was performed during the Building Recovery Project.

[10] The waste stored in this area was disposed of during the Building Recovery Project.

HEPA Equipment Room

The HEPA Equipment Room is located on the second floor of the facility. This room has a concrete floor, walls and ceiling, and contains the facility HEPA ventilation equipment. There is one large HEPA exhaust blower that holds four (4) two-foot by two-foot HEPA filters in a housing. This system services all of the isotope areas except the Hot Cell. There is a small HEPA exhaust blower with only one HEPA filter in its housing to service the Hot Cell.

The HEPA Equipment Room is a "Restricted Area" that currently contains less than 0.05 curies of activity.[11] It has average ambient exposure rates of approximately 50 mR per hour. Contamination levels in the area average less than 10,000 dpm per 100 cm^2. If it is conservatively assumed that the flat surfaces in the HEPA Equipment Room are uniformly contaminated at this level, and that the surface area is 20 m^2, there is a total of 9.01 microcuries (9.01×10^{-6} curies) of residual contamination currently in this area.

Back Basement

The Back Basement is located in the basement. This room has a concrete floor and walls. At one time, the area was used to store drums of waste. There are approximately 500 high-density concrete blocks in the room that are positioned to provide shielding from the WHUT Room. The Back Basement is a "Restricted Area", but it contains no licensable radioactivity, and contamination levels are below the RSP-009 criteria.[12]

WHUT Room

The Waste Hold-Up Tank (WHUT) Room is located in the basement directly under the Hot Cell. This room has a concrete floor, walls and ceiling. The walls of the room are three feet thick to provide shielding from the room's contents.

The room contains a 100-gallon and a 500-gallon tank for liquid wastes as well as other ancillary items.[13] When the room was still in use, wastes were "held up" in the tanks until sampling/analysis confirmed that they could be discharged to the sewer system. However, in 1989 AMS ceased discharging liquid radioactive waste to the sewer system. Shortly thereafter, the WHUT Room was sealed.

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[11] The "spent" filters in the room were changed as part of the Building Recovery Project.

[12] All of the drums in this area were removed and the floors, walls and ceiling were decontaminated during the Building Recovery Project.

[13] Wright, K., "Waste Hold-Up Tank Room Survey", Scientific Ecology Group, Inc., February, 1995.

During the Building Recovery Project, the void spaces in the WHUT Room were filled with a hydraulically-impermeable (removable) grout in order to ensure hydraulic stability while the room remains sealed. Prior to grout injection, the exposure rates in the room ranged from 50 to 240 R per hour in accessible areas.

Front Basement

The Front Basement is located on the east side of the basement next to the WHUT Room. At one time, it consists of three rooms: the passageway between the front and back basement, the Chart Room, and the Blue Tank Room. However, the interior walls were removed during the Building Recovery Project. Currently, the area has concrete floors, ceiling and exterior walls.

The Front Basement is a "Restricted Area". However, it currently has average ambient exposure rates of about one (1) mR per hour due to the materials in the WHUT Room. The contamination levels that are less than the release criteria contained in RSP-009.[14]

Miscellaneous Restricted Areas

There are a number of miscellaneous areas within the AMS facility. These include the air lock, the Isotope Shop warehouse, portions of a caged storage area, and office areas on the second floor. These areas have been designated as "Restricted Areas". The average ambient exposure rates in these areas are indistinguishable from "background". The contamination levels are less than the release criteria contained in RSP-009.

Miscellaneous Unrestricted Areas

There are a number of other miscellaneous areas within the AMS facility that are not restricted for purposes of radiological control. These are a former chemistry laboratory, the Hot Cell control office, the first floor office areas, portions of a caged storage area, and the counting room. The exposure rates and contamination levels in these areas are not distinguishable from background.

Areas Outside of the Building

AMS and its predecessor disposed of ^{60}Co into the sanitary sewer system under the provisions of Title 10, Code of Federal Regulations, Part 20.303. All discharges were accounted for and below permissible limits.

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[14] The Front Basement was decontaminated during the Building Recovery Project.

As part of a 1989 decommissioning effort, the lateral connection from the AMS facility to the sewer system interceptor owned by the Northeast Ohio Regional Sewer District (NEORSD) was partially decontaminated and covered with a layer of concrete in order to stabilize residual materials. In May of 1989, AMS ceased generating any liquid radioactive waste, and discontinued the disposal of licensed material into the sanitary sewerage system.

Between August 17 and October 14, 1994, the USNRC performed a special inspection of the London Road interceptor and the lateral connection from the AMS building to the interceptor.[15] During this inspection, samples of sewer debris, water effluent, and a series of wipes were collected and analyzed. The findings of the inspection were that residual radioactive materials in excess of the criteria contained in USNRC Regulatory Guide 1.86, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material" were present in the interceptor in the immediate vicinity (outfall) of the AMS lateral connection.[16] However, there was no evidence of removable ^{60}Co activity above the release criteria in the outlet from the AMS processing drain, the sewer walls, or inside the lateral itself.[17]

Later in 1994, the NEORSD intentionally isolated AMS from the sewage treatment system. This action rendered the storm- and ground-water drainage system for the facility non-functional, increased the hydrostatic pressure on the foundation structure, and caused groundwater to flow into the basement of the AMS facility. AMS instituted remedial actions for "isolation and remediation of the radioactively contaminated manhole and sewer line exiting the facility to the London Road Interceptor", and recovery of the facility drainage system.

