FINAL STATUS SURVEY REPORT IN SUPPORT OF THE TERMINATION OF THE PATHFINDER BYPRODUCT MATERIAL LICENSE

Revision 0

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EXECUTIVE SUMMARY

The Final Status Survey Report (FSSR) documents the radiological status of the Pathfinder Site, license no. 22-08799-02, following decommissioning activities performed in 2006 and demonstrates that the site meets the criteria for release for unrestricted use. The guidance contained in Section 4.5.2 of NUREG-1757, Volume 2 was used to aide in the preparation of the Final Status Survey Report.

Table 1 lists the requirements of NUREG-1757 and where in the FSSR the requirements are addressed.

The final status survey of the Pathfinder Site resulted in the establishment of 59 survey areas and included approximately:

Number	Type
5,650 measurements	Total beta activity
5,650 measurements	Removable alpha activity
5,550 measurements	Removable Beta activity
200 measurements	Exposure rate
20 measurements	Removable tritium activity
110 samples	Off site analysis

Individual measurements and sample analysis results did not identified licensed activity in excess of the criteria for release for unrestricted use. The criteria for release for unrestricted use, which are also referred to as Derived Concentration Guideline Values ($DCGL_w$) are provided within this report. Therefore, it was not necessary to perform elevated measurement comparisons or evaluate the data using non parametric statistics to demonstrate that the criteria for release for unrestricted use was met.

Exposure rate measurement results from within the condenser hotwell identified numerous areas of elevated activity at the base of the vertical support pipes. Investigations determined that these areas of elevated activity were due to discrete radioactive particles within the pipes. The decision not to remediate the vertical support pipes was based on an informal as low as reasonably achievable (ALARA) cost benefit analysis. A site specific dose estimate has been prepared and provided as Appendix 6, *Dose Estimate to a Hypothetical Individual Exposed to Residual Contamination Following the Decommissioning of the Pathfinder Condenser Hotwell*, to this report justifying leaving the activity in the pipes while allowing for unrestricted license termination.

Table 1

NUREG 1757, Section 4.5.2, Requirements	FSSR Location
An overview of the results of the Final Status Survey Report	Section 10
A summary of the derived concentration guideline values, DCGLs	Section 4
A discussion of any changes that were made in the Final Status Survey from what was proposed in the Decommissioning Plan or prior submittals	Section 6.5 Section 8.6 Appendix 6
A description of the method by which the number of samples was determined for each survey unit	Section 7.5
A summary of the values used to determine the number of samples and a justification for values	Section 7.3 and Section 7.4
The survey results for each unit	Appendixes 2 through 5
The number of samples taken in each survey unit	Section 10
A discussion of remedial actions	Section 6
A description of each survey unit	Appendix 1
A map or drawing showing the reference system and random starting location for the systematic sample in Class 1 and 2 survey units	Appendix 1
A map or drawing showing the reference system and sampling locations in Class 3 survey units	Appendix 1
The measured sample results in units comparable to the DCGLs	Section 10
An acknowledgement that judgmental and miscellaneous sample data sets are reported separately from those samples collected for performing statistical evaluations.	None of the final status survey data sets contain any judgemental or miscellaneous measurement and/or sample analysis results. However, Section 6 of this report discusses the sample analysis results associated with several investigations performed to validate the final status survey results.
The statistical evaluation of the measured sample results	NA (No Final Status Survey results in excess of DCGLs)
A discussion of anomalous data including any areas of elevated activity detected during scanning that exceeded the investigation level or any measurements in excess of the $DCGL_w$	Section 11
A statement that a given survey unit satisfies the $DCGL_w$ and the elevated measurement comparison if any sample point exceeds the $DCGL_w$	This Executive Summary
A description of any changes in the initial survey unit assumptions relative to the extent of residual radioactivity	Section 6.5 and Section 6.9
A description of how ALARA practices were employed to achieve final activity levels	Section 4.5 Section 6.5

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1.0 Introduction

This Final Status Survey Report documents the radiological status of the Pathfinder Site following decommissioning activities performed in 2006 and demonstrates that the site meets the criteria for release for unrestricted use justifying the termination of the site's NRC byproduct materials license, license number 22-08799-02.

The final status survey was performed in accordance with the *Final Status Survey Plan for the Pathfinder Plant*, Reference 13.1, contained as Appendix F to the *Pathfinder Decommissioning Plan*, Reference 13.2.

The Pathfinder Atomic Plant was designed to generate 66 MW of electrical energy. The operating license, license number DPR-11, for the Pathfinder Atomic Power Plant was obtained in 1964. The reactor vessel had a unique design that employed in-core superheaters. Outside of the vessel, the plant's configuration was similar to that of a boiling water reactor.

The plant achieved initial criticality on March 24, 1964 and commenced commercial operations on August 1, 1966. The Pathfinder Atomic Plant was permanently shut down on September 16, 1967. Its brief period of operation involved phased testing. Sustained full power operation, at its designed power level, was never obtained.

During its brief period of operation the Balance Of Plant (BOP) systems located outside the Reactor Building became contaminated through the translocation of radioactive material from the reactor vessel. During the final shut down, a condenser tube leak occurred resulting in the contamination of the service water system and cooling tower basin. Immediately following the condenser tube leak the cooling tower basin was deconned. In 1968 the remaining BOP systems were deconned. The steam, reactor feedwater, and other nuclear process piping were isolated and capped. The BOP systems were then integrated into a fossil fueled peaking plant. Three new gas/oil package boilers housed in a new Boiler Building supplied steam to the original turbine. Commercial operation of the Pathfinder Peaking Plant commenced in May 1969 and continued until July 2000.

In 1970 the reactor fuel associated with the operation of the Pathfinder Atomic Power Plant was shipped offsite to a licensed repository. In August 1972 the operating license was terminated and the current byproduct material license issued. In 1991 the Reactor Building, Fuel Handling Building, and the Temporary Loading and Storage Building were decommissioned. Following the decommissioning, the above grade portions of the Reactor Building were removed and the below grade portions backfilled and capped. The Fuel Handling Building and the Temporary Loading and Storage Building are still used to support site activities, primarily those of the combustion turbine plants which were constructed on the eastern end of the Pathfinder Site.

The first of the combustion turbine plants were put into service in September 1994. The only physical connection that existed between these plants and the Pathfinder Peaking Plant was through a service connection to the cooling tower basin for fire protection. The service water lines between the cooling tower basin and the Pathfinder Peaking Plant have been cut and capped. The combustion turbine plants were not included in the final status survey of the Pathfinder Site.

Xcel Energy notified the NRC that it had permanently ceased operating the Pathfinder Peaking Plant in February 2003. In February 2004, Xcel Energy submitted a Decommissioning Plan and license amendment request in preparation for decommissioning the site. On May 27, 2005, the NRC approved the Decommissioning Plan.

2.0 Facility Description

The Pathfinder Site is owned by Northern States Power Company (NSP)-Minnesota a wholly owned subsidiary of Xcel Energy. The site is located at 7100 East Rice Street in Sioux Falls, South Dakota. In 1994 the Pathfinder Site was renamed the Angus Anson Generating Station with the addition of two combustion turbine plants

Figure 2.1 shows the layout of the Pathfinder Site. Figure 2.1 does not show the location of the combustion turbine plants. The final status survey was limited to the buildings within the secured area of the site, the open land areas inside and outside of the secured area, the paved areas within the secured area, the effluent discharge pathway leading to the Big Sioux River, the construction lay down area, and the four settling basins.

Figure 2.2 is an enlarged view of the Pathfinder Site's historical secured area. Shown in Figure 2.2 is the historical location of the Reactor Building. Since the Reactor Building had been previously decommissioned, its above grade portion removed and its below grade portion backfilled and capped, it was not included in the final status survey of the Pathfinder Site.

Based on numerous ground water surveys, it has been determined that the ground water surrounding the Pathfinder Site does not contain licensed activity. In addition no licensed source terms capable of causing groundwater contamination have been identified. Therefore, the final status survey of the Pathfinder Site did not include ground water surveys per the approved Decommissioning Plan.

In 2005, prior to the 2006 decommissioning of the Pathfinder Site, the above grade portions of the turbine were removed to allow for alternative uses of the turbine deck. The portions of the turbine removed in 2005 were either surveyed and free released or were stored on site awaiting the 2006 decommissioning effort. The criterion for free releasing portions of the turbine was no detectable activity in excess of the minimum detectable activity (MDA). The results of the survey for free release are documented in Reference 13.3, *Free Release Survey of the Turbine/Generator Within the Pathfinder Plant in Sioux Falls, South Dakota.* Portions of the turbine stored awaiting the 2006

decommissioning could not be effectively surveyed due to their geometry. The items that could not be effectively surveyed were disposed of as radioactive waste during the 2006 decommissioning effort.

Figure 2.1
Pathfinder Site Layout

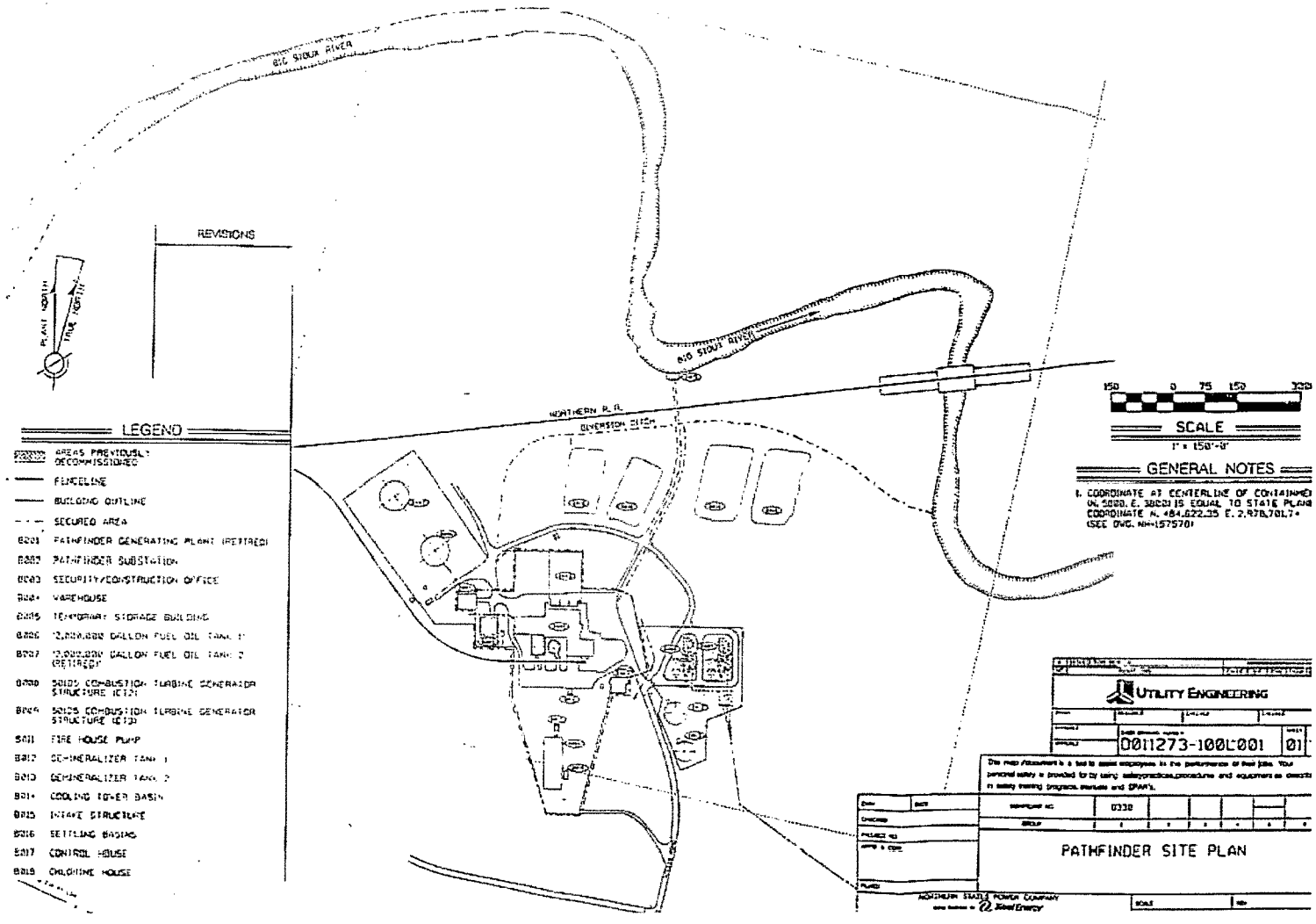
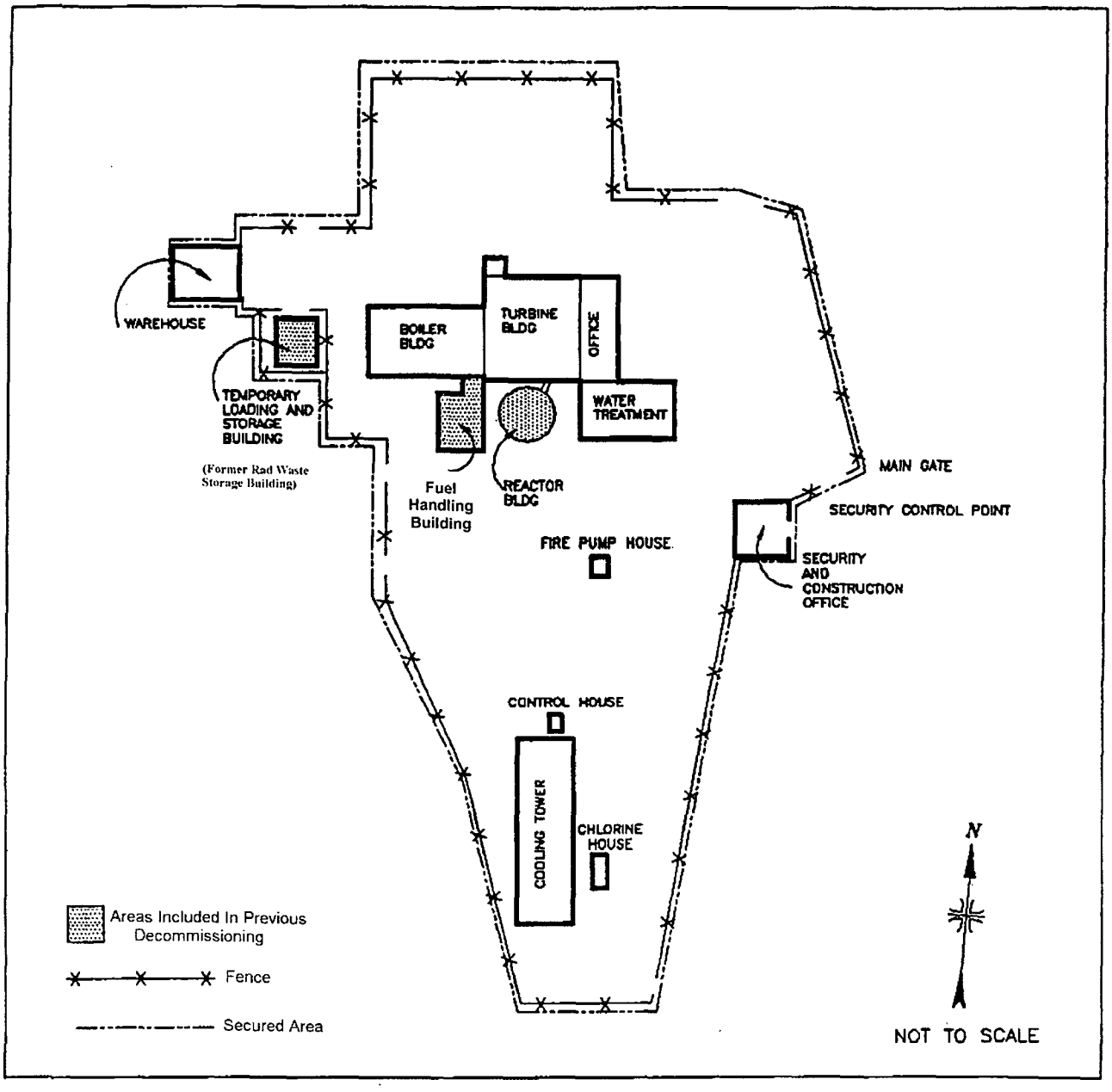


