MAY 25 1993

License No. SMB-1527
Docket No. 040-08976
Control No. ~~115462~~ 112591

Westinghouse Electric Corporation
ATTN: C. W. Bickerstaff
Manager, Corporate Industrial Hygiene
P.O. Box 355
Pittsburgh, Pennsylvania 15230

Dear Mr. Bickerstaff:

Please find enclosed an amendment to your NRC Material License.

Please review the enclosed document carefully and be sure that you understand all conditions. If there are any errors or questions, please notify the Region I Material Licensing Section, (215) 337-5093, so that we can provide appropriate corrections and answers.

Please be advised that you must conduct your program involving licensed radioactive materials in accordance with the conditions of your NRC license, representations made in your license application, and NRC regulations. In particular, please note the items in the enclosed, "Requirements for Materials Licensees."

The portion of the Westinghouse facility in Bloomfield, New Jersey west of Arlington Avenue, including Buildings 1 through 6, the garage and surrounding land, are hereby released for unrestricted use. The basis for this action is described in the attached Safety Evaluation Report (SER). The possession limit on the license has been appropriately reduced.

Since serious consequences to employees and the public can result from failure to comply with NRC requirements, the NRC expects licensees to pay meticulous attention to detail and to achieve the high standard of compliance which the NRC expects of its licensees.

You will be periodically inspected by NRC. A fee may be charged for inspections in accordance with 10 CFR Part 170. Failure to conduct your program safely and in accordance with NRC regulations, license conditions, and representations made in your license application and supplemental correspondence with NRC will result in prompt and vigorous enforcement action against you. This could include issuance of a notice of

violation, or in case of serious violations, an imposition of a civil penalty or an order suspending, modifying or revoking your license as specified in the General Policy and Procedures for NRC Enforcement Actions, 10 CFR Part 2, Appendix C.

We wish you success in operating a safe and effective licensed program.

Sincerely,

Original Signed By:

John D. Kinneman, Chief
Research, Development and
Decommissioning Section
Division of Radiation Safety
and Safeguards

Enclosures:
1. Amendment No. 01
2. Safety Evaluation Report dated May 24, 1993
3. Requirements for Materials Licensees

cc:
Canberra NSD
ATTN: Lee Booth
150 Spring Lake Drive
Itasca, Illinois 60143

State of New Jersey
ATTN: Robert Stern
Chief, Bureau of Environmental Radiation
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bcc:
Region I Docket Room (w/ concurrences)
M. Roberts, RI

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5/24/93	5/24/93

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Docket No. 040-08976 License No. SMB-1527

SAFETY EVALUATION REPORT
RELEASE FOR UNRESTRICTED USE
BLOOMFIELD LAMP PLANT
BUILDINGS 1 - 6 AND THE GARAGE
WESTINGHOUSE ELECTRIC COMPANY
BLOOMFIELD, NEW JERSEY

1. Site History:

The Westinghouse Electric Company (Westinghouse) Bloomfield Lamp Plant is comprised of eleven principal buildings (identified as Buildings 1 through 11) and several lesser structures, including a garage, on a 5.7 hectare (14 acre) site in Bloomfield, New Jersey. The site is bounded by MacArthur Avenue to the north, railroad tracks to the west and south, and by commercial properties along Bloomfield Avenue to the east. The site is divided into two parcels by Arlington Avenue which runs generally southwest to northeast. The garage lies on the opposite side of MacArthur Avenue across from Building 1. Most of the principal buildings have multiple floor levels. The buildings, constructed between 1907 and 1930, contain approximately 93,000 square meters (1,000,000 square feet) of floor space and cover approximately half of the area of the site. Most of the area between the buildings is paved with asphalt or concrete. The primary unpaved areas on the site are a small reservoir for fire protection water behind Building 2, a large incinerator also behind Building 2, and the areas adjacent to the railroad tracks. Operations at this facility were primarily devoted to engineering, research and development and production of electric lamps. In connection with this work, radioactive materials, primarily thorium, were used for the manufacture of metallic wire and components for lamp filaments. During World War II, the facility was contracted to produce uranium in support of the Manhattan Project. Uranium was also used in projects after this period.

Both the U. S. Nuclear Regulatory Commission (NRC) and Westinghouse's records are incomplete concerning the extent and timing of early activities at the site. Initial activities with uranium were conducted before licensing was required. Activities for the Manhattan Project also did not require the authorization of a license. However, records do indicate that in November 1964 the Atomic Energy Commission (AEC) issued AEC License No. SMB-353 to Westinghouse to conduct research and development with thorium and uranium and to manufacture thorium-tungsten wire (for lighting applications) and welding rods containing thorium at the Bloomfield facility. A second license for the facility, AEC License No. STB-467, was also issued to Westinghouse for use of thorium in the manufacture of mercury vapor lamps. The two licensed activities were consolidated under License No. SMB-353 and License No. STB-467 was subsequently terminated in November 1967.

In 1976 the Energy Research and Development Administration (ERDA) began a review of the radiological status of the facilities involved in supporting the Manhattan Project.

An October 1976 survey by ERDA staff identified contamination in the basement of Building 7 in floor drains, along the base of the walls and support columns where they joined the floor and around support columns of a loading dock at the rear of the building. This survey was limited to Building 7 since it was the only portion of the facility where Manhattan Project work was performed. Westinghouse used the services of an outside contractor to clean contaminated areas. Although some contamination remained above the then current criteria for release for unrestricted use, ERDA did not recommend further remediation, but suggested that the residual contamination be licensed by NRC as a means of further control. In February 1978, Westinghouse requested that the NRC amend their license to include this residual contamination.

In May 1979 the NRC informed Westinghouse that the NRC would not amend the license and that they believed that the Building 7 basement should be decontaminated. In November 1979 a Westinghouse contractor performed remediation in the contaminated areas identified. Additional remediation was conducted in April 1980 following the discovery of several contaminated areas during a February 1980 NRC survey. Following a January 1981 survey, the NRC indicated in a letter to Westinghouse that the Building 7 basement had been satisfactorily decontaminated .