During the remedial activities, it was discovered that the underdrain system (e.g., drain tile and gravel layer) was contaminated with ^{60}Co. Removable activity as high as 100,000 dpm/100 cm^2 was noted in the drain tile during excavation and investigation efforts. However, the shale layer upon which the building is built and which forms the base of the footer drains, did not contain

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[15] The connection is comprised of a sewer line, a manhole, and a lateral.

[16] Removable activity in excess of 1,000 dpm per 100 cm^2 was found on the sewer interceptor brick directly below the AMS lateral. Other locations (e.g., the iron ladder below the lateral, the outer surfaces of the lateral, and at the 2:00 position of the lateral approximately one foot into the lateral from the interceptor) demonstrated measurable activity, but at levels well below the release criterion.

[17] A site characterization study performed by ORISE in 1989 confirms the lack of significant residual activity in the AMS system. During this study, ambient gamma exposure rates in excess of background were not identified in the vicinity of the lateral. Furthermore, soil samples collected in this area were negative for the presence of ^{60}Co.

detectable ^{60}Co. In fact, no ^{60}Co was identified other than between the drain tile and the shale. This finding confirms that contaminant migration did not occur.

AMS replaced the underdrains along the east (front) and south sides of the building were replaced and the area back-filled with clean gravel and soil. However, the underdrains in the vicinity of the Source Garden could not be replaced because of the presence of high ambient gamma exposure rates in the work area at the time.[18] If it is assumed that 20 linear feet of foundation drains remain outside the Source Garden, and that this length is uniformly contaminated to levels of 100,000 dpm per 100 cm^2, approximately 0.768 millicuries (7.68×10^{-4} curies) remain in this location.[19]

Also, prior to abandoning the lateral connection that runs from the west side of the AMS facility to the London Road interceptor, the four-inch discharge line from the AMS building, the AMS manhole and the 15-inch lateral connection were filled with grout. In advance of this action, the ambient exposure rates within the lateral were measured and found to be approximately one (1) milliR per hour. The exposure rate in the manhole prior to grouting ranged from 0.2 to 0.5 milliR per hour, with a maximum measured exposure rate of four (4) milliR per hour at the base. The contamination status of the lateral was determined using dry disk smears and a pancake GM detector. The results from this effort were negative for removable activity.

If it is assumed that the contamination inside the abandoned lateral and the manhole is evenly distributed, the Microshield code can be used to generate "dose rate-to-activity" conversion factors.[20] Applying these factors to the measured exposure rate of one (1) millirem per hour in the lateral and 0.5 milliR per hour in the manhole, translates into approximately 0.607 and 0.353 millicuries (6.07×10^{-4} and 3.53×10^{-4} curies), respectively, of residual radioactivity at this locations, for a total of 9.60 millicuries (9.60×10^{-4} curies).[21]

Depleted Uranium Inventory

AMS currently possesses approximately 2200 kilograms of depleted uranium for use as shielding and in the form of parts for teletherapy machines. The physical nature of this material is stable,

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[18] A concrete wall constructed between the abandoned drains and the new foundation drains, and the presence of an impermeable liner on the ground surface above the drainage systems serve to fully isolate the residual contamination in the abandoned drains from the new drainage system.

[19] Estimated activity as of August 14, 1996.

[20] Grove Engineering, Inc. Microshield 4.10, dated October, 1993.

[21] Estimated activity as of August 14, 1996.

and it has commercial value. Thus, it can be readily sold/transferred to other licensees when it is no longer required by AMS. Consequently, this material is not addressed further in this report.

APPLICABLE DECOMMISSIONING ALTERNATIVES

Description of Alternatives

Once a USNRC-licensed facility reaches the end of its useful operating life, it must be decommissioned. This typically means that the facility must be safely removed from service, and that all radioactive materials in excess of levels which would permit unrestricted use of the facility will be disposed of. However, the USNRC has determined that several decommissioning alternatives will potentially satisfy this general requirement. These are "No Action", DECON, SAFSTOR and ENTOMB.[22] The following are brief descriptions of each of these alternatives:

- No Action - This alternative implies that the licensee would simply abandon or leave the facility after ceasing operations.

- DECON - This alternative is to remove all radioactive materials such that residual levels permit the property to be released for unrestricted use. DECON would lead to termination of the facility license and facility re-use shortly after cessation of facility operations. Since DECON is generally completed within a few months or years following facility shutdown, personnel radiation exposures are generally higher than for options that spread the decommissioning work over longer time periods in order to take advantage of radioactive decay. Similarly, larger commitments of money and waste disposal site space are also required for DECON.

- SAFSTOR - This alternative places and maintains the facility in a condition that ensures the risk to members of the general public is acceptable, that the facility can be safely maintained in a shutdown condition to allow for radioactive decay, and that it can be subsequently decontaminated and released for unrestricted use at a later date (deferred decontamination). SAFSTOR typically consists of a short period of preparation for safe storage; a variable-length safe storage period of continuing care consisting of security, surveillance, and maintenance; and a short period of deferred decontamination.