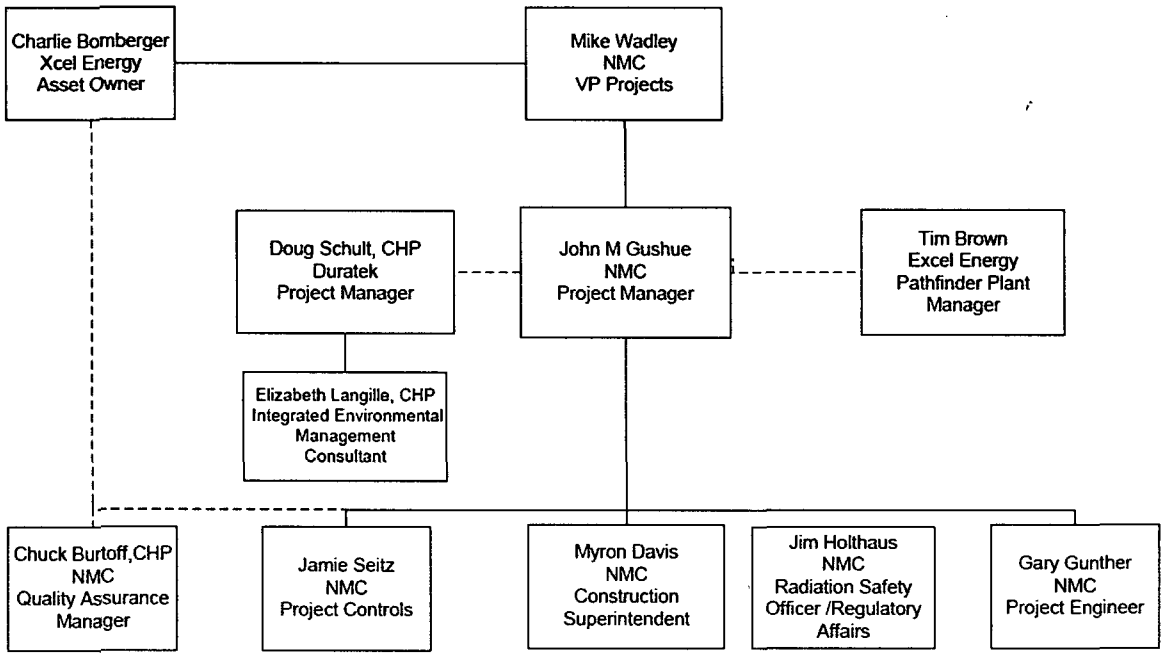
Figure 2.2
Pathfinder Site's Historical Secured Area



3.0 Decommissioning Organization

The organizational chart for the Pathfinder Site decommissioning is shown in Figure 3.1

Figure 3.1
Organizational Chart



Duratek was contracted by NMC on behalf of Xcel Energy to perform all decommissioning activities including remedial activities, waste disposal and performance of the final status survey. NMC provided site access, project oversight, and facilitated site support, when necessary.

4.0 Criteria for Release for Unrestricted Use

This section of the report presents the radionuclides of interest for the final status survey, the approved criteria for release for unrestricted use, and a discussion on how using the approved criteria for release for unrestricted use is consistent with the requirement for reducing residual activity to levels that are as low as reasonably achievable (ALARA). Also presented are the derivations of site specific $DCGL_w$s which were used to account for nondetectable radionuclides when evaluating total beta measurements.

4.1 Radionuclides of Interest

Based on the results of the characterization survey and as documented in the Decommissioning Plan, the radionuclides of interest during the decommissioning and final status survey were expected to potentially include H-3, Co-60, Zn-65, Ag-108m, Eu-152, and Eu-155. To confirm the radionuclides of interest and their relative fractions two samples were collected for analysis during the decommissioning. Each of these samples were analyzed for the following radionuclides: Ni-59, Ni-63, Sr-90, Tc-99, Fe-55, Pu-238, Pu-239/240, Th-228, Th-230, Th-232, U-234, U-235, U-238, C-14, H-3, and gamma emitting radionuclides (Co-60, Zn-65, Ag-108m, Cs-137, Eu-152, and Eu-154). One sample was collected from within one of the Turbine Building hot side floor drains that was removed during the decommissioning. The other sample was collected from within the HEPA vacuum used to aid in the decon of the condenser hotwell.

The analysis results associated with these two samples are provided in Appendix 5, *Sample Analysis Results*, and summarized in Table 4.1.1. Only those sample analysis results in excess of the MDA and attributable to licensed activity are shown in Table 4.1.1.

Table 4.1.1
Confirmatory Characterization Sample Analysis Results

Sample ID	Radionuclide	Sample Analysis Result pCi/g	Relative Fraction f_i
Char-Pipe-1	Ni-63	14.1	0.619
	Co-60	8.67	0.381
	Sum	22.77	1.00
Vac-01	Ni-63	8.82	0.293
	Co-60	21.3	0.707
	Sum	30.12	1.00

Based on the sample analysis results in Table 4.1.1, it was determined that Ni-63 and Co-60 were the radionuclides of interest when interpreting non specific radionuclide measurement and/or analysis results obtained during the final status survey. Based on the sample analysis results in Table 4.1.1, a relative fraction of 0.50 was assigned to both Ni-63 and Co-60.

4.2 Building Surfaces

For building surfaces the criteria for release for unrestricted use were, when listed, the screening values listed in Appendix B of NUREG-1757, Volume 1. For those radionuclides not listed in Appendix B the criteria for release for unrestricted use were, when supported, calculated using the NRC's D&D Code. One of the radionuclides of interest, Ag-108m, was not listed in Appendix B and was not a

radionuclide supported within the NRC's D&D Code. Therefore, the RESRAD BUILD Code was used to calculate the criteria for release for unrestricted use for Ag-108m. The criteria for Ag-108m was approved for use, as needed, by the NRC as part of the Decommissioning Plan.

The screening values for building surfaces were deemed applicable since the conditions specified in NUREG-1757 were met. Specifically:

- Residual licensed activity did not penetrate the surfaces to a depth in excess of 10 mm.
- The removable fraction of the residual licensed activity did not exceed 10% of the screening values.
- The screening values were not applied to buried structures or equipment.

Table 4.2.1 contains the criteria that are acceptable to evaluate total beta activity measurements to demonstrate that building surfaces are acceptable for release for unrestricted use. The criteria for release for unrestricted use are also referred to as the Derived Concentration Guideline Values, ($DCGL_w$).

Table 4.2.1
Criteria for Release for Unrestricted Use for Building Surfaces

Radionuclide	Criteria dpm/100 cm^2
H-3	1.2E 8
Co-60	7.1E 3
Ni-63	1.8E 6
Zn-65	4.8E 4
Ag-108m	1.7E 4
Cs-137	2.8E 4
Eu-152	1.3E 4
Eu-154	1.1E 4
Eu-155	1.6E 5

Based on the analysis results presented in Section 4.1 a site specific $DCGL_w$ was calculated as follows for interpreting the total beta activity measurement results collected on building surfaces during the final status survey.

$$\text{Site Specific } DCGL_w = \frac{F}{\sum \frac{f_i}{DCGL_i}}$$

Where F = The fraction of the radionuclide mix that is taken to be detectable. To be conservative only Co-60 is

considered to be detectable due to the end point beta energy (66 keV) of Ni-63.

f_i = The relative fraction of the i_{th} radionuclide

$DCGL_i$ = The DCGL of the i_{th} radionuclide

For purposes of interpreting the total beta activity measurement results on building surfaces the Site Specific $DCGL_w$ equals 7,070 dpm/100 cm^2.

When evaluating building surfaces for removable activity it was verified that the removable activity did not exceed 10% of the Site Specific $DCGL_w$, i.e. 707 dpm/100cm^2.

4.3 Open Land Areas

For open land areas the criteria for release for unrestricted use were the screening values listed in Appendix B of NUREG-1757, Volume 1.

The screening values for soils were deemed applicable since the conditions specified in NUREG-1757 were met. Specifically:

- Residual licensed activity was contained within the top 15 cm of soil
- The unsaturated zone and groundwater were free of licensed residual activity
- The vertical saturation hydrological conductivity was greater than the infiltration rate, i.e. there is no ponding or surface run off.

Table 4.3.1 contains the criteria for release for unrestricted use of open land areas. The criteria for release for unrestricted use are also referred to as the Derived Concentration Guideline Values ($DCGL_w$).

Table 4.3.1
Criteria for Release for Unrestricted Use of Open Land Areas

Radionuclide	Criteria pCi/g
H-3	1.1E 2
Co-60	3.8E 0
Ni-63	2.1E 3
Zn-65	1.1E 1
Cs-137	1.1E 1
Eu-152	8.7E 0
Eu-154	8.0E 0
Eu-155	2.8E 2

4.4 Non Permanent Structures

For non permanent structures the criteria for release for unrestricted use were taken from NRC Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors.* Examples of non permanent structures include small pumps, valves, work benches, etc. Table 4.4.1 lists the criteria that were used to evaluate measurements for total beta activity to demonstrate that non permanent items are acceptable for release for unrestricted use.

Table 4.4.1
Criteria for Release for Unrestricted Use of Non Permanent Items

Radionuclide	Criteria dpm/100 cm^2
H-3	5,000
Co-60	5,000
Ni-63	5,000
Zn-65	5,000
Ag-108m	5,000
Cs-137	5,000
Eu-152	5,000
Eu-154	5,000
Eu-155	5,000

Based on the analysis results presented in Section 4.1 a site specific $DCGL_w$ was calculated as follows for interpreting the total beta activity measurement results collected on non permanent items during the final status survey.

$$\text{Site Specific DCGL} = \frac{F}{\sum \frac{f_i}{DCGL_i}}$$

Where F = The fraction of the radionuclide mix that is taken to be detectable. To be conservative only Co-60 is considered to be detectable due to the end point beta energy (66 keV) of Ni-63.

f_i = The relative fraction of the i_{th} radionuclide

$DCGL_i$ = The DCGL of the i_{th} radionuclide

For purposes of interpreting the total beta activity measurement results on non permanent items the Site Specific $DCGL_w$ = 2,500 dpm/100 cm^2.

When evaluating non permanent structures for removable activity, it was verified that the removable activity did not exceed 10% of the Site Specific $DCGL_w$, i.e. 250 dpm/100 cm^2.

4.5 ALARA

The decision to base the criteria for release for unrestricted use whenever possible on the screening values listed in Appendix B of NUREG-1757, Volume 1, or on screening values calculated using the NRC's D&D Code, was based on ALARA considerations and the expected scope of the required remedial actions.

Appendix N of NUREG 1757, Volume 2 states: "*In light of the conservatism in the building surface and surface soil generic screening levels developed by the NRC staff, the NRC staff presumes, absent information to the contrary, that licensees who remediate building surfaces or soils to the generic screening levels do not need to provide analyses to demonstrate that these screening levels are ALARA.*"

Based on the results of the characterization survey, Reference 13.4, *Characterization Survey Report for the Pathfinder Plant in Sioux Falls, South Dakota,* it was anticipated that the average residual contamination levels remaining following the completion of all remedial actions would be significantly below applicable screening values. Therefore, the decision was made to ensure all final status survey results were less than the criteria for release for unrestricted use when applying the generic screening values. Although allowed by the Decommissioning Plan, the use of elevated measurement criteria was not required.

5.0 Radiation Safety and Health

A Radiation Safety and Health Program was implemented during decommissioning activities to ensure that potential exposures to radioactive materials were kept as low as reasonable achievable, ALARA. Based on the results of the characterization survey, Reference 13.4, *Characterization Survey Report for the Pathfinder Plant in Sioux Falls, South Dakota,* and routine surveys performed throughout the decommissioning it was determined that no worker was likely to receive a total effective dose equivalent (TEDE) in excess of 0.5 rem. Therefore, monitoring for internal and external exposures through the use of personal dosimetry, bioassays, whole body counting, etc. was not required.

Work activities involving potential exposures to radioactive materials were performed under a Hazardous/Radiation Work Permit (HRWP). The HRWPs required that air samples be collected during work activities involving the potential for creating airborne contamination. The 44 air samples collected during the decommissioning activities did not result in a derived air concentration (DAC) fraction in excess of 0.01 based on a DAC of 1.00E-8 uCi/ml for gross beta activity and 3.00E-13 uCi/ml for gross alpha activity.