In February 1983, Westinghouse sold the lamp manufacturing business to North American Philips Company. As part of this sale, North American Philips operated the Bloomfield Lamp Plant facilities, but only leased the plant from Westinghouse. The NRC issued License No. SMB-1423 to North American Philips Electric Company and terminated License No. SMB-353 issued to Westinghouse. The license issued to North American Philips only authorized manufacturing of products containing thorium. In 1984 North American Philips stopped thorium wire production and ceased all manufacturing operations at the site in 1985. North American Philips moved from the Bloomfield facility by November 1986. In May 1988, Region I amended the North American Philips license to authorize only storage of the licensed radioactive material then at the facility. Since North American Philips had only leased the Bloomfield facility, Westinghouse then took control of the facility.

In November 1988, Westinghouse submitted an application for a license to authorize decommissioning of the facility. Included in the license request was a decommissioning plan and the results of radiological surveys conducted in 1986 and 1988 that characterized the quantity and extent of radioactive contamination at the Bloomfield facility. Westinghouse also requested that the North American Philips Company license be terminated with the issue of a new license to Westinghouse. In February 1989, NRC issued License No. SMB-1527 to Westinghouse for decommissioning the Bloomfield facility and terminated License No. SMB-1423.

2. Decommissioning Plan

The facility decommissioning plan, submitted by Westinghouse with the November 4, 1988 license application and approved when the license was issued, discussed only the generic tasks associated with the decommissioning of the Bloomfield facility. Detailed information and procedures were not provided since Westinghouse indicated that the remediation work would be performed by experienced contractor personnel. The decommissioning plan included remediation of the contaminated areas identified in surveys performed by RMC/Canberra, Westinghouse's radiological contractor, in 1986 and 1988. A final site survey was to be performed after completion of the remediation work. The report of the final survey would be transmitted to the NRC to support release of the facility for unrestricted use and termination of the license. The remediation contractor, methodologies and procedures were not specifically identified. The procedures were to consist of a variety of methods to include removal of contaminated material and/or appropriate cleaning. The supervisor of the decommissioning activities was required to have two years of experience in similar type projects. Wastes were to be controlled and packaged for eventual disposal.

3. Applicable Limits

The decommissioning plan submitted by Westinghouse in their license application specified the criteria in the NRC's May 1987 "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material" as the criteria to be utilized for acceptable residual surface contamination. The criteria specified for acceptable residual soil contamination are those found in Option 1 of the Branch Technical Position for "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations", 46 FR 52061-52063.

The Branch Technical Position does not specify criteria for processed uranium, i.e. uranium neither enriched or depleted in the U-235 isotope, but which does not include the radioactive daughter products of U-234. Residual radioactive material of this type was present at the Bloomfield facility. The NRC concluded that the criteria for depleted uranium are appropriate for processed uranium due to their radiological similarity.

Westinghouse's decommissioning plan does not specify criteria for the exposure rate from residual licensed radioactive material. Pending NRC rulemaking on generic radiological criteria for decommissioning, the NRC will use existing guidance published in the "NRC Action Plan to Ensure Timely Cleanup of SDMP (Site Decommissioning Management Plan) Sites" (57 FR 13389-13392). Although the Bloomfield site is not on the SDMP list, this guidance is applicable and appropriate for release of this facility for unrestricted use. Therefore, contaminated concrete, components and structures should be removed so that the indoor exposure rate is less than 5 microroentgens per hour above

natural background at one meter from floor and wall surfaces with an overall dose objective of no more than 10 millirem per year to the maximally exposed individual (a continuous occupant).

The criteria described above are appropriate to evaluate the suitability of this facility for release for unrestricted use.

4. Characterization Measurements

Radiological surveys conducted by RMC/Canberra, Westinghouse's radiological contractor, in May through July of 1986 identified contamination above the specified criteria on floor and wall surfaces in the buildings, on equipment in the buildings and in soil samples areas around the buildings. Residual radioactive material, primarily thorium, was also found stored in drums or in piles in various locations within the buildings. The surveys conducted in 1986 were extensive for areas where radioactive materials were known to have been used. Where these extensive surveys were performed, accessible surfaces of the floors and walls were systematically divided into one-meter by one-meter grids. Measurements were made with a GM detector in each grid square and smears were taken in 25 percent of the grid squares to measure removable contamination. Direct measurements were made in ten percent of the grid squares with an alpha detector. Exposure rates were measured in the general areas with a micro R meter. Objects and equipment with irregular surfaces were continuously scanned with a GM survey meter. Smears were taken to evaluate removable contamination in drain covers, vent openings, handles and in storage areas. Samples of soil, water, floor sweepings or concrete chips were obtained and analyzed by high resolution gamma spectroscopy to identify and quantify any radioactive contaminants.

Areas without a history of radioactive material use were presumed to be free of radioactive contamination and were subjected to less extensive surveys. These less extensive surveys consisted of a walk-through survey conducted with a count rate meter and sodium iodide (NaI) detector probe. The probe was held one meter above the floor and traverses across the floor were made at intervals of two meters by the surveyor. An area was extensively surveyed if the observed count rate in an area was statistically significant above background (exceeding three times the standard deviation of the measured background). All drains, pipes and ducts in these areas were monitored directly and extensively surveyed if statistically significant count rates were obtained.

Outdoor areas were surveyed with similar protocols. A walk-through survey was conducted in all outdoor areas with the sodium iodide probe and count rate meter. In small outdoor areas where radiation levels were above normal background or where contamination was suspected, a three-meter by three-meter grid was established and additional measurements were performed. For larger outdoor areas, a ten-meter by ten-meter grid was established for the additional measurements. Representative soil (or other

media) were collected from these areas and analyzed by high resolution gamma spectrometry.