- ENTOMB - This alternative requires the encasement of the facility in concrete to protect the public from radiation exposure until its radioactive contents have decayed to levels permitting unrestricted use of the facility.

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[22] Terms and definitions taken from NUREG-0568 (U. S. Nuclear Regulatory Commission, Office of Standards Development, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities", NUREG-0568, January, 1981).

The "no action" alternative is clearly unacceptable to both AMS, regulatory agencies, and state/local officials. Given the short half-life of the radioactivity at AMS, ENTOMB is also not considered to be a viable alternative for the AMS facility. Therefore, at AMS, only DECON and SAFSTOR are considered to be potentially applicable decommissioning alternatives.

Comparison of Alternatives

DECON is the more traditional approach to facility decommissioning. Its primary advantages are that it is relatively uncomplicated, eliminates the need for continued monitoring, and releases the facility for other uses within a relatively short time frame.[23] Activities under this option would include removal of contaminated equipment (e.g., hot cell contents, ventilation systems, packaged materials, sources), and decontamination of remaining room surfaces to eliminate residual radioactive materials above the release criteria, and performance of a final release survey.

DECON would require a large initial commitment of money, and would maximize the radiation exposure of personnel. It would also result in a higher disposal volume than as would be required for SAFSTOR. Table 3 shows the manpower estimate for the DECON alternative when applied to AMS.

SAFSTOR satisfies the requirements for protection of the public while minimizing initial commitments of time, labor, money, occupational radiation exposure, and waste disposal. Modifications to the facility would be limited to those designed to ensure the security of the building against intruders, and containment of the licensed inventory. As a result of radioactive decay of this material, reductions in personnel exposure and simplifications in the complexity of operations can be achieved by deferring major decontamination efforts for a period of years. Also, because much of the residual radioactivity present in the facility will have decayed to background levels after the storage period, the volume of material that must be packaged for disposal, if any, will be greatly reduced.

The primary disadvantage of SAFSTOR is that personnel familiar with the facility at the time of deferred decontamination may not be available. Consequently, more time for training and orientation would be needed if the procedures for final license termination are extensive. Other disadvantages might include the fact that the site could be tied up in a non-useful purpose for an extended period, regulatory uncertainties in the future, possible interferences by state or local

[23] Other advantages of DECON include the availability of a work force highly knowledgeable about the facility, and elimination of the need for long-term security, maintenance and surveillance.

agencies, and the continuing need for maintenance, security and surveillance. Table 3 shows the manpower estimate for the SAFSTOR alternative when applied to AMS.

Short-term Risks

Both DECON and SAFSTOR were evaluated with respect to their potential for increasing health and safety risks for members of the general public and workers involved in implementing each alternative at AMS. For this assessment, it was assumed that the general public will be protected from exposures by administrative and procedural controls. Therefore, the short-term impacts on this population group are considered to be negligible. It was also assumed that workers will follow ALARA procedures and all OSHA regulations, and that internal exposures will be prevented.

For the DECON option, the goal is to maintain radiation exposures to decommissioning workers to below regulatory limits. At AMS, the critical exposure time would be during source packaging and shipment, the removal/dismantling of the hoods, ventilation system, hot cell, source garden, and WHUT Room contents. For the work durations and exposure rates shown in Table 4, the total worker dose for the DECON alternative is estimated to be 46.7 person-rem.

For the SAFSTOR option, only minimal personnel exposures are anticipated as the facility is placed into a safe storage mode. Assuming that these activities are on-going for the person-days shown in Table 4, the total worker dose from external radiation is estimated to be 0.66 person-rem.

Long-Term Risks

The primary long-term risk incurred by humans after decommissioning is complete is exposure to the radioactive materials at the location of final deposition. For the DECON option, the long-term risks to members of the general public will be negligible. Also, for the ^{60}Co that is maintained inside of the building under SAFSTOR, the long-term risks to members of the general public will also be negligible. A previous assessment of the impact of the residual radioactivity that exists in the abandoned lateral and footer drains on members of the general public confirmed this conclusion.[24] Therefore, the relative long-term risks of DECON and SAFSTOR are equivalent, and will result in individual doses of members of the general population that are well-below the decommissioning objective.

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[24] Integrated Environmental Management, Inc., "ALARA Analysis for Remediation of the AMS Lateral Connection to the Sewer System", Report No. 94009/G-115, January 10, 1995.

Relative Costs

Table 3 shows the decommissioning cost estimates for DECON and SAFSTOR. These are based on a variety of cost-estimating data, including curves, generic unit costs, vendor information, conventional cost estimating guides, and prior similar estimates as modified by site-specific information. Both capital and operation and maintenance (O&M) costs were considered, where appropriate, along with O&M costs that may continue beyond implementation of the decommissioning action. Present-worth analysis was used.[25] The following are the assumptions used to develop Table 3.

- The AMS building will not be demolished during the decommissioning (i.e., the building structure will remain intact).

- There is no evidence that the soil underneath the building is contaminated. Any residual radioactivity that may exist in this area is clearly not mobile and will remain in place until eventual demolition of the building.[26] Because the soil activity will have decayed to negligible levels by this time, no removal action is required.