During decommissioning activities, items free released from a radiologically controlled area were first surveyed for fixed and removable contamination. No item was released if the survey results exceeded the minimum detectable activity (MDA) for the survey protocol. Items were also not released if they could not be effectively surveyed based on their configuration/geometry. Items not free released were disposed of as radioactive waste.

For free release surveys, the survey protocols were established to ensure that the MDAs did not exceed those specified in Table 5.1.

Table 5.1
MDAs Required for Free Release Surveys

Type of Radiation	Total Contamination	Removable Contamination
Alpha	*	100 dpm/100 cm^2
Beta	5,000 dpm/100 cm^2	500 dpm/100 cm^2

*No total alpha activity measurements were taken due to the absence of licensed alpha emitting radionuclides.

6.0 Site Remediation

This section of the report describes the efforts required to remediate area identified in the Decommissioning Plan as potentially requiring remediation. The site remediation generated approximately 34,000 pounds of radioactive waste. A photo essay, included as Appendix 8, *Pathfinder Photo Essay*, to this report may help provide clarification for those not familiar with the site.

6.1 Turbine Building Hot Side Floor Drains

The majority of the Turbine Building hot side floor and equipment drains were removed. In order to access the drains the concrete above the drains was cut with a diamond tipped blade, jack hammered, and removed. Once exposed, the drains were sectioned, their ends were taped, and they were disposed of as radioactive waste.

In order to access the drain lines beneath the condenser, a portion of the south end of the condenser and a portion of the floor of the condenser had to be removed. The condenser was cut using an oxy lance. The majority of the steel plate removed from the condenser was surveyed and free released. Pieces of steel from within the condenser (pipes, braces, hardeners, etc.) were bagged and disposed of as radioactive waste.

Due to the thickness of concrete above the floor drains in three locations, three pieces of pipe were remediated and surveyed in place:

- Pipe 1 is approximately 18 ft long and is located between the south end of the condenser and the hot side sump.

- Pipe 2 is approximately 3 feet long and runs through the concrete wall at the north end of the condenser.

- Pipe 3 is approximately 1.5 ft long and enters the Turbine Building hot side sump from the west.

6.2 Circulating Water Piping

Although identified in the Decommissioning Plan as an area potentially requiring remediation, elevated activity was not found within the circulating water piping. Access to the internal surface of the two circulating water pipes was obtained by using an oxy acetylene torch to cut holes in each of the pipes on the Turbine Building mezzanine. The steel plate removed from the pipes was surveyed and free released.

6.3 Condensate Pump Area Sump

The condensate pump area sump was completely removed using jack hammers. The resulting rubble was disposed of as radioactive waste. The sump, which was located in the basement of the Turbine Building, was adjacent to the concrete wall at the north end of the condenser. Removing the sump allowed direct access to both ends of Pipe 2, discussed in Section 6.1.

6.4 Turbine Building Hot Side Sump

Although identified in the Decommissioning Plan as an area potentially requiring remediation, elevated activity was not found within the Turbine Building hot side sump.

6.5 Condenser Hotwell

In order to access the condenser hotwell a portion of the south end of the condenser was removed. At the same time, a portion of the condenser floor was also removed to allow access to a drain line beneath the condenser. The condenser was cut using an oxy-lance. The steel plate removed from the south end and floor of the condenser was surveyed and free released.

While cutting the condenser floor, two steel box-strainers used to direct water to the condensate pumps were removed as was the piping. The steel box - strainers were disposed of as radioactive waste. The pipes to the condensate pumps were surveyed and free released.

Initially the remediation of the hotwell consisted of removing scale and debris using scrappers, wire brushes, and a HEPA vacuum. Internal structures needed to be removed to allow access for remediation and to allow access for surveying.

Following the initial remediation a final survey was performed within the condenser hotwell and it appeared that the criteria for release for unrestricted use was met.

Subsequent to the initial final survey, the NRC performed a confirmatory survey within the condenser hotwell. Using a gamma detector they were able to identify two areas of residual radioactivity in excess of the $DCGL_w$. Although these areas could have been evaluated using the elevated measurement criteria and shown to meet the criteria for release for unrestricted use, the decision was made to remediate the two areas.

Following the remediation of the two elevated areas identified by the NRC, additional surveys with a gamma detector were performed within the condenser hotwell to verify it was ready for a second final status survey. The surveys with the gamma detectors identified numerous areas of very isolated, elevated activity. Several of these areas were remediated. However, the majority of the areas of elevated activity were located at the base of the vertical support pipes within the condenser and could not be easily remediated.

The elevated activity at the base of the vertical support pipes was primarily due to discrete radioactive particles within the pipes. Due to structural concerns associated with the condenser, it was decided that the vertical support pipes should not be removed to allow for remediation of the discrete particles. A site specific dose estimate was prepared to justify leaving the activity in the vertical support pipes while allowing for license termination. The dose assessment is provided in Appendix 6, *Dose Estimate to a Hypothetical Individual Exposed to Residual Contamination Following the Decommissioning of the Pathfinder Condenser Hotwell.* The dose assessment quantified the residual activity and conservatively estimated the deep dose equivalent, to a hypothetical individual, to be less than 0.1 mrem/yr.

The decision not to remediate the vertical support pipes was based on an informal ALARA cost benefit analysis. Since the vertical support pipes, support the condenser's internals, removing the vertical support pipes would require removing the condenser's internals or engineering and installing new supports. Both options were estimated to cost in excess of $100,000 while the potential dose averted was estimated to be less than 0.05 man-rems.

Based on the follow up investigations within the condenser hotwell, it was decided to supplement the final status survey requirements specified in the approved Decommissioning Plan by requiring measurements with gamma detectors as part of the final status survey of the condenser hotwell.

In addition to performing measurements with gamma detectors within the condenser hotwell, measurements with gamma detectors were also performed throughout the plant. These measurements identified several overhead pipes that

required remediation on the hot side of the Turbine Building basement and on the Turbine Building mezzanine. The remediation of the overhead pipes required that the final status survey of the affected areas be repeated.

6.6 Floor Under Condenser

Although identified in the Decommissioning Plan as an area potentially requiring remediation, no specific remedial actions were performed on the floor under the condenser. However, with the remedial actions being performed on the floor drains beneath the condenser and within the condenser hotwell, the floor beneath the condenser was repeatedly cleaned with a HEPA vacuum to control the potential spread of contamination.

The final status survey of the floor under the condenser was repeated following the completion of all remedial activities and investigations performed within the condenser hotwell.

6.7 Condenser Expansion Joint

Due to limited accessibility, the condenser expansion joint was removed because it could not be remediated or effectively surveyed. An oxy lance was used to cut the expansion joint from the condenser. The expansion joint was bagged and disposed of as radioactive waste.

6.8 Mud Drums

The steel doors to each of the six mud drums located in the Boiler Building were removed using an oxy lance to improve accessibility to the mud drums. The steel doors were surveyed and free released. Each of the six mud drums was cleaned using a HEPA vacuum and wire brush in preparation for the final status survey. All debris removed from within the mud drums was disposed of as radioactive waste.

6.9 Miscellaneous Overhead Piping Within the Turbine Building

As a result of the experiences remediating the condenser hotwell, measurements with gamma detectors were performed throughout the plant. These measurements identified several overhead pipes that required remediation on the hot side of the Turbine Building basement and on the Turbine Building mezzanine. A criterion of 5 uR/hr on contact with the pipes was established to identify pipes requiring remediation. The criterion of 5 uR/hr was based on relative exposure rates as the response of the gamma detector was not corrected for energy or geometry dependences.

The source of these elevated exposure rates was likely contamination on the internal surfaces of the pipes as none of the pipes in question exhibited total beta

activity measurements approaching the criteria for release for unrestricted use. The areas of elevated activity appeared to be very localized and may have been due to discrete particles similar to those found within the vertical support pipes discussed in Section 6.5. Gamma spectral measurements collected in the field identified Co-60 as the gamma emitting radionuclide of interest.

The pipes requiring remediation were cut using an oxy-acetylene torch. Once cut, the pipes were sectioned, their ends were taped, and they were disposed of as radioactive waste. Although the areas of elevated activity associated with each pipe appeared to be localized, the length of pipe removed was determined based on the availability of hangers/structural supports for the pipes that remained.

Since the final status survey of the Turbine Building basement and on the Turbine Building mezzanine had been completed prior to the measurements with the gamma detectors identifying pipes requiring remediation, the areas affected by the remediation had to be resurveyed.

6.10 Radioactive Waste Disposal

All radioactive waste generated during the decommissioning was shipped to Duratek's licensed facility in Oak Ridge, TN for processing and/or disposal. During the course of the decommissioning two waste shipments were made. Both shipments were considered non radioactive per Department of Transportation (DOT) regulations.

Shipment number T065977 (manifest number 11-2-06-1) left the site on November 2, 2006 and consisted of four B-25 boxes with a gross weight of 12,660 pounds. For the purpose of completing the shipping manifest it was calculated that this shipment contained 0.0912 mCi of Co-60 and 0.0912 mCi of Ni-63.

Shipment number T066624 (manifest number 12-07-06-1) left the site on December 7, 2006 and consisted of five B-25 boxes with a gross weight of 21,700 pounds. For the purpose of completing the shipping manifest it was calculated that this shipment contained 0.1002 mCi of Co-60 and 0.1002 mCi of Ni-63.

7.0 Final Status Survey Overview

This section of the report describes the data quality objectives for the final status survey and includes a discussion on how the minimum number of measurements and/or samples to be collected in a given survey area was determined. The actual number of measurements and/or samples collected in each survey area is presented in Section 10.

7.1 Data Quality Objectives

The objective of the final status survey was to collect sufficient data to demonstrate that the Pathfinder Site meets the criteria for unrestricted use. To ensure that the data collected was of sufficient quality to support its intended use, the following Data Quality Objectives were incorporated into the final status survey:

- Only properly trained individuals with experience performing similar final status surveys, were allowed to participate in the survey.
- All survey data was reviewed by the individual performing the survey and a second individual not directly involved in the survey.
- All instrumentation used during the final status survey was appropriate for detecting the radionuclides of interest.
- All instrumentation used during the final status survey was operated in a manner that ensured that the required minimum detectable activities were achieved.
- A statistically significant number of measurements and/or samples were collected from each survey unit.
- All data was properly analyzed.
- All outliers were investigated.
- Proper documentation of the survey results was maintained with traceability back to the original data.

7.2 Non Parametric Statistics

The Final Status Survey Plan specified that it may be necessary to use non parametric statistics such as the Wilcoxon Rank Sum (WRS) Test and/or the Sign Test to evaluate the final status survey data if any of the data exceeded the criteria for release for unrestricted use. Since the final status survey data did not exceeded the criteria for release for unrestricted use, the non parametric statistics were not used to evaluate any of the final status survey data.

7.3 Decision Errors

There are two types of decision errors that could apply when planning a survey or evaluating the results of the survey: Type I (α) and Type II (β) errors. A Type I error, or false positive, is the probability that a survey result is above the criteria for release for unrestricted use when it is not. A Type II error, or false negative, is

the probability of determining that a survey result is below the criteria for release for unrestricted use when it is not. The probability of making decision errors is controlled through an approach known as hypothesis testing.

In this approach the null hypothesis (H_o) is the baseline condition that is assumed to be true unless proven otherwise. For example:

H_o = the residual activity in the survey area exceeds the criteria for release for unrestricted use.

Thus, the survey unit is assumed to exceed the criteria for release for unrestricted use until proven otherwise. For the purposes of the final status survey the Decommissioning Plan required that Type I and Type II errors to be set at 0.05, or five percent.

7.4 Relative Shift

The relative shift is defined as Δ/σ, where Δ is the $DCGL_w$ – LBGR (Lower Bound of The Gray Region) and σ is the standard deviation in the distribution of residual radioactivity.

As discussed in the Decommissioning Plan, the LBGR is typically set at 50% of the $DCGL_w$. Given a $DCGL_w$ of 7,070 dpm/100 cm^2, the LBGR was 3,535 dpm/100 cm^2 and Δ was also 3,535 dpm/100 cm^2.

The standard deviation in the distribution of residual radioactivity is usually determined from characterization and/or remedial action surveys or final status surveys of similar areas. As shown in Table 10.1.1 the standard deviation in the distribution of the total beta activity final status measurement results is typically less than 1,000 dpm/100 cm^2.

Based on a LBGR of 3,535 dpm/100 cm^2 and a σ of 1,000 dpm/100 cm^2, the relative shift (Δ/σ) was approximately 3.5.

7.5 Number of Samples and/or Measurements

The minimum number of samples and/or measurements collected in each survey area is dependent of the non parametric statistics likely to be used to test the null hypothesis, acceptable decision errors, and the relative shift. In cases where scanning sensitivities are not adequate to detect activity equal to the criteria for release for unrestricted use, the number of samples and/or measurements needs to be increased. However, the number of samples and measurements were not affected by scan sensitivities, since scan sensitivities for both the beta scans and the exposure rate scans were adequate to detect activity equal to the criteria for release for unrestricted use

Wilcoxon Rank Sum (WRS) Test

Once the relative shift has been determined the decision errors defined Table 7.5.1 can be used to determine the number of samples and/or measurements required to evaluate a survey area using the WRS Test. The interpolated value of N/2 gives the number of measurements required in a given survey area. An equal number of samples and/or measurements would also be required from within an appropriate reference area if the WRS Test were to be used.

Table 7.5.1
Values of N/2 for the Wilcoxon Rank Sum (WRS) Test When α and β Both Equal 0.05

Δ/σ	N/2
0.1	2726
0.2	685
0.3	307
0.4	175
0.5	114
0.6	81
0.7	61
0.8	48
0.9	39
1.0	32
1.1	28
1.2	24
1.3	22
1.4	19
1.5	18
1.6	16
1.7	15

Sign Test

Once the relative shift has been determined and the decision errors defined, Table 7.5.2 can be used to determine the number of samples and/or measurements required to evaluate a survey area using the Sign Test. The interpolated value of N gives the number of measurements required in a given survey area. When using the Sign Test, samples and/or measurements are not required in a reference area.