A total of eighty-six individual areas where radiation levels were statistically significant above background or which had a prior history of storage or use of radioactive materials were surveyed extensively. Many of the locations surveyed were found to be contaminated only marginally in excess of the criteria in the decommissioning plan. Approximately nineteen areas with a total area of less than 1,800 square meters (20,000 square feet) were reported to have residual contamination that clearly exceeded these criteria and required substantial remediation. Beta contamination levels ranged from less than detectable to 208,000 dpm/100 cm^2 on the first floor of Building 2, with most of the detectable quantities in the range of a few thousand dpm/100 cm^2. Concentrations of thorium in soil ranged from background to 130 pCi/g (basement of the garage) with most samples between background and 40 pCi/g. Concentrations of uranium in these samples ranged from background to 1,100 pCi/g for uranium (railroad bed behind Building 4) with most samples having an activity of approximately 75 pCi/g.

RMC/Canberra performed a survey in September 1988 to evaluate changes in the radiological condition of the facility and to generate an inventory of the remaining radioactive material on the site. This survey consisted of walk-through measurements throughout the facility using a portable NaI detector and count rate meter. Since the July 1986 survey was completed, some minor clean up, removal of equipment and relocation of material had taken place. Although the survey identified a few additional contaminated objects, the contractor reported that the radiological condition of the site had not significantly changed since the 1986 survey.

5. Remediation Activities

The contaminated areas of the facility were remediated from 1989 through 1990 by Westinghouse's Scientific Ecology Group (SEG), a contractor for Westinghouse. The major interior remediation work was performed in Buildings 2 through 6 and the garage. Significant exterior remediation work was conducted in the reservoir area, the incinerator and along the railway spurs behind Buildings 4 and 6. No remediation activities were performed on any of the roofs of the buildings since contamination in excess of the criteria was not identified on these areas. The total remediated area (interior and exterior) covered approximately 1,600 square meters (17,200 square feet). In May 1990, Westinghouse submitted the results of a confirmatory survey for Buildings 1 through 6, the garage and property on the west side of Arlington Avenue and requested these buildings and property be released for unrestricted use. This report also briefly discussed the extent of the remediation of each contaminated area. Remediation was continuing on Buildings 7, 8 and 9 and the area east of Arlington Avenue. Westinghouse stated they would make a separate request to release these buildings once remediation was completed.

The May 1990 report of the decontamination surveys for the remediated areas contained brief summaries of the remediation methods. In December 1990, Canberra Industries' Nuclear Services Division (Canberra, (formerly RMC/Canberra)), Westinghouse's radiological survey contractor, provided further descriptions of the remediation activities in each area, provided an estimated size of each remediated area and identified the radionuclide contaminant. Canberra performed radiological measurements and sample analysis as remediation progressed to determine when an area was completely remediated. Only the final surveys were documented to show that the facility met the current standards for release for unrestricted use.

For areas inside buildings, contaminated concrete was removed by scabbling, chipping or grinding with air-operated tools since contamination on these areas was generally limited to the surface of the floor or wall. Vacuuming was used to remove loose contamination or to pick-up the residue generated during the concrete remediation. Contaminated tile or wood floors were completely removed and disposed as radioactive waste. Contaminated pipe was also completely removed and disposed. Contaminated soil around these pipes was excavated until soil samples showed concentrations less than the criteria for release for unrestricted use. Drums filled with radioactive residues and piles of radioactive debris were packaged and disposed as radioactive waste. Contaminated equipment and fixtures that could not be readily cleaned, e.g. ducts, blowers and filters, were cut into pieces and disposed in a similar manner. Sumps or contaminated metal equipment were steam cleaned to remove contamination and to limit the overall volume to be disposed. Empty containers previously containing thorium powder were cleaned when possible or disposed as radioactive waste.

Contamination in outside areas was handled in a manner similar to that inside buildings. Concrete pads were chipped or scabbled to remove contamination and the resultant debris discarded as radioactive waste. In the reservoir and rail spur areas, contaminated soil was excavated from areas as large as 5.3 meters (17.5 feet) by 24.4 meters (80 feet). Soil contamination in excess of the criteria typically did not exceed a depth of 0.6 meters (2 feet). Railroad tracks and railroad ties were removed from the rail beds and pressure-washed to remove contamination. The contaminated ash residue from the incinerator building and stack was collected and disposed as radioactive waste. All radioactive waste was sent to the SEG facility in Oak Ridge, Tennessee for incineration, compaction or repackaging. Wastes were eventually disposed at a licensed low-level radioactive waste disposal facility. The waste was typically shipped in B-25 containers (strong, tight containers of approximately 2.5 cubic meters (90 cubic feet)).

6. Initial Licensee Confirmatory Survey

The survey completed by Canberra in 1990 and documented in the May 1990 report included measurements of both total and removable alpha and beta surface contamination levels and surface dose rates. Portable survey instruments with either alpha or beta

detector probes were used for total surface contamination measurements. Beta measurements were made directly on each surface to be monitored with a 16 square centimeter GM "pancake" probe and count rate meter. This instrument typically exhibited a background count rate of approximately 40 counts per minute (cpm) with an efficiency ranging from 19 to 22 percent. Direct alpha contamination measurements were made with a rate meter equipped with an alpha scintillation detector with an active area of 50 square centimeters. A counting efficiency of approximately 15 percent was obtained with this device with a negligible background count rate (typically less than 10 cpm). In the remediated areas, the contractor reported surveying from 25 to 100 percent of the area surfaces. Removable contamination was measured by wiping filter paper smears on the areas to be monitored and subsequently counting the smears in a gas-flow proportional counter. The counting times for smear samples were typically two minutes which yielded a Minimum Detectable Activity (MDA) of less than 10 dpm/100 cm^2 for either alpha or beta activity. High resolution gamma spectroscopy measurements were used to identify and quantify the radionuclide concentrations in soil and sludge samples from the remediated areas. Positive activity values and MDA's were computed by the system's software. Exposure rates were not measured in any of the interior or exterior areas. The contractor indicated that since the contamination was thorium and/or uranium, and based on previous decommissioning experience and the earlier characterization measurements, the limiting condition for release for unrestricted use of the facility would be the residual surface contamination levels and/or residual soil concentrations. Exposure rates in excess of the decommissioning criteria would not be the limiting condition.