- Any remaining Co-60 sources or depleted uranium at the facility will be shipped off site to another licensee.

- To ensure pricing consistency, all radioactive materials will be assumed to disposed of at the radioactive burial facility located in Barnwell, South Carolina.

- The final release surveys will be performed pursuant to the guidance contained in NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination", USNRC Division of Regulatory Applications, 1990, with release criteria consistent with those contained in NUREG-1500, "Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment", USNRC Office of Nuclear Regulatory Research, 1994.

- The following unit costs were assumed: Local technician labor at $30/hour; local supervisory labor and licensing/regulatory support at a mean rate of at $60 per hour; B-25 box cost at $500 per box; personnel protective equipment at $20 per day per person; waste transport at $2.65 per mile; and radioactive waste disposal costs at $340 per cubic foot.

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[25] Since AMS will set aside cash to fund decommissioning in an interest-bearing account, the effects of inflation on the present-day costs are negated.

[26] Meschter, Robert, Advanced Medical Systems, Inc., written communication to John Madera, U. S. Nuclear Regulatory Commission, June 7, 1996.

- For the SAFSTOR option: The HEPA equipment room, and the hot cell will be placed in a safe storage condition for 20 years to allow decay of the radioactive materials present in those rooms, at which time they will be decontaminated; a total of two (2) hours per week (labor) are required for facility maintenance/surveillance during the SAFSTOR period; additional security systems and facility alarms will be installed to detect intrusion into the facility, water leakage, the presence of smoke/fire, and other incursions; the lateral connection to the sewer, old manhole, and abandoned drain tile will remain in place until the end of the SAFSTOR period, at which time it, and the remainder of the site, will require no additional action other than the final status survey.

- For the DECON option, it was assumed that all radioactive wastes generated during the decommissioning, including the remaining sealed sources, will be sent for disposal or transferred to an authorized recipient; a total of 3,000 cubic feet of the 9,000 cubic feet of soil generated during the sewer remediation project is contaminated such that off-site disposal is required; and that all contaminated areas of the facility will be decontaminated prior to performance of the final status survey.

Using the above assumptions, and assuming a 25% contingency, the cost estimates for DECON and SAFSTOR are $3,149,974 and $460,080, respectively.

Cost/Benefit Analysis and Selection of Preferred Alternative

According to the International Commission on Radiological Protection (ICRP), most decisions about human activities are based on an implicit form of balancing the costs and benefits leading to the conclusion that the conduct of a chosen practice is "worthwhile".[27] Thus the ICRP - as well as the USNRC - recommends that:

- No practice shall be adopted unless its introduction produces a positive net benefit;

- All exposures to ionizing radiation shall be kept as low as reasonably achievable, economic and societal factors being taken into account; and

- The dose equivalent to individuals shall not exceed applicable regulatory dose limits.

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[27] International Commission on Radiological Protection, ICRP Publication 55, "Optimization and Decision-Making in Radiological Protection", Pergamon Press, 1989.

With respect to radiological impacts only, a simple cost-benefit analysis can be performed by evaluating the following:

$$X + \alpha S = Minimum$$

where X = the cost of achieving the decommissioning objective, S = the collective dose associated with the decommissioning activities, and α = a constant expressing the cost assigned to the unit collective dose.[28] Table 5, which is a summary of the cost-benefit analysis for the two decommissioning options, clearly demonstrates that the SAFSTOR option provides the greatest benefit at the lowest cost when radiological impacts are considered.

[28] A value of $1,000 per person-rem for α from Title 10, Code of Federal Regulations, Part 50, Appendix I, Section II.D is assumed to be valid for this assessment.

CONCEPTUAL DECOMMISSIONING PLAN

When ready to decommission, the residual radioactivity of interest at AMS will consist primarily of residual materials generated as a result of source manufacturing and sealed sources. In its current state, the hazards to the general population from this licensable inventory are negligible. Furthermore, the short half-life of the materials demands consideration for delayed decommissioning in order to take advantage of radioactive decay. Therefore, consistent with the previous section, the SAFSTOR option presents the lowest overall radiological risk, results in the smallest volume of solid waste to be disposed of, and ensures that radiation exposures will be maintained as low as reasonably achievable with economic benefits taken into account. Therefore, SAFSTOR is the preferred decommissioning methodology for the AMS facility.

SAFSTOR Category

There are several subcategories of SAFSTOR. These are custodial SAFSTOR,[29] passive SAFSTOR,[30] and hardened SAFSTOR.[31] The following are brief descriptions of each:

- Custodial SAFSTOR - requires a minimum cleanup and decontamination effort initially, followed by a period of continuing care with the active protection systems kept in service throughout the storage period. Full-time onsite surveillance by operating and security forces is required to carry out radiation monitoring, to maintain the equipment, and to prevent accidental or deliberate intrusion into the facility and the subsequent exposure to radiation or the dispersal of radioactivity beyond the confines of the facility.

- Passive SAFSTOR - requires a more comprehensive cleanup and decontamination effort initially, sufficient to permit deactivation of the active protective (ventilation) systems during the safe storage period. All structures are secured and electronic surveillance is provided to detect accidental or deliberate intrusion. Periodic monitoring and maintenance of the integrity of the structure is also required.