Table 7.5.2
Values of N for the Sign Test When α and β Both Equal 0.05

Δ/σ	N
0.1	2048
0.2	518
0.3	234
0.4	136
0.5	89
0.6	65
0.7	50
0.8	40
0.9	34
1.0	29
1.1	26
1.2	23
2.3	21
1.4	20
1.5	18
1.6	17
1.7	17
1.8	16
1.9	16
2.0	15

A review of Tables 7.5.1 and 7.5.2 reveals that with a relative shift (Δ/σ) in excess of 2.0, that 15 or less samples and/or measurements are required in each survey area. Therefore, to ensure an adequate number of samples and/or measurements were collected from each survey area, the Final Status Survey Plan required that a minimum of 15 samples and/or measurements be collected from each survey area.

The summary statistics presented in Section 10 of this report demonstrate that the minimum number of samples and/or measurements in each survey area exceeded 15.

7.6 Elevated Measurement Criteria

Although the Final Status Survey Plan allowed for the use of elevated measurement criteria in the event that residual licensed activity exceeded the $DCGL_w$, it was decided that all areas where residual licensed activity exceeded the $DCGL_w$ would be remediated in accordance with the commitment to ALARA.

The final status survey results did not exceed the criteria for release for unrestricted use, $DCGL_w$, and elevated measurement criteria were not used.

8.0 Survey Design and Implementation

This section of the report discusses the design and implementation of the final status survey. Included is a listing of the 59 survey packages developed to support the implementation of the survey.

8.1 Instrumentation

Table 8.1.1 lists instrumentation used during the final status survey.

Table 8.1.1
Final Status Survey Instrumentation

Instrument/Detector	Detector Type	Primary Type of Radiation Detected	Calibration Source	Use
Eberline BC-4	Shielded GM	Beta	Tc-99	Smear Counting
Eberline SAC-4	Zinc Scintillator	Alpha	Th-230	Smear Counting
Ludlum Model 2350 with a 43-68 (or equivalent) detector	126 cm^2 Gas Flow Proportional	Beta	Tc-99	Beta Scans and Total Beta Activity Measurements
Ludlum Model 2350 with a 44-2 or 44-10 detector	NaI (Tl)	Gamma	Cs-137	Gamma Scans and Exposure Rate Measurments
Ludlum Model 2350 with a PSL 3R detector	100 cm^2 Cylindrical Gas Flow Proportional	Beta	Tc-99	Total Beta Activity Measurements Within Pipes
Exploranium	NaI (Tl)	Gamma	Cs-137, Am-241. Co-60, and Th-232	In Situ Gamma Spec Measurements

All field measurements, except the investigatory in situ gamma spec measurements, were collected using the Ludlum Model 2350 data logger. The data logger is a microprocessor computer based counting instrument. Measurement results, along with supporting documentation, were stored for subsequent down loading for data analysis and report generation. The data logger is designed to operate with a variety of detectors and stores the operating parameters for each detector used.

All instrumentation used during the final status survey were calibrated within 6 months of use. The Exploranium was calibrated within 12 months of its being used but was only used during field investigations and not for final status survey measurements.

Calibration labels showing the instrument identification number, calibration date, and calibration due date were attached to all instruments. All instruments were inspected and source checked daily prior to use to verify calibration status and proper operation. In addition, all field instrumentation was source checked at the end of each day's use to bind the data collected during that day. Source check criteria were established for each instrument prior to its initial use.

All sources used for calibration, and efficiency determinations were chosen to be representative of the instruments response to the radionuclides of interest and are traceable to NIST.

8.2 Efficiency Determination for the Total Beta Activity Measurements

The gas flow proportional counters used to collect the total beta activity measurements were calibrated using NIST traceable Tc-99 sources which have an end point energy of 294 keV. This approximates the 318 keV end point energy of Co-60. In determining the efficiency to the Tc-99 sources, their 4Π emission rates were used. Therefore to correct the total beta activity measurement results to account for lower counting efficiencies when making field measurements due to self attenuation and self absorption, the efficiencies used for determining total beta activity were reduced by a factor of two. This method is consistent with the recommendations in ISO-7503-1, *Evaluation of Surface Contamination – Part I: Beta Emitters and Alpha Emitters.*

8.3 Minimum Detectable Activity

Minimum Detectable Activity (MDA) is defined as the smallest amount or concentration of radioactive material that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity. The MDA is dependent upon count times, geometry, sample size, detector efficiency, background; and for scanning, the scanning rate and the efficiency of the surveyor.

The MDAs for total beta activity measurements and removable beta activity measurements were set at less than 1,000 dpm/100 cm^2 and 200 dpm/100 cm^2 respectively, for the final status survey.

The MDA for removable alpha activity measurements was set less than 20 dpm/100 cm^2.

The MDA for the beta scans was set less than 5,000 dpm/100 cm^2.

The MDA for the gamma scans was set less than the criteria for release for unrestricted use for Co-60 in open land areas (3.8 pCi/g).

Table 8.3.1 provides the *a priori* MDAs requested for the analysis of soil samples by Eberline Services in support of the final status survey

Table 8.3.1
MDAs for Off Site Analyses

Radionuclide	MDA
Co-60, Cs-137, Ag-108m	0.1 pCi/g
H-3	10.0 pCi/g

8.3.1 Total Beta Activity and Removable Beta Activity MDAs

The equation used for calculating the MDA for total beta activity measurements, removable alpha activity measurements, and removable beta activity measurements is:

$$MDA = \frac{\frac{2.71}{t_s} + 3.29\sqrt{\frac{R_b}{t_s} + \frac{R_b}{t_b}}}{E\left(\frac{A}{100}\right)}$$

Where:

MDA	=	Minimum Detectable Activity (dpm/100 cm^2)
R_b	=	Background Count Rate (cpm)
t_b	=	Background Count Time (min)
t_s	=	Sample Count Time (min)
A	=	Detector Area (cm^2)
E	=	Detector Efficiency (c/d)

The efficiency (E) used to determining the MDA for the total beta activity measurements includes the terms to account for the detector's efficiency and the surface efficiency. See Section 8.2.

8.3.2 Beta Scan MDA

The equation used for calculating the MDA for beta scans is:

$$MDA = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{E_i * E_s * \sqrt{p} * \frac{A}{100}}$$

Where:	MDA	=	Minimum Detectable Activity (dpm/100 cm^2)
	d'	=	Decision error taken from Table 6.5 of MARSSIM
	i	=	Observation counting interval (scan speed divided by the detector width)
	b_i	=	Background count per observation interval
	E_i	=	Detector Efficiency (c/d)
	E_s	=	Surface Efficiency (typically around 50% for beta contamination on concrete)
	p	=	Surveyor Efficiency (typically 50%)
	A	=	Detector Area (cm^2)

8.3.3 Gamma Scan MDA

The equation used for calculating the MDA for gamma scans is essentially the same as that for beta scans. However conversion factors are required to convert the $MDCR_{Surveyor}$ in terms of cpm to an activity concentration in terms of pCi/g.

$$MDCR_{Surveyor} = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{p}$$

Where:	$MDCR_{Surveyor}$	=	Minimum Detectable Count Rate (cpm)
	d'	=	Decision error taken from Table 6.5 of MARSSIM
	i	=	Observation counting interval (scan speed divided by the detector width)
	b_i	=	Background count per observation interval
	p	=	Surveyor Efficiency (typically 50%)

The first conversion factor needed to convert the $MDCR_{Surveyor}$ into an activity concentration is the exposure rate due to a volume of soil contaminated with the radionuclide of interest (Co-60). This conversion factor in terms of pCi/g per uR/hr was derived using MicroShield. The second conversion factor that is needed is one that converts an exposure rate due to the radionuclide of interest to a count rate for the detector used during the scan (uR/hr per pCi/g).

$$MDA = \left(MDCR_{surveyor}(cpm)\right) * \left(\frac{uR/hr}{cpm}\right)\left(\frac{pCi/g}{uR/hr}\right)$$

Where: MDA = The minimum detectable activity (pCi/g)

8.4 Survey Areas

Survey areas are discrete areas, consisting of building surfaces or open land areas, of a specific size and shape with separate decisions relative to the criteria for release for unrestricted use. All areas surveyed during the final status survey were divided into survey areas. Survey areas were established based on physical characteristics, history, and potential for residual contamination.

All survey areas were classified as Class 1, 2, or 3 based on the following:

- A Class 1 survey area is an area that has or had residual contamination approaching 75% of the criteria for release for unrestricted use. The Fuel Handling Building and the Temporary Loading and Storage Building are exceptions to this classification. These two buildings were free released for unrestricted use during the previous decommissioning. For the purposes of this decommissioning, these two buildings were classified as Class 3 survey areas. However, a portion of the Fuel Handling Building was resurveyed as a Class 2 survey area due to elevated measurement results.

- A Class 2 survey area is an area that does not have a history of residual contamination approaching 75% of the criteria for release for unrestricted use.

- A Class 3 survey area is an area that does not have a history of residual contamination that exceeds a small fraction (<25%) of the criteria for release for unrestricted use.

Survey areas are limited in size to ensure adequate survey coverage. The size limits for the various classifications of survey areas are provided in Table 8.4.1.

Table 8.4.1
Survey Area Size Limits

Survey Area Classification	Size Limit, m^2
Class 1	
Building Surfaces	<100
Open Land Areas	<1,000
Class 2	
Building Surfaces	<1,000
Open Land Areas	<10,000
Class 3	
Building Surfaces	No Limit
Open Land Areas	No Limit

Table 8.4.2 lists the 59 survey areas established for implementing the final status survey.

Table 8.4.2
Final Status Survey Areas

Survey Area	Classification	Description
1	2	Effluent Discharge Pathway to Big Sioux River
2	3	Open Land Areas Surrounding Plant
3	2	Four Settling Basins
4	2	Construction Lay Down Area
5	3	Paved Areas Surrounding The Pathfinder Plant
6	2	Cooling Tower Basin
7	2	Temporary Loading and Storage Building, Floors and Walls Below 2 Meters
8	3	Temporary Loading and Storage Building, Walls Above 2 Meters and Ceiling
9	3	Warehouse
10	3	Basement of Fuel Handling Building
11	3	First Floor of Fuel Handling Building
12	3	Second Floor of Fuel Handling Building
13	2	Turbine
14	3	Turbine Deck
15	3	Control Room
16	3	First Floor of Administrative Building
17	3	Second Floor of Administrative Building
18	2	First Floor of Boiler Building, Floors and Walls Below 2 Meters
19	3	First Floor of Boiler Building, Walls Above 2 Meters and Ceiling
20	3	Second Floor of Boiler Building
21	1	Floors and Walls Below 2 Meters on Hot Side of Turbine Building Basement
22	3	Walls Above 2 Meters and Ceilings on Hot Side of Turbine Building Basement
23	1	Inside of Condenser Hotwell
24	1	Hot Side Sump
25	1	Floor Beneath Condenser
26	1	Condensate Pit and Sumps
27	2	Floors and Walls Below 2 Meters on Cold Side of Turbine Building Basement
28	3	Walls Above 2 Meters and Overhead Structures on Cold Side of Turbine Building Basement
29	2	Floors and Walls Below 2 Meters on Turbine Building Mezzanine
30	1	Rad Waste Storage Room
31	3	Roofs of Turbine Building, Boiler Building, and Fuel Handling Building
32	3	Security and Construction Offices

Table 8.4.2
Final Status Survey Areas - Continued

Survey Area	Classification	Description
33	3	Fire Pump House
34	2	Turbine Building Stairwells
35	2	Floors and Walls Below 2 Meters in the Maintenance Shops in the Basement of the Turbine Building
36	3	Walls Above 2 Meters and Overhead Structures in the Maintenance Shops in the Basement of the Turbine Building
37	2	Floors and Walls Below 2 Meters in the Water Treatment Building
38	3	Walls Above 2 Meters and Overhead Structures in the Water Treatment Building
39	1	Turbine Building Hot Side Drain Lines
40	1	Turbine Building Hot Side Trenches
41	NA	H-3 Survey
42	2	Lowest Level of Fuel Handling Building
43	3	Turbine Building Elevator
44	3	Precipitator Building
45	3	Walls Above 2 Meters and Overhead Structures on Turbine Building Mezzanine
46	3	Electrical Room, Office, and Storage Room on Turbine Building Mezzanine
47	2	Overhead Structures in the Larger Room on the Bottom Floor and the Top Floor of the Water Treatment Building
48	1	Inside of Condenser Hotwell
49	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Turbine Building Mezzanine, Section A
50	1	Floors, Walls Below 2 Meters,and Overhead Structures on the Turbine Building Mezzanine, Section B
51	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Turbine Building Mezzanine, Section C
52	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Turbine Building Mezzanine, Section D
53	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Turbine Building Mezzanine, Section E
54	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Hot Side of the Turbine Building Basement, Section A
55	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Hot Side of the Turbine Building Basement, Section B
56	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Hot Side of the Turbine Building Basement, Section C
57	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Hot Side of the Turbine Building Basement, Section D

Table 8.4.2
Final Status Survey Areas - Continued

Survey Area	Classification	Description
58	1	Floors, Walls Below 2 Meters, and Overhead Structures on the Hot Side of the Turbine Building Basement, Section E
59	1	Floor Beneath Condenser

8.5 Survey Packages

Packages were developed for each of the 59 survey areas. Each survey package included survey instructions, location codes to identify the data collected, and any relevant identified atypical conditions or safety concerns.

Location codes were used to identify all samples and measurements collected during the final status survey. They were used to identify the measurement data, which were stored in the data loggers, and were downloaded to the computers and used to analyze and report on the survey results.

As the final status survey of a particular survey area progressed, the survey results were placed in a file along with a copy of the survey package. Maps or drawings of the survey areas were included to identify measurement and/or sample locations. Also included in the file were copies of any investigations and/or analyses used to support the final status survey results for the survey area.

Appendix 1, *Final Status Survey Packages*, provides copies of the 59 survey packages along with the maps or drawings prepared to document the measurement and/or sampling results.

8.6 Gridding

Building surfaces and open land areas associated with Class 1 and Class 2 survey areas were gridded. The grid spacing was determined using a square grid pattern as follows:

$$L = \sqrt{\frac{A}{N}}$$

Where A = Area of survey area, m^2
N = Number of required measurements and/or samples
L = Grid spacing, m

Once a survey area was gridded, the measurement and/or sampling location within each grid was determined by generating a pair of random numbers. The random numbers were then multiplied by the grid spacing to provide an offset from the grid reference point using an x, y coordinate system. The reference point for each grid was the southwest corner of the grid. The same offset was used for all the grids in a given survey area. The random numbers and corresponding grid offsets were provided in each survey package.