The licensee's contractor compared the results obtained to the criteria contained in the decommissioning plan and reported that all areas north (also referred to as west) of Arlington Avenue had been successfully remediated and that these areas are suitable for unrestricted release. Actual survey data was reported for twenty-two specific remediated areas. Data for surfaces included measured values for removable and total contamination and also included surface dose rates. Although 86 locations were originally targeted for more extensive surveys, physical remediation (other than removal of contaminated equipment or debris) was required at only 22 locations. In the remaining areas, a confirmatory survey performed after the removal of contaminated equipment or material or additional data analysis indicated that the area met the criteria for release for unrestricted use. Additional data was not provided for these non-remediated areas.

The results in the 1990 report indicate gross beta activities of 3,100 dpm/100 cm^2 and 3,400 dpm/100 cm^2 remaining in two drain pipes exiting Buildings 3 and 4 into a sump between the two buildings. The drain lines and sump had been flushed and steam cleaned. Subsequently, removable activity was less than either the uranium or thorium criteria. Concentrations of radioactive materials in the sludge removed from the sump were less than detectable for U-238 and 2.3 pCi/g for Th-232.

7. ORAU Confirmatory Survey

Region I reviewed Westinghouse's confirmatory survey results and transmitted a copy to the staff of the Environmental Survey and Site Assessment Program at Oak Ridge Associated Universities (ORAU). ORAU performs radiological safety evaluations and surveys under contract to the NRC and was requested to perform a confirmatory survey at the Bloomfield site. Following the data review, NRC and ORAU met with Westinghouse and their decommissioning and survey contractors to discuss the remediation and survey activities and make a preliminary evaluation of the scope of the ORAU confirmatory survey. ORAU then developed a confirmatory survey plan to determine if the licensee's final survey accurately reflected the condition of the facility. The ORAU survey is not intended to duplicate the licensee's final survey, but is intended to provide sufficient measurements at random locations representative of the conditions of both the remediated and non-remediated areas so that NRC can judge whether the licensee's survey is accurate and adequate. Region I reviewed the survey plan and recommended changes to the scope of the survey and identified specific locations in the remediated areas and non-remediated areas to be included in the survey. In February 1991, ORAU submitted a survey plan that was accepted by the NRC.

In March 1991 ORAU conducted the confirmatory radiological survey of the areas described in the final scope of work. The ORAU measurements included surface scans with large area gas-flow proportional detectors, alpha scintillation detectors and pancake GM detectors; surface smears that were counted on a gas-flow proportional counter for removable activity; and gamma exposure rate determinations using a pressurized ionization chamber (PIC) or a gamma scintillation detector and rate meter that was cross-calibrated to the PIC. Soil samples were taken and analyzed at the ORAU analytical laboratories using a high resolution gamma spectrometry system.

The results of the survey indicated eleven locations in both remediated and non-remediated areas that apparently exceeded the criteria in the decommissioning plan. ORAU marked each of the areas so that they could be resurveyed or remediated as necessary. Three of the locations (one exterior and two interior) were areas that had been previously remediated. The remainder were in areas that had not been extensively surveyed and where no remediation was performed. In one of the three areas, the total contamination measurement exceeded the maximum criterion for thorium-232, but did not exceed the uranium-238 criteria. Since the contaminant was not identified, the result was conservatively reported as exceeding the criteria. In many of the locations, several, isolated spots of contamination were found.

Measurements were also conducted by ORAU on drain lines in the sump between Buildings 3 and 4. Results reported by ORAU were 1,200 dpm/100 cm^2 and 1,300 dpm/100 cm^2 for alpha/beta activity. The ORAU results do not confirm the

Westinghouse measurements which indicated the presence of contamination in excess of the criteria for unrestricted use in the drain lines.

Region I reported the preliminary results to Westinghouse in an April 1991 letter and requested that the licensee perform additional confirmatory measurements and remediation as necessary. Region I also asked Westinghouse to explain why these areas requiring remediation had not been identified in the previous surveys conducted by the licensee's contractor and why the NRC should not be concerned that other areas requiring remediation in the facility were not yet identified. Region I also requested information concerning the MDA (Minimum Detectable Activity) for the portable survey instrumentation used by the contractor.

8. Additional Remediation and Surveys

In its September 1991 response to the NRC's April 1991 letter, Westinghouse reported the results of the additional remediation and confirmatory surveys performed by their contractor. Of the three locations in remediated/surveyed areas where residual contamination was identified in the ORAU survey, subsequent measurements by the contractor at one of these locations (the common loading dock for Buildings 3, 4 and 5) found surface activity in excess of background, but not exceeding the criterion for residual uranium activity (5,000 dpm/100 cm^2). Both uranium and thorium were originally reported to have been used at this location; however, only uranium was found to be actually present. Since the uranium criterion is not exceeded, no additional remediation is required. In the other interior remediated area (Building 2, 2nd floor, the moly ribbon room), several small spots of residual contamination in excess of the criteria were identified. Approximately 1.9 square meters (20 square feet) were scabbled to remediate the spots of contamination. The remediated areas were then resurveyed and found to meet the criteria. In the one exterior remediated area where contamination was found (the reservoir area), a single elevated reading was confirmed and approximately 0.34 cubic meters (12 cubic feet) of soil and sludge were removed and disposed as radioactive waste. During confirmatory measurements in this location, a jar containing thorium nitrate was also detected and removed for disposal. Further measurements did not indicate any other areas which required remediation.

The remainder of the areas with residual contamination in excess of the criteria for release for unrestricted use were found in non-remediated areas. Since there was no history of radioactive material use in these locations, only random walk-through surveys had been conducted and these apparently missed the contamination in these areas.