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[29] Nomenclature taken from Schneider, K. J. And C. E. Jenkins, Technology, Safety and Costs of Decommissioning a Reference Nuclear Fuel Reprocessing Plant, NUREG-0278, October, 1977.

[30] Nomenclature taken from U. S. Nuclear Regulatory Commission, Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", June, 1974.

[31] Nomenclature taken from Manion, W. J. And T. S. LaGuardia, "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives", AIF/NESP-009, Atomic Industrial Forum, November, 1976.

- Hardened SAFSTOR (temporary entombment) - requires comprehensive cleanup and decontamination, and the construction of barriers around areas containing significant quantities of radioactivity. These barriers should be of sufficient strength to make accidental intrusion impossible and deliberate intrusion extremely difficult. Surveillance requirements are limited to detection of attack upon the barriers, maintenance of the integrity of the structures, and infrequent monitoring.

All three categories of safe storage require some positive action at the conclusion of the period of continuing care to release the property for unrestricted use and terminate the license for radioactive materials. Depending on the amount of residual radioactivity, these actions may range from completion of the final termination survey only, to dismantlement and removal of residual radioactive materials prior to the termination survey. Maintenance of the facility's structures and an ongoing program of environmental surveillance are also necessary for all categories of SAFSTOR.

Custodial SAFSTOR was deemed to be inappropriate for the AMS facility because of the need for ventilation systems and other support systems to remain operational to support AMS source exchange operations. Hardened SAFSTOR was deleted as an alternative because the existing AMS physical layout and security structure is sufficient to preclude intrusion into the facility.

The methodology of passive SAFSTOR is deemed appropriate because AMS intends to maintain a qualified staff on site to handle teletherapy source exchanges. This will require some of the systems at AMS to remain operational, such as the ventilation system, fire, security, and alarm system, and other equipment, to allow for source exchanges to take place. The on-site staff will conduct radiation monitoring, maintain equipment, prevent intrusion into the facility and deter release of materials from the facility.

Duration of Safe Storage Period

The duration of the storage and surveillance period under SAFSTOR can vary from a few years to approximately 100 years, depending on the type of facility. For the London Road facility, a safe storage period of 20 years is deemed appropriate. This period is based on consideration of such factors as desirability of terminating the license, radiation dose reductions, level of residual contamination in restricted areas, and cost. It is also consistent with the USEPA policy on institutional control reliance for radioactivity containment. Since the value of the property is

small, even if released for unrestricted use, there is little incentive to decontaminate the facility earlier than would otherwise be dictated by the decay of radioactivity within the facility.[32]

Procedure for Placement into Safe Storage

The AMS facility will be placed in a passive SAFSTOR mode by taking the following actions:

- The Hot Cell ventilation system will not be disassembled so that it may be returned to use at the end of the safe storage period. However, contaminated HEPA filters will be removed and containerized. A gross decontamination will be performed in the HEPA equipment room with strip coat or by wiping and the room will be surveyed upon completion. All water sources and electrical power will be disconnected from the system.

- The WHUT Room, which will have been hydrologically stabilized and completely isolated from the basement during the Building Recovery Project, will remain sealed. No entry will be made into the WHUT Room during preparations for SAFSTOR.

- Alarming level devices will be installed in the basement to indicate water incursion if the water discharge issues facing AMS on the date of this report remain an issue.[33]

- All waste materials generated during placement of the facility into safe storage will be containerized, characterized, and placed into the Hot Cell.

- The Hot Cell will be surveyed for contamination and radiation levels, sealed shut, and removed from service. The manipulators will be rendered inoperable and placed out of service as well. All water and electric utilities to the Hot Cell will be discontinued.[34]

- All other areas with residual contamination above the RSP-009 release criteria at the time the facility is placed into passive SAFSTOR will require no further action

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[32] U. S. Nuclear Regulatory Commission, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities", NUREG-0586, January, 1981.

[33] Meschter, Robert, Advanced Medical Systems, Inc., written communication to Mr. Geoffrey Wright, U. S. Nuclear Regulatory Commission, July 1, 1996.

[34] The only lighting for inspection of the area will be through the Hot Cell window.

at the end of the safe storage period because the residual contamination at time will have decayed to levels that are releasable for unrestricted use (see Table 2).[35]

Procedure for Decontamination at the End of Safe Storage

At the end of the safe storage period, the contents of the WHUT Room will be excavated, materials segregated based upon radionuclide concentration, packaged, and, as necessary, disposed of as low level radioactive waste. The Hot Cell will be opened, the sealed sources will be removed form the stuck plug and transferred to an authorized recipient, and all surfaces will be decontaminated to levels that are below the release criteria. All ancillary equipment (e.g., manipulator parts, stored waste) that exceed the release criteria but that is not amenable to decontamination will be disposed of as low level waste.

Final Release Survey

A final release survey will be performed upon completion of the safe storage period and prior to any area restoration. In general, the survey methodology will be designed in accordance with the recommendations of NUREG/CR-5849.[36] The objective of the survey will be to demonstrate that the radiological conditions at the AMS site meet specific decommissioning objectives, and that surface radioactivity in the building is less than the site-specific release criteria. These conditions will be demonstrated at the 95% confidence level. The survey results will also contain an estimate of the total inventory of residual radioactivity at the London Road facility when decommissioning is complete.