The normal gridding requirements were not considered applicable to long winding pathways such as the effluent discharge pathway or to bodies of water such as the settling basins. The effluent discharge pathway is a winding depression 2-5 meters in width extending some 600 meters from the edge of the asphalt behind the Boiler Building and terminating in the Big Sioux River. To meet the gridding and systematic sampling requirements of the Decommissioning Plan, a 20 meter length of rope was used to designate sampling locations in the middle of the effluent pathway every 20 meters beginning at the edge of the asphalt behind the Boiler Building.

The four settling basins were not gridded due to a large amount of standing water in each of them. In this case, the systematic sampling requirements of the Decommissioning Plan were met by designating sample locations on each side of the four settling basins as close to the water as practical.

8.7 Survey Protocols

The final status survey of building surfaces, structures, and non permanent items consisted of beta scans, total beta activity measurements, and smears for assessing removable alpha and beta activity. In addition, exposure rate measurements and smears, for assessing removable H-3, were taken in specific areas as described in the appropriate survey package. The final status survey of open land areas consisted of gamma scans/measurements and the collection of soil samples for assessing gamma emitting radionuclides.

Beta Scans

For Class 1 survey areas, beta scans were performed over 100% of the accessible surfaces using a gas flow proportional detector coupled to a Ludlum 2350 data logger. The detector was held approximately one half inch above the surface being scanned and moved at a rate of approximately 1 detector width per second while the operator listened to the audible output of the data logger. For Class 2 survey areas, beta scans were performed over approximately 50% of the accessible surface area. For Class 3 survey areas, beta scans were performed over approximately 10% of the accessible surface area.

For survey areas that were gridded, scans were performed in each grid. For non gridded survey areas, the scans were centered around each total beta activity measurement location.

Total Beta Activity

Total beta activity measurements were performed using a gas flow proportional detector coupled to a Ludlum 2350 data logger. For each total beta activity measurement counts were integrated over a 30 second count time.

Removable Alpha and Beta Activity

At each total beta activity measurement location, smears for assessing removable alpha and beta activity were collected. Each smear was counted twice - once for alpha activity and once for beta activity.

Gamma Scans/Measurements

The final status survey of all open land areas included gamma scans/measurements. The gamma scanning process actually resulted in the collection of numerous 2 second position sensitive exposure rate measurements. The gamma scans/measurements were performed using a 2 inch by 2 inch NaI detector coupled to a Ludlum 2350 data logger and a GPS system. The detector was held approximately 6 inches above the surface being scanned and moved at a rate of approximately 0.5 meters per second. The paired output of the data logger and GPS system were stored in an auxiliary data storage device for eventual downloading to a computer for data analysis and report formatting.

The gamma scan/measurement results are reported in units of uR/hr but should be considered as relative results as the measurements have not been corrected to address the energy dependence of the NaI detectors.

For Class 1 survey areas, the scans/measurements were performed over 100% of the accessible areas. For Class 2 survey areas, scans/measurements were performed over approximately 50% of the accessible areas. For Class 3 survey areas, scans/measurements were performed over approximately 10% of the accessible areas.

Gamma Emitting Radionuclides

Surface (0-6 inches) soil samples were collected from the open land area survey areas as specified in the applicable survey packages (Survey Packages 1 through 4). Composite concrete/debris samples were collected within the Turbine Building hot side trenches following removal of the drain lines as specified in Survey Package 40.

All samples were sent to Eberline Services in Oak Ridge, TN for gamma spectral analysis.

Removable H-3 Activity

Smears for assessing removable H-3 activity were collected at various locations throughout the Pathfinder site as specified in Survey Package 41. Prior to collection, each smear was dampened with a small quantity of demineralized (DI) water. Immediately following collection, each smear was placed in a liquid scintillation vial and sealed

All smears collected for assessing removable H-3 activity were sent to Eberline Services in Oak Ridge, TN for analysis.

Exposure Rate Measurements

Although not required by the Decommissioning Plan, exposure rate measurements were collected as part of the final status survey of selected survey areas. The exposure rate measurements were taken using a 2 inch by 2 inch NaI detector coupled to a Ludlum 2350 data logger. For each exposure rate measurement, counts were integrated over a 15 second count time.

Survey Packages 48 through 56 required exposure rate measurements as part of the final status survey for the associated survey areas. The exposure rate measurement results are reported in units of uR/hr but should be considered as relative measurement results as the results have not been corrected to address the energy dependence of the NaI detectors.

Since no criteria for release for unrestricted use in terms of exposure rate were specified in the Decommissioning Plan the exposure rate measurement results were compared to the background exposure rates and reviewed to identify potential outliers.

8.8 Reclassification

The Final Status Survey Plan required that survey areas be reclassified and resurveyed when residual licensed activity on building surfaces or in open land areas exceeded the following:

- 25% of the criteria for unrestricted release in a Class 3 survey area. In such cases the Class 3 survey area is reclassified as a Class 2 survey area and resurveyed.

- 75 % of the criteria for unrestricted release in a Class 2 survey area. In such cases the Class 2 survey area is reclassified as a Class 1 survey area and resurveyed.

In performing the final status survey two Class 3 survey areas, Survey Areas 10 and 38, had suspected residual activity attributable to licensed activity that exceeded 25% of the criteria for release for unrestricted use. The affected areas were reclassified as Class 2 and were resurveyed. Following the resurveys further investigations revealed that the source of the elevated activity was natural radioactivity.

9.0 Quality Assurance and Quality Control

Quality Control measures were in place to ensure that all quality and regulatory requirements relative to the final status survey were satisfied. All activities that affected quality were controlled by the Decommissioning Plan and/or implementing procedures. The following Quality Control measures were an integral part of the final status survey.

Selection of Personnel

The Project Manager, who was certified by the American Board of Health Physics, had extensive experience in developing and implementing final status survey plans. He had experience performing final status surveys at other NRC licensed facilities and in implementing the guidance contained in NUREG-1575. He also had experience working with the radionuclides of concern and in operating the instrumentation used to detect these radionuclides.

The Health Physics Technicians who participated in the final status survey had previous experience performing final status surveys and implementing the guidance in NUREG-1575. They also had experience with the implementing procedures used during the final status survey.

The Project Manager and the Senior Health Physics Technicians who participated in the final status survey met or exceeded the applicable requirements of ANSI/ANS-3.1-1999

Training

All personnel participating in the final status survey received site specific training which included a review of the requirements of the Final Status Survey Plan, a review of the applicable implementing procedures, and a review of unique features and/or hazards associated with specific survey areas.

Instrument Selection, Calibration and Operation

Survey instruments were selected based on a history of reliability in detecting the radionuclides of interest. All instrumentation was calibrated using approved procedures and sources traceable to the National Institute of Standards and Technology (NIST).

Source check criteria was established for each instrument prior to its initial use for future reference and all instrumentation was source checked daily prior to use to verify proper operation.

Procedures for the calibration, maintenance, accountability, operation and quality control of instruments implement the applicable guidance contained in American National Standard Institute (ANSI) standards ANSI N323-1978 and ANSI N42.17A-2003.

Survey Documentation

All survey measurement and sample analysis results for a given survey area were filed along with a copy of the associated survey package. These files were the primary method of controlling and tracking the preliminary survey results. Each survey measurement result includes the date of the measurement, the name of the responsible technician, the instrument type and serial number, the detector type and serial number, the applicable location code, and the type of measurement. Chain of custody forms were included with all sample analysis results except those for assessing removable alpha and beta contamination.

Chain of Custody

The custody of all samples from the time they were collected until results were obtained, was controlled by procedure. All samples, except those for assessing removable alpha and beta contamination, were accompanied by a chain of custody record.

Duplicative Review of Survey Results

The survey packages and survey results for each survey area were reviewed by the responsible survey technician and the Project Manager to verify that all documentation was complete and accurate.

Sample Analysis

Quality control samples to assess the quality of sampling and subsequent analysis were collected during all sampling except for the collection of smears for assessing removable activity. The quality control samples consisted of duplicate samples collected with a frequency of approximately 5%. The duplicate samples collected from a given survey area were handled and analyzed in the same manner as all the other samples from that survey area.

10.0 Final Status Survey Results

The final status survey results are presented in this section of the report. Included are total beta activity measurement results, removable beta activity measurement results, removable alpha activity measurement results, exposure rate measurement results, removable H-3 results, and sample analysis results. Also included are the results for numerous samples collected to support the final status survey and a discussion of quality control related to sampling and analysis. As the various subsections of this section show, none of the individual measurement results or sample analysis results exceeded the criteria for release for unrestricted use ($DCGL_w$).

10.1 Total Beta Activity Measurement Results

Table 10.1.1 provides a summary of the total beta activity measurement results collected during the final status survey by survey package number. Table 8.4.2 provides a list of survey packages, a brief description of the corresponding survey areas, and the classification of the survey areas. Appendix 2, *Total Beta Activity Measurement Results*, contains the results from which Table 10.1.1 was derived.

A review of the survey results presented in Table 10.1.1 shows that none of the total beta activity measurement results exceeded the criteria for release for unrestricted use of 7,070 dpm/100 cm^2. Therefore the survey results were not analyzed using non parametric statistics and the use of elevated measurement criteria was not required.

When reviewing the measurement results it should be remembered that none of the results have been corrected for the natural radioactivity that may be present in various building materials. Section 11.0 of this report discusses the results of several investigations associated with elevated natural radioactivity associated with different building materials.

The results for the survey areas presented in Table 10.1.1 are broken down into various surfaces to aid in identifying where the measurements were obtained.

Note: If any of total beta activity measurement results had exceeded the criteria for release for unrestricted use, the measurement results for the survey area in question would have been combined into a single data set and evaluated using the non parametric statistics.

Table 10.1.1 does not contain total beta activity measurement results for all survey packages as indicated by the notation *NA* within the table. In such cases, total beta activity measurements were either not required or the survey area, or portion thereof, was resurveyed as part of a different survey package. The following provides clarification for the use of NA in Table 10.1.1.

- Survey Packages 1 through 4 are open land areas. Total beta activity measurements were not required.

- The lower floor associated with Survey Package 10 (Basement of Fuel Storage Building) was resurveyed as a Class 2 survey area. Survey Package 42 was prepared to facilitate the resurvey of this surface.

- The floor and walls associated with Survey Package 21 (Hot Side of Turbine Building Basement) was resurveyed following the remediation of overhead piping within the survey area. Survey Packages 54 through 58 were prepared to facilitate the resurvey of these surfaces.

- The survey area associated with Survey Package 22 (Hot Side of Turbine Building Basement) was resurveyed following the remediation of overhead piping within the survey area. Survey Packages 54 through 58 were prepared to facilitate the resurvey of these surfaces.

- The survey area associated with Survey Package 23 (Condenser Hotwell) was resurveyed following the remediation within the condenser hotwell. Survey Packages 48 was prepared to facilitate the resurvey of these surfaces.

- The survey area associated with Survey Package 25 (Floor Beneath Condenser) was resurveyed following additional remediation within the condenser hotwell. Survey Packages 59 was written to facilitate the resurvey of these surfaces.

- The overhead structures in the larger room on the bottom floor and the overhead structures on the top floor associated with Survey Package 38 (Water Treatment Building) were resurveyed as a Class 2 survey area. Survey Package 47 was prepared to facilitate the resurvey of these surfaces.

- Survey Package 40 is for the trenches on the hot side of the Turbine Building and total beta activity measurements were not required.

- Survey Package 41 was written to facilitate a survey for removable H-3 contamination. Total beta activity measurements were not required.

Table 10.1.1
Summary of Total Beta Activity Measurement Results

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
1	Open Land Area Effluent Discharge Pathway	NA	NA	NA	NA
2	Open Land Area Surrounding Plant	NA	NA	NA	NA
3	Open Land Area Four Settling Basins	NA	NA	NA	NA
4	Open Land Area Construction Lay Down Areas	NA	NA	NA	NA
5	Paved Areas Surrounding Plan	51	787	2126	509
6	Cooling Tower Basin Floor	30	835	1268	226
6	Cooling Tower Basin Walls	26	1155	1893	405
6	Cooling Tower Basin Center Divide	10	1111	1679	382
6	Cooling Tower Basin Spillway	10	1229	2259	476
7	Temporary Loading and Storage Building Floor	42	704	1126	190
7	Walls Below 2 Meters	24	-144	190	138
7	Non Permanent Structures	50	-25	360	228
8	Temporary Loading and Storage Building Walls Above 2 Meters	30	163	603	193
8	Ceiling	30	765	1296	222
8	Non Permanent Structures	21	321	797	262

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
9	Warehouse First Floor	30	888	1322	194
9	First Floor Walls	20	-185	199	157
9	First Floor Ceiling	10	58	244	119
9	Stairs	10	59	214	138
9	Second Floor - Floor	20	171	469	165
9	Second Floor Walls	20	-350	268	201
9	Second Floor Ceiling	10	276	589	184
9	Non Permanent Structures	31	-29	1420	412
10	Basement of Fuel Handling Building Upper Floor	20	1152	1667	292
10	Upper Walls	30	706	1371	280
10	Upper Ceiling	15	951	1465	341
10	Lower Floor (See Survey Package 42)	NA	NA	NA	NA
10	Lower Walls	29	926	1994	414
10	Lower Ceiling	20	1205	1703	239
10	Stairs	10	467	765	198
11	First Floor of Fuel Handling Building Floor	30	429	1226	357
11	Walls	30	110	1652	653
11	Ceiling	30	223	1061	351
11	Non Permanent Structures	50	-167	850	290
12	Second Floor of Fuel handling Building Upper Floor	20	619	984	227

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
12	Upper Walls	30	304	2303	1077
12	Upper Ceiling	30	120	562	173
12	Lower Floor	30	624	1102	197
12	Lower Walls	30	942	2094	783
12	Lower Ceiling	20	63	1477	432
12	Stairs	10	201	374	164
13	Turbine Concrete Floor	48	543	1065	342
13	I Beams	30	548	886	192
13	Turbine Internals	30	194	1544	430
13	Exposed Structures	30	8	519	263
13	Turbine Internals (Limited Accessibility)	20	-782	1489	1044
14	Turbine Deck Floor	32	98	702	386
14	Walls	30	877	2463	875
14	Ceiling	19	86	1303	365
14	Crane and Crane Rails	21	0	643	347
14	Floor Plugs	20	115	399	202
14	Non Permanent Items	50	77	900	269
15	Control Room Floor	31	1743	2330	497
15	Walls	20	-156	48	134
15	Ceiling	30	683	1138	264
15	Non Permanent Structures	20	-213	252	284