The following contamination levels are the values reported in the ORAU final survey. Only the range or a maximum is reported for the contamination levels in the ORAU survey.

1.) Building 2, 1st floor - Six small, isolated spots of radium-226 (Ra-226) were identified. Approximately 1.9 square meters (20 square feet) were remediated. Follow-up surveys identified approximately 19 square meters of contaminated floor (200 square feet) that were also remediated. Gross alpha levels ranged from 35 to 5,000 dpm/100 cm^2 and gross beta levels ranged from 3,600 to 49,000 dpm/100 cm^2.

2.) Building 3, 1st floor - A corridor approximately 46 meters (150 feet) long was determined to contain spotty, randomly distributed uranium contamination in excess of the criteria for residual uranium activity. The entire floor surface was removed rather than attempting to remove individual contamination spots. Follow-up surveys identified an additional 6 - 9 meters (20 - 30 feet) length with spotty contamination that was also remediated. Gross beta activity ranged from 14,000 to 170,000 dpm/100 cm^2 in the contaminated areas.

3.) Building 3, 1st floor - A 3-meter (10-foot) long storage area adjacent to the corridor was confirmed to be contaminated. The wooden flooring was removed from this area and the area vacuumed. Specific contamination levels were not provided for this area.

4.) Building 3, 3rd floor - A lab room was reported to have elevated readings throughout; however, a survey by the licensee's contractor identified only 0.4 square meter (4 square feet) that required remediation. Naturally occurring radioactive materials were identified in the building material of a long wall that apparently contributed to the initial determination of widespread contamination in this area. Uranium was identified as the contaminant in this area with the gross beta activity recorded as 59,000 dpm/100 cm^2.

5.) Building 4, 1st floor - Approximately 3.3 square meters (36 square feet) in the carpentry shop were confirmed to exceed the clean-up criteria and was remediated. Both uranium and thorium were identified as contaminants in this area. The gross beta activity level was recorded as 22,000 dpm/100 cm^2.

6.) Building 4, 2nd floor - Approximately 0.2 square meter (2 square feet) in the machine shop was vacuumed to remove loose contamination beneath the wood flooring. Both uranium and thorium were identified as contaminants in this area. The gross beta activity ranged from 1,500 to 3,300 dpm/100 cm^2.

7.) Building 4, 2nd floor - Approximately 0.4 square meter (4 square feet) in the plating room was chipped and vacuumed to remove contamination in excess of the decommissioning criteria. Both uranium and thorium were identified as contaminants in this area. The gross beta activity ranged from 1,500 to 3,300 dpm/100 cm^2.

8.) Building 6, floor - Several isolated small spots (of contamination) were identified in this building. Five additional small spots were identified during a 100 percent resurvey of the floor. The top of the concrete surface from approximately 18.6 square meters (200 square feet) was removed to remediate this area. Thorium was identified as the contaminant in this area. The gross beta activity ranged from less than 290 to 20,000 dpm/100 cm^2.

All of the areas identified as contaminated in the ORAU survey were subsequently remediated to meet the criteria contained in the decommissioning plan. To ensure that no other contaminated areas existed in the non-remediated areas that had not been surveyed by ORAU, Westinghouse's contractor extensively surveyed all remaining non-remediated areas. These surveys identified three locations requiring remediation in addition to the those previously identified by the contractor. These areas included: a 9.3 square meter (100 square feet) area in an office on the 2nd floor of Building 1; an additional area on the 1st floor of Building 1; and a small area on the 4th floor of Building 3. Westinghouse's contractors remediated and resurveyed all of these areas. Westinghouse included the documentation of the cleanup of these contaminated areas in its September 1991 response to the NRC.

Westinghouse's radiological contractor reported that they had used the following instrumentation in the surveys discussed above: a Ludlum Model 239-1F Gas Proportional Floor Monitor equipped with a 550 cm^2; a Ludlum Model 12 Count Rate Meter equipped with either a Model 44-9 Pancake GM Detector, a Model 43-5 Alpha Scintillation Detector or a Model 43-20 Gas Proportional Detector (160 cm^2); as well as the same instrumentation that had been used in the earlier surveys. The contractor estimated that over 90 percent of the floor areas were monitored during the most recent surveys. The larger area probes facilitated covering the large area to be surveyed. Other than the results reported above, the survey results for this set of measurements did not exceed the criteria in the decommissioning plan.

9. Region I Confirmatory Measurements

Region I staff reviewed the description of the additional remediation that was performed and the results of the surveys performed after the additional remediation work had been completed. On June 5, 1992, an NRC Region I inspector surveyed those locations where licensed material in excess of the criteria in the decommissioning plan was originally identified in the ORAU report and subsequently remediated. The inspector performed direct surface contamination measurements in these remediated areas and found all results to be indistinguishable from background. The results indicated that the residual contamination was removed and these areas now meet the criteria in the decommissioning plan.

The inspector also performed exposure rate measurements with a micro-R meter throughout the buildings and at various outside locations. The instrument was kept on while walking through the buildings and, specific measurements were performed in each of the areas that had been remediated following the ORAU survey. These areas are described above. With the exception of a laboratory room on the third floor of Building 3, no exposure rates in excess of the indoor background exposure rate (8-10 microroentgens per hour) were measured. The exposure rate measured in the laboratory room on the 3rd floor of Building 3 was approximately 40 microroentgens per hour. Since the source of the elevated exposure rates appeared to be a single wall in the room, a sample of the concrete wall was obtained to investigate the radioactive material content of the building material. The sample was analyzed in the NRC Region I laboratory by gamma spectrometry. Radium-226 at a concentration of 19.1 picocuries/gram (pCi/g) was detected in the sample. Slightly lower concentrations of two Ra-226 decay products (11.5 pCi/g of bismuth-214 and 13.1 pCi/g of lead-214) were also measured in the sample. No U-238 was identified in the sample. A very small amount of lead-212 (0.3 pCi/g) was detected, indicating a similar amount of Th-232. A typical concentration of Ra-226 in soil is approximately 1 pCi/g; however, building materials often show significantly higher concentrations of these naturally occurring radioactive materials. The elevated concentration of Ra-226 in the wall is high enough to cause the elevated exposure rate measured in the room. No further remediation is needed in this area.