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[35] Daily, M. C., A. Huffert, F. Cardile, and J. C. Malaro, "Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment", NUREG-1500, U. S. Nuclear Regulatory Commission, August, 1994.

[36] Berger, J. D., "Manual for Conducting Radiological Surveys in Support of License Termination", Draft Report for Comment, NUREG/CR-5849, ORAU-92/C57, 1992.

REVIEW SCHEDULE

This conceptual decommissioning plan will be reviewed at least annually by the AMS Radiation Safety Officer (RSO) to determine if it requires revision due to any changes in the status of the AMS facility. This review will also include a review of the Decommissioning Funding Plan if changes have taken place that might impact the cost estimates presented herein. This plan may be reviewed more frequently if significant events take place, such as a reduction in the inventory of sources at the facility, decontamination of an area specifically addressed in this plan, or an incident involving the spread of contamination to previously uncontaminated areas of the facility occurs.

Should events at the AMS facility warrant a revision to this plan or the Decommissioning Funding Plan, the RSO will present the proposed changes to the Radiation Safety Committee for their review and approval. Revised plans will be submitted to the USNRC shortly thereafter.

TABLES

Table 1 - Radioactive Materials Inventory
(After Completion of Building Recovery Project)

Item	Form	Material Description	Estimated Activity (Ci)
Licensed Material	Solid	Sealed ^{60}Co Sources	4000
Licensed Material	Solid	Depleted Uranium Inventory	2175.52 kg
Surface contamination	Solid	Estimate of uncharacterized surface ^{60}Co activity in the restricted areas of the facility	0.5
		TOTALS (excluding uranium)	4000.5

Table 2 - Areas to be Decommissioned [37]
As of August 29, 1996

Area	Current Activity			Projected (20 years) Activity (Ci) Assuming No Removal Action		
	Solids or Sources (Ci)	Other Residual Activity		Solids or Sources	Other Residual Activity	
		Surface Level (dpm/100 cm²)	Total (Ci)		Surface Level (dpm/100 cm²)	Total (Ci)
Hot Cell	4.00e+03	1.00e+06	1.00e+00	2.91e+02	7.28e+04	7.28e-02
Isotope Shop	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Source Garden	0.00e+00	5.00e+03	8.54e-06	0.00e+00	3.64e+01	6.22e-07
Decontamination Room	0.00e+00	1.00e+04	1.22e-06	0.00e+00	7.28e+01	8.88e-08
High Level Waste Storage Room	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Clean Equipment Room	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
HEPA Equipment Room	5.00e-02	1.00e+04	9.01e-06	3.64e-03	7.28e+01	6.56e-07
Back Basement	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
WHUT Room	4.00e+01	0.00e+00	0.00e+00	2.91e+00	0.00e+00	0.00e+00
Front Basement	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Miscellaneous Restricted Areas	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Miscellaneous Unrestricted Areas	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Areas Outside Building	7.60e-04	0.00e+00	0.00e+00	5.53e-05	0.00e+00	0.00e+00
Totals	4.04e+03	1.03e+06	1.00e+00	2.94e+02	7.30e+04	7.28e-02

[37] Excludes depleted uranium inventory.

Table 3 - Manpower and Cost Estimates

Action	Person-days Required	Labor Costs ($)	Other Costs ($)	Total Cost ($)
DECON Option				
Hot Cell	180	43200	54600	97800
Decontamination Room	90	21600	17300	38900
HEPA Equipment Room	90	21600	19800	41400
WHUT Room	360	86400	114600	201000
Basement	180	43200	65200	108400
Excavate Outside Areas	60	14400	56300	70700
All Other Areas	200	48000	24000	72000
Building Release Survey	180	43200	11000	54200
Outdoor Release Survey	60	14400	7000	21400
Planning, Training, Mobilization	400	160000	2000	162000
Supervision	400	192000	4000	196000
Waste Disposal		10000	1446179	1456179
Subtotal		698000	1821979	2519979
25%Contingency				629995
Total				3149974

Table 3 - Continued

Action	Person-days Required	Labor Costs ($)	Other Costs ($)	Total Cost ($)
SAFSTOR Option				
Hot Cell	5	1000	1000	2000
WHUT Room	10	2000	40000	42000
HEPA Equipment Room	10	2000	4000	6000
Decon. Surveys prior to start of SAFSTOR	10	2000	1000	3000
On-going building maintenance and surveys	(20yr)	81120	20000	101120
Decontamination at end of SAFSTOR	60	12000	60000	72000
Outdoor Release Survey	40	8000	11000	19000
Building Release Survey	60	12000	7000	19000
Waste Disposal	5	1560	38544	40104
Planning, training, mobilize	120	37440	1000	38440
Supervision	75	23400	2000	25400
	Subtotal	182520	185544	368064
			25% Contingency	92016
			Total	460080