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
16	First Floor of Admin Building Floors	30	474	2583	836
16	Walls	30	671	3954	1629
16	Ceiling	30	862	2188	448
16	Miscellaneous Non Permanent Items on First Floor of Admin Building	48	253	2878	702
17	Second Floor of Admin Building Floor	30	335	1829	646
17	Walls	30	324	1611	620
17	Ceiling	30	693	1299	329
17	Miscellaneous Non Permanent Items on Second Floor of Admin Building	50	394	880	276
17	Stairs to First Floor of Admin Building	10	493	716	158
17	Stairs to Elevation 1353	10	605	975	270
17	Ventilation Duct Exterior	20	195	594	212
17	Ventilation Duct Interior	20	632	1732	599
18	Boiler Building Floor	63	378	996	530
18	Boiler Building Walls Below 2 Meters	34	116	1072	228
18	Interior of Mud Drum A1	8	67	197	119
18	Interior of Mud Drum A2	12	169	492	162
18	Interior of Mud Drum B1	9	226	590	241
18	Interior of Mud Drum B2	10	433	1023	275
18	Interior of Mud Drum C1	10	796	4894	1467
18	Interior of Mud Drum C2	10	375	1149	308
18	Exterior of Boilers	30	-54	462	232

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
18	Boiler Building Trenches	30	783	1481	299
18	Sump	20	496	1046	172
19	Boiler Building Walls Above 2 Meters	30	-231	-14	124
19	Ceiling	32	68	671	395
20	Second Floor of Boiler Building Floor	29	614	931	181
20	Walls (below 3 meters)	30	26	786	300
20	Inside Stacks 1, 2, and 3	15	-293	131	201
20	Outside Stacks 1, 2, and 3	30	-238	310	163
20	Entrance to Deairator	3	-258	-179	68
20	Outside of Deairator	20	-463	-212	125
20	Non Permanent Items	20	-236	242	233
21	Hot Side of Turbine Building Basement Floor (See Survey Packages 54 Through 58)	NA	NA	NA	NA
21	Walls Below 2 Meters (See Survey Packages 54 Through 58)	NA	NA	NA	NA
21	Expansion Joint	20	181	451	172
21	Exterior Surface of Condenser	30	-293	275	238
21	Non Permanent Items	30	-109	607	304
22	Hot Side of Turbine Building Basement Walls Above 2 Meters (See Survey Packages 54 Through 58)	NA	NA	NA	NA

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
22	Overhead Structures (See Survey Packages 54 Through 58)	NA	NA	NA	NA
23	Inside Condenser Hotwell (See Survey Package 48)	NA	NA	NA	NA
24	Hot Side Sump Floor	10	219	897	403
24	Walls	20	362	870	204
25	Floor Beneath Condenser (See Survey Package 59)	NA	NA	NA	NA
26	Condensate Pit and Sumps Floor	20	711	1079	247
26	Pit # 1	10	-194	132	154
26	Pit #2	10	-67	425	301
26	Excavation	5	196	369	294
27	Cold Side of Turbine Building Basement Floor	98	519	1100	207
27	Walls Below 2 Meters	31	521	2764	622
27	Trenches	30	690	1277	259
27	Sump	20	529	1101	269
27	Non Permanent Structures	30	-87	701	295
28	Cold Side of Turbine Building Basement Walls Above 2 Meters	30	762	2356	765

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
28	Overhead Structures	30	-132	489	299
29	Turbine Building Mezzanine Floor	50	290	1098	386
29	Walls Below 2 Meters	32	1298	3090	965
29	Internal Surfaces Of Service Water Piping	20	103	846	244
29	Non Permanent Items	16	123	680	303
29	Electrical Penetration Room	30	268	804	375
30	Rad Waste Storage Room Floor	12	116	409	150
30	Walls	28	329	688	172
30	Ceiling	12	662	988	158
31	Boiler Building Roof	25	1542	2097	371
31	Fuel Handling Building Roof	25	1648	2151	352
31	Turbine Building Roof	25	1374	2212	460
32	Security and Construction Offices Floor	29	278	683	221
32	Walls	30	-164	206	193
32	Ceiling	30	57	442	167
32	Non Permanent Structures	29	16	1825	406
33	Fire Pump House Floor	15	909	1629	259
33	Walls	20	-59	329	170
33	Ceiling	10	455	650	98
33	Non Permanent Items	10	35	524	312

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
34	Stairwell Number 1 Between the Turbine Deck And The Mezzanine	20	335	1065	300
34	Stairwell Number 1 Mezzanine Landing	9	-278	7	202
34	Stairwell Number 1 Between the Mezzanine And The Basement	20	289	698	203
34	Stairwell Number 2 Between the Turbine Deck And The Mezzanine	20	-321	-7	149
34	Stairwell Number 2 Mezzanine Landing	10	634	825	145
34	Stairwell Number 2 Between the Mezzanine And The Basement	20	110	600	222
35	Floor in Machine Shop	36	422	800	265
35	Walls in Machine Shop	28	1197	2834	912
35	Non Permanent Structures in Machine Shop	30	-140	627	263
35	Floor Electrical Shop	4	773	985	205
35	Walls in Electrical Shop	8	2058	2812	807
35	Non Permanent Structures in Electrical Shop	20	119	889	364
35	Floor in Instrument Calibration Room	6	900	1347	281
35	Walls in Instrument Calibration Room	7	777	1047	265
35	Non Permanent Structures in Instrument Calibration Room	20	-76	1574	469
35	Floor in Toilet	4	530	766	239
35	Walls in Toilet	8	2068	2443	211
35	Non Permanent Structures in Toilet	5	1721	3804	1401
35	Oil Storage Room	30	-142	642	255

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
36	Walls Above 2 Meters in Machine Shop	20	1479	2845	821
36	Overhead Structures in Machine Shop	20	123	1423	492
36	Walls Above 2 Meters in Electrical Shop	15	1964	2611	664
36	Overhead Structures in Electrical Shop	15	130	1141	491
36	Walls Above 2 Meters in Instrument Calibration Room	10	893	1344	208
36	Overhead Structures in Instrument Calibration Room	10	416	1515	810
36	Walls Above 2 Meters in Toilet	5	2434	2845	326
36	Overhead Structures in Toilet	5	-34	685	638
37	Water Treatment Building Floor In Smaller Room on Bottom Floor	20	353	1184	345
37	Walls Below 2 Meters in Smaller Room on Bottom Floor	16	-556	738	497
37	Non Permanent Structures in Smaller Room on Bottom Floor	10	-1171	-724	255
37	Floor in Larger Room on Bottom Floor	30	682	2026	474
37	Walls Below 2 Meters in Larger Room on Bottom Floor	25	246	856	235
37	Non Permanent Structures in Larger Room on Bottom Floor	10	125	459	252
37	Floor on Middle Floor	57	102	1924	508
37	Walls on Middle Floor	32	109	1110	590
37	Non Permanent Structures on Middle Floor	10	-60	3413	1278

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
37	Floor on Top Floor	55	454	1014	283
37	Walls on Top Floor	27	215	1741	890
37	Non Permanent Structures on Top Floor	10	-427	-35	262
38	Water Treatment Building Walls Above 2 Meters in Smaller Room on Bottom Floor	20	733	2306	775
38	Overhead Structures in Smaller Room on Bottom Floor	20	-93	562	314
38	Walls Above 2 Meters in Larger Room on Bottom Floor	20	203	639	256
38	Overhead Structures in Larger Room on Bottom Floor (See Survey Package 47)	NA	NA	NA	NA
38	Walls Above 2 Meters on Middle Floor	20	529	1372	521
38	Overhead Structures on Middle Floor	20	310	2205	603
38	Walls Above 2 Meters on Top Floor	20	1444	2033	625
38	Overhead Structures on Top Floor (See Survey Package 47)	NA	NA	NA	NA
38	Small Room on Top Floor	20	234	1566	582
39	Turbine Building Hot Side, Pipe Number 1	18	-136	5189	3560
39	Turbine Building Hot Side, Pipe Number 2	3	141	720	534
39	Turbine Building Hot Side, Pipe Number 3	2	880	983	145
40	See Table 10.6.1 (TB Hot Side Trenches)	NA	NA	NA	NA

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
41	See Table 10.5.1 (Removable H-3 Survey)	NA	NA	NA	NA
42	Lowest Level of Fuel Handling Building Floor	43	1940	5686	1278
43	Turbine Building Elevator	24	-140	351	244
43	Floor Beneath Elevator	5	985	1398	276
43	Elevator Room	10	759	2128	892
43	Non Permanent Structures in Elevator Room	11	397	2074	836
44	Precipitator Building Bottom of Pools	30	265	929	353
44	Walls of Pools	30	57	812	287
44	Interior Building Walls	20	778	1382	295
44	Ceiling	20	827	1126	211
44	Walkways	20	-71	227	220
45	Turbine Building Mezzanine Walls Above 2 Meters	17	642	2662	746
45	Overhead Structures	11	-280	94	204
46	Turbine Building Mezzanine Floor in Electrical Room	20	1183	1857	292
46	Walls in Electrical Room	20	1691	3160	1034
46	Overhead Structures in Electrical Room	10	874	2225	905
46	Non Permanent Items in Electrical Room	10	553	1601	628
46	Floor in Office	15	516	893	183
46	Walls in Office	15	1410	2324	858

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
46	Overhead Structures in Office	10	255	567	179
46	Non Permanent Items in Office	10	-303	-43	170
46	Floor in Storage Room	10	-197	128	172
46	Walls in Storage Room	10	788	1304	483
46	Overhead Structures in Storage Room	5	-275	-184	93
46	Non Permanent Items in Storage Room	5	-465	-227	134
47	Water Treatment Building Overhead Structures in Larger Room on Bottom Floor	30	888	1173	174
47	Overhead Structures on Top Floor	45	207	5007	787
48	Inside Condenser Hotwell Floor	41	-219	1248	292
48	Walls	27	-250	236	221
48	Overhead Structures	30	201	800	256
48	Large Diameter Pipe	10	337	797	281
48	Vertical Support Pipe	25	1145	2971	698
49	Turbine Building Mezzanine Section A Floor	63	57	473	160
49	Walls	21	803	1100	202
49	Overhead Structures	30	338	1514	367
50	Turbine Building Mezzanine Section B Floor	56	-4	368	161
50	Walls	10	627	889	153
50	Overhead Structures	25	167	3073	766

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
51	Turbine Building Mezzanine Section C Floor	70	110	423	133
51	Walls	16	683	1018	156
51	Overhead Structures	25	206	1174	382
52	Turbine Building Mezzanine Section D Floor	77	473	935	175
52	Walls	45	603	2245	430
52	Overhead Structures	20	302	813	323
53	Turbine Building Mezzanine Section E Floor	38	687	1215	214
53	Walls	18	587	1224	377
53	Overhead Structures	20	-208	666	433
54	Turbine Building Basement Section A Floor	96	606	1368	199
54	Walls	34	703	1359	213
54	Overhead Structures	20	435	1754	370
55	Turbine Building Basement Section B Floor	84	469	938	199
55	Walls	27	691	1174	249
55	Overhead Structures	20	309	994	318
56	Turbine Building Basement Section C Floor	66	536	1047	202
56	Walls	16	631	1063	220
56	Overhead Structures	20	270	683	187
57	Turbine Building Basement Section D Floor	83	527	1161	279

Table 10.1.1
Summary of Total Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
57	Walls	49	1157	3719	994
57	Overhead Structures	19	168	945	266
58	Turbine Building Basement Section E Floor	38	638	1090	260
58	Walls	19	334	777	222
58	Overhead Structures	20	30	545	224
59	Floor Beneath Condenser	55	626	1349	242

10.2 Removable Beta Activity Measurements

Table 10.2.1 provides a summary of the results of the removable beta activity measurements collected during the final status survey listed by survey package number. Table 8.4.2 provides a list of survey packages, a brief description of the corresponding survey area, and the classification of the survey area. Appendix 3, *Removable Alpha and Beta Activity Measurement Results*, contains the measurements from which Table 10.2.1 was derived.

A review of the survey results presented in Table 10.2.1 shows that none of the removable beta activity measurement results exceeded 10% of the criteria for release for unrestricted use.

Table 10.2.1 does not contain removable beta activity measurement results for all survey packages as indicated by the notation *NA* within the table. In such cases, removable beta activity measurements were either not required or the survey area, or portion thereof, was resurveyed as part of a different survey package. The following provides clarification for the use of NA in Table 10.2.1.

- Survey Packages 1 through 4 are open land areas. Removable beta activity measurements were not required.
- The lower floor associated with Survey Package 10 (Basement of Fuel Storage Building) was resurveyed as a Class 2 survey area. Survey Package 42 was prepared to facilitate the resurvey of this surface.
- The floor and walls associated with Survey Package 21 (Hot Side of Turbine Building Basement) was resurveyed following the remediation of overhead piping within the survey area. Survey Packages 54 through 58 were prepared to facilitate the resurvey of these surfaces.
- The survey area associated with Survey Package 22 (Hot Side of Turbine Building Basement) was resurveyed following the remediation of overhead piping within the survey area. Survey Packages 54 through 58 were prepared to facilitate the resurvey of these surfaces.
- The survey area associated with Survey Package 23 (Condenser Hotwell) was resurveyed following the remediation within the condenser hotwell. Survey Package 48 was prepared to facilitate the resurvey of these surfaces.
- The survey area associated with Survey Package 25 (Floor Beneath Condenser) was resurveyed following additional remediation within the condenser hotwell. Survey Package 59 was written to facilitate the resurvey of these surfaces.

- The overhead structures in the larger room on the bottom floor and the overhead structures on the top floor associated with Survey Package 38 (Water Treatment Building) were resurveyed as a Class 2 survey area. Survey Package 47 was prepared to facilitate the resurvey of these surfaces.

- Survey Package 40 is for the trenches on the hot side of the Turbine Building and removable beta activity measurements were not required.

- Survey Package 41 was written to facilitate a survey for removable H-3 contamination. Removable beta activity measurements were not required.