10. NRC Inspections and Oversight

An inspection of the remediation activities and a review of survey methodologies and analytical instrumentation capabilities was conducted in October 1990. At the time of this inspection, remediation activities and confirmatory surveys had been completed on Buildings 1 - 6 and the garage, and were continuing in Buildings 7 - 9. The inspector determined that both the remediation contractor and the radiological contractor were performing their activities in accordance with the criteria in the decommissioning plan. Region I staff also reviewed the activities conducted by the ORAU staff during their confirmatory survey. The ORAU staff were observed to be following the scope of their survey outlined in the survey plan for the facility and performing tasks in accordance with their Survey Procedures Manual. As discussed above, Region I staff conducted measurements of the areas remediated after the ORAU survey to ensure the identified areas were appropriately remediated.

11. Exposure Rates from Contaminated Surfaces

The Region I staff performed calculations to determine if the conclusion of Westinghouse's contractor was appropriate in regard to uranium and/or thorium surface contamination being the more limiting condition than exposure rates for release of the facility for unrestricted use. Calculations with a commercial shielding and exposure rate program (Microshield) for both uranium and thorium (and their appropriate daughter

products) assumed uniform surface contamination of a semi-infinite plane equal to the limit for unrestricted use for these radionuclides (5,000 dpm/100 cm^2 for uranium and 1,000 dpm/100 cm^2 for thorium). The results indicate that the exposure rate at one meter from the surface contaminated with 5,000 dpm/100 cm^2 of uranium would be 0.05 microroentgens per hour and from 1,000 dpm/100 cm^2 of thorium would be 0.88 microroentgens per hour. Either value is sufficiently less than the criterion of 5 microroentgens per hour for interior areas. Surface contamination is, therefore, the more limiting condition for release for unrestricted use in this case.

12. Ground Water Monitoring

Ground water monitoring data has been provided for three production wells on site from samples obtained in March 1986 and from ten ground water monitoring wells from samples obtained in May 1990. All 1986 and 1990 samples were analyzed for gross alpha and total uranium activities. Samples from 1990 were also analyzed for gross beta activity, gamma-emitting radionuclides, and specific Ra-226, Th-232, U-234, U-235 and U-238 concentrations. The gross alpha and gross beta concentrations from well CC3 (located between the eastern ends of Buildings 4 and 5) obtained in 1990 were significantly higher than the remainder of the wells. The measured gross alpha and gross beta concentrations for this well were 37 pCi/liter and 92 pCi/liter, respectively. Concentrations for the remainder of the wells sampled in May 1990 ranged from less than 2 to 5 pCi/liter for gross alpha activity and from 4 to 18 pCi/liter for gross beta activity. Analyses specific for the isotopes of radium, uranium and thorium and gamma spectrometry analysis did not identify any specific radioactive material above the detection sensitivity of the analyses for the sample from well CC3. Westinghouse could not provide any additional information concerning that sample and considered the gross activity results anomalous since they were unconfirmed by the specific analyses.

Ground water is to be monitored in accordance with a ground water monitoring, sampling and analysis plan that is being coordinated with the State of New Jersey. Westinghouse submitted the plan to the State in June 1992, but the State has not yet formally accepted the plan. Additional radiological data for ground water samples should be available once the State accepts the plan.

13. Summary and Discussion

To support the request to release this facility for unrestricted use, the licensee's contractor conducted a survey in 1990, ORAU surveyed the facility for the NRC in 1991 and the licensee's contractor conducted a resurvey in 1991. After eight contaminated areas were found by ORAU in locations that had not been extensively surveyed, the licensee's radiological contractor surveyed greater than 90 percent of the area of the interior floors. As a result, additional contaminated areas were identified. All areas where contamination was found in excess of the criteria in the decommissioning plan

were subsequently remediated and subjected to confirmatory measurements by the licensee's contractor and an NRC staff member to ensure that residual activity in excess of the criteria did not remain.

Region I staff is not in full agreement with the licensee's position on the MDA calculation for portable instrumentation used during these surveys (see discussion in Appendix A); however, the type and extent of measurements performed in the facility by the licensee's contractor, prior to and following the ORAU survey, were both sufficiently extensive and sensitive to identify residual contamination in excess of the criteria for release for unrestricted use.

Measurements by the licensee's contractor in drain lines in a sump between Buildings 3 and 4 indicated 3,100 dpm/100 cm^2 and 3,400 dpm/100 cm^2 of gross beta activity on the interior surfaces. If the activity consisted only of thorium, these results would exceed the maximum criteria for release for unrestricted use by approximately 10%. ORAU measurements in this same area yielded 1,200 dpm/100 cm^2 and 1,300 dpm/100 cm^2 and thus did not confirm the original measurements. NRC staff concludes that these drain lines do not pose a radiological hazard since the activity in excess of the criteria for release for unrestricted use was not confirmed. Even if the licensee's contractor's data is considered correct, the material is not readily accessible for direct exposure, inhalation or ingestion by individuals in the area since the drain lines are buried at a depth of approximately 1 meter (3 feet) and the quantity of material is not significant (less than 0.5 microcurie if the insides of the piping are uniformly contaminated at the levels measured by the contractor over the total 3 meter (12 feet) length of drain pipe). Therefore, additional remediation is not required.