Table 4 - Collective Dose Estimate for DECON and SAFSTOR

Action	Person-days Required	Average Exposure Rate (decay-corrected where necessary) per Task (mR/hr)	Collective Dose (person-rem)
DECON Option			
Hot Cell	1.80e+02	1.20e+04	1.35e+01 [38]
Decontamination Room	9.00e+01	1.00e+00	1.13e-02
HEPA Equipment Room	9.00e+01	5.00e+01	5.63e-01
WHUT Room	1.80e+02	1.45e+05	3.26e+01 [39]
Excavate Outside Areas	6.00e+01	0.00e+00	0.00e+00
All Other Areas	2.00e+02	0.00e+00	0.00e+00
Building Release Surveys	1.80e+02	0.00e+00	0.00e+00
Outdoor Release Surveys	6.00e+01	0.00e+00	0.00e+00
Planning, Training, Mobilization	4.00e+02	0.00e+00	0.00e+00
Supervision	4.00e+02	0.00e+00	0.00e+00
Waste Disposal	1.00e+01	5.00e+00	6.25e-03
		Total	4.67e+01

[38] Assumes that five (5) percent of the person-days required to perform the work required in DECON are spent in the hot cell.

[39] Although maximum use of remote operating tools and robots will be used to decontaminate the WHUT Room, it is nonetheless assumed that personnel entries will occur one (1) percent of the person-days required to perform the work required by DECON.

Table 4 - Continued

Action	Person-days Required	Average Exposure Rate (decay-corrected where necessary) per Task (mR/hr)	Collective Dose (person-rem)
SAFSTOR Option			
Hot Cell	5.00e+00	1.74e+01	5.44e-04 [40]
WHUT Room	1.00e+01	1.06e+04	6.60e-01 [41]
HEPA Equipment Room	1.00e+01	1.00e-01	1.25e-04
Decon. Surveys	1.00e+01	1.40e-03	1.75e-06
On-going building maintenance and surveys	20yr	1.00e-01	2.50e-04
Decontamination at end of SAFSTOR	6.00e+01	0.00e+00	0.00e+00
Final Release Survey	1.00e+02	1.40e-03	1.75e-05
Waste Disposal	5.00e+00	1.40e-03	8.75e-07
Planning, training, mobilize	1.20e+02	0.00e+00	0.00e+00
Supervision	7.50e+01	0.00e+00	0.00e+00
		Total	6.61e-01

[40] Assumes that five (5) percent of the person-days required to perform the work required in SAFSTOR are spent in the hot cell.

[41] Assumes that one (1) percent of the person-days required to perform the work required in SAFSTOR are spent in the WHUT Room.

Table 5 - Cost/Benefit Analysis

Option	X ($)	S (Person-Rem)	α ($ per Person-Rem)	Solution ($)
DECON	3.15e+06	4.67e+01	$1,000	3.20e+06
SAFSTOR	4.60e+05	6.61e-01	$1,000	4.61e+05

September 3, 1996

Stephen J. Haddock
Radiation Safety Officer
Advanced Medical Systems, Inc.
1020 London Road
Cleveland, OH 44110

Dear Mr. Haddock:

We have reviewed the water analysis procedures recently developed by AMS and sent to Region III on June 11, 1996. These procedures included RSP-018, *Operation of the Gamma Spectrometer*, and RSP-019, *Assessment of Radioactivity in Water Samples*. Both procedures were dated June 11, 1996. Our review identified several deficiencies, which are summarized below. Details of the deficiencies are provided in the enclosure to this letter.

1. The bases for the proposed minimum detectable activity (MDA) of 70 pCi/l for water samples and 15 pCi/l for filters are not well developed or justified in the technical basis section of Procedure RSP-019. AMS should provide a more defensible basis for its choice of MDA. In our letter dated May 31, 1996, we indicated that the MDA should be based on the capability of a detection system that is state of the art for the application but not necessarily extraordinarily specialized or sophisticated. Thus, AMS should expand its technical basis section to include a detailed description of its measurement systems and testing of these systems to evaluate its measurement capabilities.

2. The procedures make only brief mention of the quality assurance program to be used for AMS' measuring systems. AMS should develop a more detailed quality assurance program, and provide a detailed description of that program in the technical basis section. The quality assurance program should extend to any outside analytical laboratories that AMS may use to confirm its results.

3. The procedures do not fully develop the bases for determining whether a sample does or does not show activity. AMS is still using the MDA as a criterion for this purpose, which is incorrect. Thus, AMS needs to develop decision levels which are independent of the MDA, to allow this determination to be made. The development of this decision level should be described in detail in the technical basis section.

C/100

4. The procedures contain several errors concerning the manipulation of the data, most notably the error of using the MDA for making field decisions, and the incorrect equations provided in the procedures for calculating the MDA.

We will continue our review of your water analysis procedures upon receipt of this information. Please reply, in duplicate, within 30 days.

If you have any questions concerning these items, please call Michael Weber of my staff at (630)829-9528.

Sincerely,

Original Signed by John R. Madera

John R. Madera, Chief
Nuclear Materials Licensing Branch

Docket No. 030-16055
License No. 34-19089-01

Enclosure: As stated

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COMMENTS ON AMS PROCEDURES

Procedure RSP-019: Assessment of Radioactivity in Water

1. Page 3, 5.1.2: It should be clear that the laboratory performing the analyses must participate in a quality assurance/quality control program that is approved by AMS and periodically audited by a recognized group or organization outside the organization that operates the laboratory. Pre-qualification of the laboratory is only part of this ongoing program. A later section (5.4.3) states that samples may be forwarded to a commercial analytical laboratory for confirmatory analysis. Some indication should be provided as to when such an action may be necessary.