Table 10.2.1
Summary of Removable Beta Activity Measurement Results

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
1	Open Land Area Effluent Discharge Pathway	NA	NA	NA	NA
2	Open Land Area Surrounding Plant	NA	NA	NA	NA
3	Open Land Area Four Settling Basins	NA	NA	NA	NA
4	Open Land Area Construction Lay Down Areas	NA	NA	NA	NA
5	Paved Areas Surrounding Plan	50	3	84	32
6	Cooling Tower Basin Floor	30	15	141	44
6	Cooling Tower Basin Walls	26	-1	76	30
6	Cooling Tower Basin Center Divide	10	12	84	36
6	Cooling Tower Basin Spillway	10	2	43	31
7	Temporary Loading and Storage Building Floor	42	-1	56	29
7	Below 2 Meters	24	-13	31	22
7	Non Permanent Structures	50	114	236	43
8	Temporary Loading and Storage Building Walls Above 2 Meters	30	4	68	35
8	Ceiling	30	-8	68	33
8	Non Permanent Structures	20	-17	25	26

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
9	Warehouse First Floor	30	3	65	35
9	First Floor Walls	20	-12	64	31
9	First Floor Ceiling	10	-17	13	26
9	Stairs	10	6	56	25
9	Second Floor - Floor	20	1	56	31
9	Second Floor Walls	20	1	62	26
9	Second Floor Ceiling	10	8	45	40
9	Non Permanent Structures	30	12	73	35
10	Basement of Fuel Handling Building Upper Floor	20	2	44	20
10	Upper Walls	30	2	72	27
10	Upper Ceiling	30	16	75	32
10	Lower Floor (See Survey Package 42)	NA	NA	NA	NA
10	Lower Walls	30	3	64	28
10	Lower Ceiling	20	1	5	2
10	Stairs	10	8	61	24
11	First Floor of Fuel Handling Building Floor	30	-7	78	29
11	Walls	30	9	70	36
11	Ceiling	30	6	78	27
11	Non Permanent Structures	50	-2	52	24
12	Second Floor of Fuel Handling Building Upper Floor	19	8	60	24

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
12	Upper Walls	30	5	86	32
12	Upper Ceiling	30	3	72	32
12	Lower Floor	30	-5	108	39
12	Lower Walls	30	4	72	35
12	Lower Ceiling	20	-4	64	27
12	Stairs	10	-26	5	18
13	Turbine Concrete Floor	49	5	75	31
13	I Beams	30	1	57	28
13	Turbine Internals	30	13	92	37
13	Exposed Structures	30	-10	48	36
14	Turbine Deck Floor	30	-6	52	28
14	Walls	30	11	59	33
14	Ceiling	20	11	59	27
14	Crane and Crane Rails	20	17	94	38
14	Floor Plugs	20	-14	62	27
14	Non Permanent Items	50	-6	88	32
15	Control Room Floor	30	-6	81	32
15	Walls	20	9	74	33
15	Ceiling	30	-18	47	28
15	Non Permanent Structures	20	-5	48	32
16	First Floor of Admin Building Floors	30	15	77	29

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
16	Walls	30	16	69	28
16	Ceiling	30	-8	55	31
16	Miscellaneous Non Permanent Items on First Floor of Admin Building	50	-2	46	22
17	Second Floor of Admin Building Floor	30	7	65	26
17	Walls	30	0	46	27
17	Ceiling	30	-12	48	30
17	Miscellaneous Non Permanent Items on Second Floor of Admin Building	50	7	76	21
17	Stairs to First Floor of Admin Building	10	-1	54	33
17	Stairs to Elevation 1353	10	20	71	30
17	Ventilation Duct Exterior	20	-10	71	34
17	Ventilation Duct Interior	20	-18	32	25
18	Boiler Building Floor	63	2	73	33
18	Boiler Building Walls Below 2 Meters	34	8	68	30
18	Interior of Mud Drum A1	10	-14	38	32
18	Interior of Mud Drum A2	10	19	54	21
18	Interior of Mud Drum B1	10	1	79	35
18	Interior of Mud Drum B2	10	5	54	27
18	Interior of Mud Drum C1	10	19	112	43
18	Interior of Mud Drum C2	10	8	71	34
18	Exterior of Boiler A	10	9	59	32
18	Exterior of Boiler B	10	-5	43	28

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
18	Exterior of Boiler C	10	6	43	20
18	Boiler Building Trenches	30	5	65	27
18	Sump	20	12	76	37
19	Boiler Building Walls Above 2 Meters	30	10	68	27
19	Ceiling	30	-4	46	30
20	Second Floor of Boiler Building Floor	30	-4	84	35
20	Walls (below 3 meters)	30	-3	110	34
20	Inside Stacks 1, 2, and 3	15	0	53	35
20	Outside Stacks 1, 2, and 3	30	-15	57	29
20	Entrance to Deairator	3	-4	19	32
20	Outside of Deairator	20	-16	24	24
20	Non Permanent Items	20	-9	58	32
21	Hot Side of Turbine Building Basement Floor (See Survey Packages 54 Through 58)	NA	NA	NA	NA
21	Walls Below 2 Meters (See Survey Packages 54 Through 58)	NA	NA	NA	NA
21	Expansion Joint	20	17	130	37
21	Exterior Surface of Condenser	30	4	125	39
21	Non Permanent Items	30	13	125	39
22	Hot Side of Turbine Building Basement Walls Above 2 Meters (See Survey Packages 54	NA	NA	NA	NA

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
	Through 58)				
22	Overhead Structures (See Survey Packages 54 Through 58)	NA	NA	NA	NA
23	Inside Condenser Hotwell (See Survey Package 48)	NA	NA	NA	NA
24	Hot Side Sump Floor	10	-2	65	48
24	Walls	20	1	65	32
25	Floor Beneath Condenser (See Survey Package 59)	NA	NA	NA	NA
26	Condensate Pit and Sumps Floor	20	-6	48	31
26	Pit # 1	10	0	65	35
26	Pit #2	10	11	82	39
26	Excavation	5	25	91	39
27	Cold Side of Turbine Building Basement Floor	98	1	127	31
27	Walls Below 2 Meters	31	14	92	31
27	Trenches	30	-7	53	30
27	Sump	20	-5	53	39
27	Non Permanent Structures	30	-1	118	39

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
28	Cold Side of Turbine Building Basement Walls Above 2 Meters	31	1	61	28
28	Overhead Structures	30	-16	43	30
29	Turbine Building Mezzanine Floor	50	10	109	33
29	Walls Below 2 Meters	32	2	49	23
29	Internal Surfaces Of Service Water Piping	20	7	65	36
29	Non Permanent Items	30	8	65	29
29	Electrical Penetration Room	30	-9	62	36
30	Rad Waste Storage Room Floor	12	12	62	34
30	Walls	28	-7	54	25
30	Ceiling	14	-9	54	22
31	Boiler Building Roof	25	-11	30	25
31	Fuel Handling Building Roof	25	-5	47	28
31	Turbine Building Roof	25	-1	56	27
32	Security and Construction Offices Floor	30	-10	68	33
32	Walls	30	8	83	37
32	Ceiling	30	9	79	38
32	Non Permanent Structures	30	-4	74	29
33	Fire Pump House Floor	15	-5	59	31
33	Walls	20	5	42	25

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
33	Ceiling	10	-11	-1	12
33	Non Permanent Items	10	17	85	47
34	Stairwell Number 1 Between the Turbine Deck And The Mezzanine	20	12	93	33
34	Stairwell Number 1 Mezzanine Landing	10	13	93	36
34	Stairwell Number 1 Between the Mezzanine And The Basement	20	-12	50	36
34	Stairwell Number 2 Between the Turbine Deck And The Mezzanine	20	0	33	25
34	Stairwell Number 2 Mezzanine Landing	10	9	58	32
34	Stairwell Number 2 Between the Mezzanine And The Basement	20	-9	33	30
35	Floor in Machine Shop	36	-12	36	26
35	Walls in Machine Shop	28	-15	45	25
35	Non Permanent Structures in Machine Shop	30	-23	45	31
35	Floor Electrical Shop	4	-11	19	39
35	Walls in Electrical Shop	8	-19	10	28
35	Non Permanent Structures in Electrical Shop	20	-2	45	31
35	Floor in Instrument Calibration Room	6	-4	62	40
35	Walls in Instrument Calibration Room	7	-19	36	37
35	Non Permanent Structures in Instrument Calibration Room	20	-17	62	31
35	Floor in Toilet	4	-15	19	28

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
35	Walls in Toilet	8	-6	36	24
35	Non Permanent Structures in Toilet	5	-21	2	21
35	Oil Storage Room	30	-15	70	33
36	Walls Above 2 Meters in Machine Shop	20	-15	47	31
36	Overhead Structures in Machine Shop	20	-27	13	22
36	Walls Above 2 Meters in Electrical Shop	15	-15	56	35
36	Overhead Structures in Electrical Shop	15	-15	30	30
36	Walls Above 2 Meters in Instrument Calibration Room	10	-28	30	35
36	Overhead Structures in Instrument Calibration Room	10	-9	30	30
36	Walls Above 2 Meters in Toilet	5	-9	30	35
36	Overhead Structures in Toilet	5	-13	13	16
37	Water Treatment Building Floor In Smaller Room on Bottom Floor	20	6	67	25
37	Walls Below 2 Meters in Smaller Room on Bottom Floor	16	-5	50	32
37	Non Permanent Structures in Smaller Room on Bottom Floor	10	15	93	38
37	Floor in Larger Room on Bottom Floor	30	-3	58	32
37	Walls Below 2 Meters in Larger Room on Bottom Floor	26	13	58	29
37	Non Permanent Structures in Larger Room on	10	-15	24	35

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
	Bottom Floor				
37	Floor on Middle Floor	58	-3	82	32
37	Walls on Middle Floor	32	6	82	35
37	Non Permanent Structures on Middle Floor	10	2	65	32
37	Floor on Top Floor	55	2	96	37
37	Walls on Top Floor	28	-14	53	36
37	Non Permanent Structures on Top Floor	10	-17	27	30
38	Water Treatment Building Walls Above 2 Meters in Smaller Room on Bottom Floor	20	-14	62	40
38	Overhead Structures in Smaller Room on Bottom Floor	20	-11	70	32
38	Walls Above 2 Meters in Larger Room on Bottom Floor	20	-6	88	37
38	Overhead Structures in Larger Room on Bottom Floor (See Survey Package 47)	NA	NA	NA	NA
38	Walls Above 2 Meters on Middle Floor	20	9	58	35
38	Overhead Structures on Middle Floor	20	12	76	33
38	Walls Above 2 Meters on Top Floor	20	22	76	31
38	Overhead Structures on Top Floor (See Survey Package 47)	NA	NA	NA	NA
38	Small Room on Top Floor	20	10	93	38
39	Turbine Building Hot Side, Pipe Number 1	NA	NA	NA	NA
39	Turbine Building Hot Side, Pipe Number 2	NA	NA	NA	NA

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
39	Turbine Building Hot Side, Pipe Number 3	NA	NA	NA	NA
40	See Table 10.6.1 (TB Hot Side Trenches)	NA	NA	NA	NA
41	See Table 10.5.1 (Removable H-3 Survey)	NA	NA	NA	NA
42	Lowest Level of Fuel Handling Building Floor	40	-1	77	34
43	Turbine Building Elevator	24	-1	68	34
43	Floor Beneath Elevator	5	-2	114	72
43	Elevator Room	10	15	71	35
43	Non Permanent Structures in Elevator Room	10	7	62	40
44	Precipitator Building Bottom of Pools	30	-1	62	30
44	Walls of Pools	30	-3	62	35
44	Interior Building Walls	20	-5	45	25
44	Ceiling	20	-11	45	35
44	Walkways	20	0	53	28
45	Turbine Building Mezzanine Walls Above 2 Meters	17	15	93	32
45	Overhead Structures	11	-14	76	36
46	Turbine Building Mezzanine Floor in Electrical Room	20	0	53	31
46	Walls in Electrical Room	20	-5	45	27

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
46	Overhead Structures in Electrical Room	10	-3	62	30
46	Non Permanent Items in Electrical Room	10	8	45	26
46	Floor in Office	15	-9	36	28
46	Walls in Office	15	3	62	29
46	Overhead Structures in Office	10	17	53	21
46	Non Permanent Items in Office	10	12	53	29
46	Floor in Storage Room	10	-3	53	38
46	Walls in Storage Room	10	-1	71	37
46	Overhead Structures in Storage Room	5	2	53	36
46	Non Permanent Items in Storage Room	5	-5	79	48
47	Water Treatment Building Overhead Structures in Larger Room on Bottom Floor	30	9	71	28
47	Overhead Structures on Top Floor	45	-8	53	29
48	Inside Condenser Hotwell Floor	39	-11	53	30
48	Walls	28	14	156	47
48	Overhead Structures	30	-4	79	33
48	Large Diameter Pipe	10	7	45	32
48	Vertical Support Pipe	25	-2	53	34
49	Turbine Mezzanine Section A Floor	64	10	74	29
49	Walls	22	23	100	36
49	Overhead Structures	30	-11	45	31

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
50	Turbine Building Mezzanine Section B Floor	56	6	89	35
50	Walls	10	3	55	33
50	Overhead Structures	25	-7	72	30
51	Turbine Building Mezzanine Section C Floor	70	-3	74	29
51	Walls	16	-7	57	29
51	Overhead Structures	25	-1	66	30
52	Turbine Building Mezzanine Section D Floor	77	10	60	27
52	Walls	44	4	94	32
52	Overhead Structures	20	-2	74	34
53	Turbine Building Mezzanine Section E Floor	38	-2	66	30
53	Walls	19	1	66	36
53	Overhead Structures	20	5	60	29
54	Turbine Building Basement Section A Floor	94	9	78	31
54	Walls	34	14	87	30
54	Overhead Structures	20	7	102	40
55	Turbine Building Basement Section B Floor	85	3	77	29
55	Walls	27	33	95	31
55	Overhead Structures	20	-3	52	25
56	Turbine Building Basement Section C Floor	65	-2	84	35

Table 10.2.1
Summary of Removable Beta Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
56	Walls	16	5	50	29
56	Overhead Structures	20	2	59	30
57	Turbine Building Basement Section D Floor	82	9	67	30
57	Walls	49	1	93	31
57	Overhead Structures	20	8	59	32
58	Turbine Building Basement Section E Floor	38	-1	76	35
58	Walls	16	7	50	28
58	Overhead Structures	20	7	76	33
59	Floor Beneath Condenser	55	-3	66	31

10.3 Removable Alpha Activity Measurements

Table 10.3.1 provides a summary of the results of the removable alpha activity measurements collected during the final status survey listed by survey package number. Table 8.4.2 provides a list of survey packages, a brief description of the corresponding survey area, and the classification of the survey area. Appendix 3, *Removable Alpha and Beta Measurement Results*, contains the measurements from which Table 10.3.1 was derived.