The elevated exposure rates measured in the laboratory on the 3rd floor of Building 3 are due to the presence of Ra-226 in the building material of one of the walls in the room. Since the uranium used by Westinghouse at the site had been previously processed, the radioactive daughter products in the decay chain below U-234 (including Ra-226) had been removed. Due to the long half-lives of U-234 and Th-230, the precursors of Ra-226, virtually no ingrowth of Ra-226 has occurred. Concentrations of Ra-226 above typical background concentrations of approximately 0 to 2 pCi/g have not been confirmed in the characterization or closeout soil and sludge samples from the facility, even where elevated concentrations of U-238 were identified. Therefore, the Ra-226 concentration measured in the sample of concrete from the wall is inherent in the building material and not due to the past licensed operations of the facility. The measured exposure rate in the area, although elevated, is a result of naturally occurring radioactive materials and remediation is not required.

Although the staff concludes that the surface contamination are the more limiting criteria in this case, it is prudent to have measurements that show external gamma radiation exposure rates at the facility meet the criteria. The exposure rate measurements and the

walk through measurements conducted with the NaI detector and rate meter performed during the initial surveys by Westinghouse's contractor and the exposure rate measurements performed by the NRC inspector provide adequate assurance that there is no external radiation hazard and that the facility meets these criteria for release for unrestricted use.

The majority of the radioactive contamination identified on this portion of the site was in the interior of the buildings. The contamination identified in soil was not extensive and did not require deep excavation to remove. Based on these facts and the results of the ground water monitoring, an effect on ground water from activities at the site appears unlikely. The potential for future effects on the ground water from operations at the site has been reduced or eliminated due to the fact that possible sources of ground water contamination have been removed. Assessment of the conditions in Buildings 7, 8 and 9 and the surrounding areas is still needed to make a final conclusion that all sources of significant radioactive contamination have been removed. Ground water monitoring should continue in accordance with the monitoring plan negotiated with the State of New Jersey. This plan includes the addition of a new ground water monitoring well in the vicinity of the former reservoir. A final decision on the condition of the ground water will be made as part of the assessment of the remaining area of the site.

Based on the review of all of the available data, it appears that residual radioactive contamination in excess of the criteria for unrestricted use has been removed from the areas described in the first paragraph of this evaluation and that a sufficient fraction of that area has been surveyed to conclude that that portion of the facility meets the criteria for release for unrestricted use.

14. Conclusion

The remediation of the portion of the facility west of Arlington Avenue and the remediation performed following identification of additional contamination during the ORAU survey was sufficient to remove residual contamination at the facility to levels that are below the current criteria for release for unrestricted use. The results from all of the types of measurements performed (surface contamination measurements, soil sampling, radiation exposure rates and ground water monitoring) confirm that the buildings and property on the west side of Arlington Avenue (Buildings 1 through 6, the garage and the surrounding land) meet the criteria in the decommissioning plan and current NRC criteria for release for unrestricted use. Radioactive wastes generated as a result of the remediation activities have been properly transported from the site and transferred to an authorized licensee.

This evaluation makes conclusions only on the radiological condition of the site and does not address the possible presence of EPA or State of New Jersey regulated hazardous wastes at the site. As of the date of this document, NRC confirmatory measurements

have not been conducted on the property on the east side of Arlington Avenue (Buildings 7, 8 and 9 and surrounding land) and thus no conclusion has been reached on the condition of that portion of the site. License No. SMB-1527 can be modified to delete the portion of the site west of Arlington Avenue as an authorized location of use and the natural thorium possession limit can be reduced, but the license can not be terminated until the entire facility meets the criteria for release for unrestricted use.

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APPENDIX A

Analysis of Detection Levels for Surface Activity Measurements

To understand the concept of Minimum Detectable Activity (MDA), the definition of MDA must be examined. In NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination", a recent document prepared for the NRC, MDA is defined as: "The minimum level of radiation or radioactivity that can be measured by a specific instrument and technique. The MDA is usually established on the basis of assuring false positive and false negative rates of less than 5%".

A false positive type of error is known as a Type I (or alpha) error where one concludes that activity is present when activity is not actually present. A false negative type of error, Type II (or beta) error concludes that activity is not present when indeed there is activity present. In the NUREG/CR-5849 calculation, the MDA is based on a statistical hypothesis test in which both Type I (alpha) and Type II (beta) errors have a 5% chance of occurring. This means that we are 95% confident that neither of these types of errors have occurred. In an earlier and generally well-recognized discussion on the concept of MDA (Currie, 1968), Currie reported that the MDA (L_D), guards against both Type I and Type II errors. Thus, the MDA is a chosen conservative level that has a "built-in protection-level, alpha, against falsely concluding that a blank observation represents a 'real' signal."

In response to our letter dated April 29, 1991 requesting additional information on the minimum detectable activity calculation for rate meter instruments used in the confirmatory surveys at the Westinghouse Bloomfield site, the licensee submitted calculations and an explanation which states that they assume the MDA to be approximated by the (percent) standard error of the meter reading (σ), where σ is calculated by the following:

$$\sigma = (r2RC)^{-1/2} * 100$$

where: r = detector input (counts per minute)

RC = time constant (minutes)

Using the above formula and factoring in the instrument parameters to give the result in units of dpm/100 cm^2, an MDA value can be calculated. For the instrumentation used in the licensee's confirmatory surveys (a Ludlum Model 12 rate meter equipped with a Model 44-9 pancake GM probe), the licensee's contractor indicates a measured counting efficiency of 22 percent and a background count rate of 40 cpm. For this equipment the vendor catalogue reports a time constant of four (4) seconds (0.067 minutes) and a probe area of 15.5 cm^2. A value of 510 dpm/100 cm^2 is computed for the MDA. According to this computation, this survey instrument is able to detect levels of contamination below the 1,000 dpm/100 cm^2 criteria for residual total surface contamination for thorium.