2. Page 3, 5.2.1: Analysis results from AMS Tank 880 and others indicate that different results are obtained from samples taken from various locations within the tank. The differences in the results have not been explained, giving the impression that the mixing used by AMS to date has not been effective, and that stratification of the Co-60 remained even after prolonged mixing. Therefore, it is necessary for AMS to demonstrate that its proposed method does indeed produce representative samples. Without this information, the results will remain suspect because of unexplained past anomalies.

3. Page 4, 5.4.2: We believe that AMS can achieve a lower MDA than 70 pCi/l. In our May 31, 1996 letter, we indicated that AMS should establish a counting method that is considered typical of current and ordinary state of the art for such an application. We have not seen any data to show that AMS has done that. We therefore request that AMS establish its well-shielded counting system in a low background area, select a reasonably long counting time, and then establish the sensitivities achievable by such a system. We are confident that the MDA will be far lower than the proposed 70 pCi/l.

The equation for MDA given in this section, and elsewhere in the procedure, is incorrect. The equation, in the form given, contains the implicit assumption that the sample (or gross) counting time and the background counting time are equal. This is not the case, however, because the background is counted for 8 hours, whereas the samples are counted for times less than 8 hours (See procedure RSP-018 for sample counting times). The equation in the form given will underestimate the MDA.

COMMENTS (continued)

4. Page 4, 5.5.1:

This step requires that all samples less than 100 pCi/l be drawn through a filter, even those that show no activity that is statistically different from background. AMS should confirm that this is the intent.

Finally, information should be added to the section that indicates that proper procedures will be used by trained individuals to ensure that the sample will be drawn correctly through the filter.

5. Page 5, 5.5.3:

Although the origin of the 15 pCi/l detection concentration level is mentioned in the technical basis section of the document, adequate technical support for this number is not provided. This information should be provided.

This step, or the remainder of the procedure, does not describe what to do with the results of the analyses on the filter. What criteria are to be used to decide if the filter indicates insoluble activity?

6. Page 6, 5.7.4:

The condition given in 5.7.4.2 is not acceptable. Use of the MDA to make the decision of whether there is or isn't any activity detected in a specific sample is incorrect, for the following reason. The MDA represents the center of the distribution of the activities that the system is claimed to be able to detect with a 95% probability. Consider a sample that contains an MDA of activity. If that sample is counted repeatedly, half the results of these counts will be expected to fall below the center of the distribution, which is the MDA. Thus, if the MDA was used as the detection criterion, it would be concluded that half the counts obtained from that sample represent undetected activity. This is a 50% detection probability, clearly below the required 95% probability. (For further details and discussion on the proper application of the MDA, we refer you to a journal article by Lloyd Currie (*Analytical Chemistry*, Vol. 40, No. 3, March 1968). This article describes methods of using the MDA concept that are acceptable to the NRC.) Thus, AMS must establish a decision level which is independent of the MDA, that will be used to make this determination.

COMMENTS (continued)

Technical Basis for Water Discharge Criteria

1. Page 7, Second point: This point contradicts the first point. The first point stresses the regulatory requirement that no insoluble Co-60 may be discharged to the sewer. The second point tries to estimate the amount of insoluble Co-60 that may be discharged to the sewer without causing the ash to exceed 8 pCi/g. The analysis in the second point also neglects to consider the possibility that Co-60 discharged to the sewer as soluble cobalt may still end up in the ash because of a number of reasons, such as precipitation of the "soluble" cobalt during waste treatment, or settling of the "soluble" cobalt that is, in fact, not soluble but very finely dispersed insoluble material. Therefore, this point should be reassessed and possibly deleted.

2. Page 8, Second Point from the bottom: This statement concerning Information Notice (IN) 94-07, that "the standard does not provide guidance on how much gross beta activity indicates an insoluble material," is incorrect. The standard states, on Page 4, that "activity in the suspended solids portion of the effluent greater than that found in similarly processed background water samples would indicate the presence of insoluble radioactive material." In other words, the IN states that any activity that is statistically distinguishable from background indicates the presence of insoluble material. Background in this case is the filter residue from water filtered in the same manner as the sample. The water used to produce the background filter is water obtained locally but that is not contaminated by AMS' operation.

3. Page 9, First point: This point is in disagreement with the data NRC has been receiving from the commercial laboratories that were used by AMS and NEORSD to analyze the water samples from the discharge tanks. The results from these laboratories were routinely reported as having been obtained using equipment capable of measuring approximately 2 pCi/l using counting times as low as 200 minutes. How can these values be reconciled with the values indicated in this point?

In this connection, AMS has not described the system it intends to use for sample analyses. This should be included in the technical basis section. It is necessary to know the system to be used, type and size of detector, counting times, background levels in the

COMMENTS (continued)

counting laboratory, location of laboratory within the AMS facility, shielding for the detector, methods of spectral analysis to be used, type of blank samples, and source of water to serve as the background, and the quality assurance program for the system.