In draft NUREG/CR-5849, a different MDA calculation is provided. The MDA is calculated as follows:

$$MDA = 4.65\frac{\sqrt{B_R / (2t_c)}}{E*A/100}$$

where: B_R = Background count rate (cpm)
t_c = meter time constant (minutes)
E = Counting Efficiency (counts per disintegration)
A = Active area of probe (cm^2)

Using the same parameters as the previous calculation and the above MDA equation, an MDA of 2,360 dpm/100 cm^2 results. According to this calculation method, this meter would not reliably detect levels of contamination at or below the 1,000 dpm/100 cm^2 surface contamination criterion for release for unrestricted use for thorium. The 5,000 dpm/100 cm^2 criterion for uranium contamination is met with either MDA calculation. The problem is thus: What represents an acceptable computation for the Minimum Detectable Activity for a rate meter measurement? It should also be pointed out that regardless of how the MDA is calculated, as the amount of activity increases, the confidence in the ability to measure that value increases. What this means is that high levels of activity will be reliably detected during a survey and not missed.

When determining whether an area meets decommissioning criteria, we are less concerned about Type I errors since the result of such an error is the remediation of an area that already meets the acceptable criteria. Although remediation of a clean area is not an ideal situation, it may be acceptable if it allows a less sensitive measurement technique to be employed. For decommissioning and confirmatory surveys, we are more concerned with Type II errors where one concludes that activity in excess of the criteria is not present when indeed such activity is present. If only a Type II error is considered, the multiplier (4.65) in the MDA equation can be reduced by a factor of two (2.33 instead of 4.65), since the statistical test becomes one-tailed rather than two-tailed.

Most MDA calculations assume the random fluctuation in background measurements is normally distributed about the mean. This assumption and the acceptance of a 95% confidence level is manifested in the MDA calculation in NUREG/CR-5849. The multiplicative constant of 4.65 in the calculation consists of the factors 2, 1.645 and $\sqrt{2}$. The factor 1.645 is the value of the "Z" statistic for the normal distribution at the 95% confidence level for a one-tailed test. Although the 95% confidence level has been used frequently in the past, the selection of this value is arbitrary. Accepting a lower confidence level would lower the calculated MDA; accepting a higher confidence level would result in a higher MDA.

The MDA calculation provided by the licensee in which the MDA is assumed to be approximated by the standard error of the meter reading can be mathematically rearranged and put into a form similar to the MDA calculation in NUREG/CR-5849. By rearrangement and substitution, the following equation results:

$$MDA = \frac{\sqrt{B_R / (2t_c)}}{E*A/100}$$

with all terms defined as in the NUREG/CR-5849 MDA calculation.

The only difference in the two equations is the lack of the constant 4.65 in the latter equation. If the normal distribution is again assumed for the distribution of background, the resultant MDA equation provides confidence at approximately the 64% confidence level. Although, as discussed earlier, the selection of a confidence level can be arbitrary, a 64% confidence level does not provide sufficient confidence that all contaminated areas have been identified and remediated.

In the 1990 survey and in the post-remediation surveys following the ORAU survey, the licensee's contractor made direct measurements with a Ludlum Model 12 rate meter equipped with a Model 43-5 alpha scintillation detector. Instrument parameters for this survey meter are as follows: an efficiency of 15%; background count rate of 10 cpm; a time constant of 4 seconds; and a probe area of 50 cm^2. The calculated MDA based on the NUREG/CR-5849 methodology is 537 dpm/100 cm^2. This value readily meets the criterion for thorium. However, when directly monitoring for alpha activity, the actual efficiency of the detector is likely to be far less than the measured efficiency due to attenuation and self-absorption of the alpha particles in the surface to be monitored. Since alpha particles have a very limited range, alpha contamination imbedded in the surface being monitored is not likely to be counted. Dirt, other coatings on the surface to be monitored or an irregular surface (like concrete) can dramatically reduce the efficiency of alpha counting. The magnitude of this effect is extremely variable and not readily able to be quantified. Although the calculated, *a priori* (theoretical) MDA meets the thorium criterion and useful measurements can be obtained, in practice, this instrument can not be reliably used by itself to confirm that the thorium criterion has been met.

During the surveys performed after the ORAU survey and after additional remediation was performed, the licensee's contractor made numerous measurements using a Ludlum Model 12 rate meter equipped with a Model 4320 gas flow proportional detector. For this instrument the following parameters were measured or obtained from the instrumentation catalogue: an efficiency of 18%; background count rate of 100 cpm; a time constant of 4 seconds; and a probe area of 160 cm^2. Using the NUREG formula for MDA, this calculates to an MDA of 440 dpm/100 cm^2. However, since the probe

area is greater than 100 cm^2 and in order to avoid the problem of averaging over a large probe area, it is more appropriate to assume that the probe is only 100 cm^2. The calculated MDA is then 707 dpm/100 cm^2, which also readily meets the thorium criterion.

Although the NRC provides criteria for allowable residual surface contamination for release of a facility for unrestricted use, the calculational method to determine if a rate meter measurement meets this criteria is not defined. Draft guidance in NUREG/CR-5849 provides an *a priori* method, the Minimum Detectable Activity, to calculate this value. An *a priori* calculation, by definition, is deductive and based on assumptions or theory rather than experience or experiment. The selection of a measurement technique in which the *a priori* MDA meets the decommissioning criteria generally provides an acceptable level of confidence that the criteria for release for unrestricted use can be met. In this case, the measurements performed with the Ludlum Model 12 rate meter and the Model 4320 gas proportional probe provide an acceptable level of confidence that the decommissioning criteria has been met since the *a priori* MDA for this instrument is less than the decommissioning criteria. Selection of a measurement technique where the *a priori* MDA does not meet the necessary release criteria (i.e. the Ludlum Model 12 rate meter and the Model 44-9 pancake GM probe) may also be acceptable in practice; however, additional verification measurements are often required to have the necessary confidence that the appropriate criteria are met. The measurements performed with the pancake GM probe were not sufficient to enable the NRC to conclude that the decommissioning criteria was reliably met. The measurements performed by ORAU and those measurements performed by Westinghouse's contractor after the ORAU survey were performed with gas proportional detectors in which the *a priori* MDA is less than the decommissioning criteria. Since these measurements generally confirmed the measurements obtained with the pancake GM detectors, these measurements provide the necessary verification of the GM detector measurements.

APPENDIX B

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