A review of the survey results presented in Table 10.3.1 shows that essentially no removable alpha activity was identified. None of the removable alpha activity measurement results exceeded the MDA. The MDAs for the removable alpha measurement results are presented in Appendix 3.

Table 10.3.1 does not contain removable alpha activity measurements results for all survey packages as indicated by the notation *NA* within the table. In such cases, removable alpha activity measurements were either not required or the survey area, or portion thereof, was resurveyed as part of a different survey package. The following provides clarification for the use of NA in Table 10.3.1.

- Survey Packages 1 through 4 are open land areas. Removable alpha activity measurements were not required.
- The lower floor associated with Survey Package 10 (Basement of Fuel Storage Building) was resurveyed as a Class 2 survey area. Survey Package 42 was prepared to facilitate the resurvey of this surface.
- The floor and walls associated with Survey Package 21 (Hot Side of Turbine Building Basement) was resurveyed following the remediation of overhead piping within the survey area. Survey Packages 54 through 58 were prepared to facilitate the resurvey of these surfaces.
- The survey area associated with Survey Package 22 (Hot Side of Turbine Building Basement) was resurveyed following the remediation of overhead piping within the survey area. Survey Packages 54 through 58 were prepared to facilitate the resurvey of these surfaces.
- The survey area associated with Survey Package 23 (Condenser Hotwell) was resurveyed following the remediation within the condenser hotwell. Survey Packages 48 was prepared to facilitate the resurvey of these surfaces.
- The survey area associated with Survey Package 25 (Floor Beneath Condenser) was resurveyed following additional remediation within the condenser hotwell. Survey Packages 59 was written to facilitate the resurvey of these surfaces.

- The overhead structures in the larger room on the bottom floor and the overhead structures on the top floor associated with Survey Package 38 (Water Treatment Building) were resurveyed as a Class 2 survey area. Survey Package 47 was prepared to facilitate the resurvey of these surfaces.

- Survey Package 40 is for the trenches on the hot side of the Turbine Building. Removable alpha activity measurements were not required.

- Survey Package 41 was written to facilitate a survey for removable H-3 contamination. Removable alpha activity measurements were not required.

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
1	Open Land Area Effluent Discharge Pathway	NA	NA	NA	NA
2	Open Land Area Surrounding Plant	NA	NA	NA	NA
3	Open Land Area Four Settling Basins	NA	NA	NA	NA
4	Open Land Area Construction Lay Down Areas	NA	NA	NA	NA
5	Paved Areas Surrounding Plan	50	0	5	2
6	Cooling Tower Basin Floor	30	0	2	1
6	Cooling Tower Basin Walls	26	1	5	2
6	Cooling Tower Basin Center Divide	10	1	5	2
6	Cooling Tower Basin Spillway	10	0	2	1
7	Temporary Loading and Storage Building Floor	42	0	5	2
7	Walls Below 2 Meters	24	0	5	1
7	Non Permanent Structures	50	0	5	1
8	Walls Above 2 Meters	30	0	5	2
8	Ceiling	30	1	5	2
8	Non Permanent Structures	20	0	5	2

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
9	Warehouse First Floor	30	0	2	1
9	First Floor Walls	20	-1	-1	0
9	First Floor Ceiling	10	0	2	1
9	Stairs	10	0	2	1
9	Second Floor - Floor	20	0	2	1
9	Second Floor Walls	20	0	2	1
9	Second Floor Ceiling	10	0	2	1
9	Non Permanent Structures	30	0	2	1
10	Basement of Fuel Handling Building Upper Floor	20	1	5	2
10	Upper Walls	30	1	5	2
10	Upper Ceiling	30	1	5	2
10	Lower Floor (See Survey Package 42)	NA	NA	NA	NA
10	Lower Walls	30	1	5	2
10	Lower Ceiling	20	1	5	2
10	Stairs	10	0	2	1
11	First Floor of Fuel Handling Building Floor	30	0	2	1
11	Walls	30	1	5	2
11	Ceiling	30	1	11	3
11	Non Permanent Structures	50	1	5	2
12	Second Floor of Fuel Handling Building Upper Floor	19	0	4	2

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
12	Upper Walls	30	0	2	1
12	Upper Ceiling	30	2	10	4
12	Lower Floor	30	0	3	1
12	Lower Walls	30	1	5	1
12	Lower Ceiling	20	0	3	1
12	Stairs	10	0	3	1
13	Turbine Concrete Floor	49	0	5	1
13	I Beams	30	0	5	2
13	Turbine Internals	30	0	2	1
13	Exposed Structures	30	0	3	1
14	Turbine Deck Floor	30	1	8	2
14	Walls	30	1	3	1
14	Ceiling	20	2	8	3
14	Crane and Crane Rails	20	2	8	3
14	Floor Plugs	20	0	2	1
14	Non Permanent Items	50	0	2	1
15	Control Room Floor	30	0	2	1
15	Walls	20	1	5	2
15	Ceiling	30	0	2	1
15	Non Permanent Structures	20	0	3	1
16	First Floor of Admin Building Floors	30	-1	2	1

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
16	Walls	30	-1	2	1
16	Ceiling	30	0	3	1
16	Miscellaneous Non Permanent Items on First Floor of Admin Building	50	0	3	1
17	Second Floor of Admin Building Floor	30	0	2	1
17	Walls	30	0	2	1
17	Ceiling	30	-1	2	1
17	Miscellaneous Non Permanent Items on Second Floor of Admin Building	50	0	2	1
17	Stairs to First Floor of Admin Building	10	0	2	1
17	Stairs to Elevation 1353	10	-1	-1	0
17	Ventilation Duct Exterior	20	-1	2	1
17	Ventilation Duct Interior	20	0	5	1
18	Boiler Building Floor	63	-1	2	1
18	Boiler Building Walls Below 2 Meters	34	0	5	1
18	Interior of Mud Drum A1	10	0	5	2
18	Interior of Mud Drum A2	10	0	2	1
18	Interior of Mud Drum B1	10	-1	2	1
18	Interior of Mud Drum B2	10	-1	2	1
18	Interior of Mud Drum C1	10	-1	2	1
18	Interior of Mud Drum C2	10	-1	2	1
18	Exterior of Boiler A	10	0	2	1
18	Exterior of Boiler B	10	0	2	1

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
18	Exterior of Boiler C	10	0	0	0
18	Boiler Building Trenches	30	0	2	1
18	Sump	20	0	2	1
19	Boiler Building Walls Above 2 Meters	30	0	2	1
19	Ceiling	30	0	3	1
20	Second Floor of Boiler Building Floor	30	1	8	2
20	Walls (below 3 meters)	30	2	22	4
20	Inside Stacks 1, 2, and 3	15	1	3	1
20	Outside Stacks 1, 2, and 3	30	1	8	2
20	Entrance to Deairator	3	0	0	0
20	Outside of Deairator	20	1	5	2
20	Non Permanent Items	20	1	8	2
21	Hot Side of Turbine Building Basement Floor (See Survey Packages 54 Through 58)	NA	NA	NA	NA
21	Walls Below 2 Meters (See Survey Packages 54 Through 58)	NA	NA	NA	NA
21	Expansion Joint	20	1	5	2
21	Exterior Surface of Condenser	30	0	2	1
21	Non Permanent Items				

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
22	Hot Side of Turbine Building Basement Walls Above 2 Meters (See Survey Packages 54 Through 58)	NA	NA	NA	NA
22	Overhead Structures (See Survey Packages 54 Through 58)	NA	NA	NA	NA
23	Inside Condenser Hotwell (See Survey Package 48)	NA	NA	NA	NA
24	Hot Side Sump Floor	10	-1	-1	0
24	Walls	20	1	5	2
25	Floor Beneath Condenser (See Survey Package 59)	NA	NA	NA	NA
26	Condensate Pit and Sumps Floor	20	0	2	1
26	Pit # 1	10	0	5	2
26	Pit #2	10	1	5	2
26	Excavation	5	0	2	1
27	Cold Side of Turbine Building Basement Floor	98	0	5	2
27	Walls Below 2 Meters	31	0	5	2
27	Trenches	30	-1	3	2
27	Sump	20	-2	0	1
27	Non Permanent Structures	30	0	5	1

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
28	Cold Side of Turbine Building Basement Walls Above 2 Meters	31	0	4	2
28	Overhead Structures	30	0	2	1
29	Turbine Building Mezzanine Floor	50	0	5	1
29	Walls Below 2 Meters	32	0	5	1
29	Internal Surfaces Of Service Water Piping	20	0	2	1
29	Non Permanent Items	30	0	5	2
29	Electrical Penetration Room	30	0	6	2
30	Rad Waste Storage Room Floor	12	1	5	2
30	Walls	28	0	2	1
30	Ceiling	12	0	2	1
31	Boiler Building Roof	25	0	0	0
31	Fuel Handling Building Roof	25	0	3	1
31	Turbine Building Roof	25	1	5	2
32	Security and Construction Offices Floor	30	0	2	1
32	Walls	30	-1	2	1
32	Ceiling	30	0	5	1
32	Non Permanent Structures	30	0	2	1
33	Fire Pump House Floor	15	0	3	1
33	Walls	20	0	3	1

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
33	Ceiling	10	1	3	1
33	Non Permanent Items	10	1	3	1
34	Stairwell Number 1 Between the Turbine Deck And The Mezzanine	20	1	11	3
34	Stairwell Number 1 Mezzanine Landing	10	1	2	1
34	Stairwell Number 1 Between the Mezzanine And The Basement	20	1	2	1
34	Stairwell Number 2 Between the Turbine Deck And The Mezzanine	20	1	5	2
34	Stairwell Number 2 Mezzanine Landing	10	1	5	2
34	Stairwell Number 2 Between the Mezzanine And The Basement	20	0	8	2
35	Floor in Machine Shop	36	-1	7	2
35	Walls in Machine Shop	28	-1	1	1
35	Non Permanent Structures in Machine Shop	30	-1	4	2
35	Floor Electrical Shop	4	0	1	2
35	Walls in Electrical Shop	8	0	1	1
35	Non Permanent Structures in Electrical Shop	20	-1	7	2
35	Floor in Instrument Calibration Room	6	0	4	2
35	Walls in Instrument Calibration Room	7	-1	1	1
35	Non Permanent Structures in Instrument Calibration Room	20	-1	1	1
35	Floor in Toilet	4	0	1	2

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
35	Walls in Toilet	8	-1	4	2
35	Non Permanent Structures in Toilet	5	1	1	1
35	Oil Storage Room	30	-1	4	2
36	Walls Above 2 Meters in Machine Shop	20	-2	3	2
36	Overhead Structures in Machine Shop	20	-1	3	2
36	Walls Above 2 Meters in Electrical Shop	15	-1	0	1
36	Overhead Structures in Electrical Shop	15	-1	6	3
36	Walls Above 2 Meters in Instrument Calibration Room	10	-2	0	1
36	Overhead Structures in Instrument Calibration Room	10	-1	6	3
36	Walls Above 2 Meters in Toilet	5	-2	0	2
36	Overhead Structures in Toilet	5	-1	3	3
37	Water Treatment Building Floor In Smaller Room on Bottom Floor	20	1	5	2
37	Walls Below 2 Meters in Smaller Room on Bottom Floor	16	0	5	2
37	Non Permanent Structures in Smaller Room on Bottom Floor	10	1	8	3
37	Floor in Larger Room on Bottom Floor	30	0	5	1
37	Walls Below 2 Meters in Larger Room on Bottom Floor	26	0	2	1
37	Non Permanent Structures in Larger Room on	10	1	5	2

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
	Bottom Floor				
37	Floor on Middle Floor	58	0	5	1
37	Walls on Middle Floor	32	1	5	2
37	Non Permanent Structures on Middle Floor	10	0	[2]	1
37	Floor on Top Floor	55	-1	4	2
37	Walls on Top Floor	28	0	4	2
37	Non Permanent Structures on Top Floor	10	-1	1	1
38	Water Treatment Building Walls Above 2 Meters in Smaller Room on Bottom Floor	20	-1	4	2
38	Overhead Structures in Smaller Room on Bottom Floor	20	0	4	2
38	Walls Above 2 Meters in Larger Room on Bottom Floor	20	0	4	2
38	Overhead Structures in Larger Room on Bottom Floor (See Survey Package 47)	NA	NA	NA	NA
38	Walls Above 2 Meters on Middle Floor	20	1	2	1
38	Overhead Structures on Middle Floor	20	0	5	2
38	Walls Above 2 Meters on Top Floor	20	0	2	1
38	Overhead Structures on Top Floor (See Survey Package 47)	NA	NA	NA	NA
38	Small Room on Top Floor	20	1	5	2
39	Turbine Building Hot Side, Pipe Number 1	NA	NA	NA	NA
39	Turbine Building Hot Side, Pipe Number 2	NA	NA	NA	NA

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
39	Turbine Building Hot Side, Pipe Number 3	NA	NA	NA	NA
40	See Table 10.6.1 (TB Hot Side Trenches)	NA	NA	NA	NA
41	See Table 10.5.1 (Removable H-3 Survey)	NA	NA	NA	NA
42	Lowest Level of Fuel Handling Building Floor	40	3	17	4
43	Turbine Building Elevator	24	1	5	2
43	Floor Beneath Elevator	5	-2	0	1
43	Elevator Room	10	-1	3	2
43	Non Permanent Structures in Elevator Room	10	-1	0	1
44	Precipitator Building Bottom of Pools	30	-1	3	2
44	Walls of Pools	30	-1	3	2
44	Interior Building Walls	20	-2	3	1
44	Ceiling	20	-1	3	2
44	Walkways	20	-2	0	1
45	Turbine Building Mezzanine Walls Above 2 Meters	17	0	5	2
45	Overhead Structures	11	0	2	1
46	Turbine Building Mezzanine Floor in Electrical Room	20	-1	3	2
46	Walls in Electrical Room	20	-1	3	2

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
46	Overhead Structures in Electrical Room	10	-1	0	1
46	Non Permanent Items in Electrical Room	10	0	3	3
46	Floor in Office	15	-1	3	2
46	Walls in Office	15	-2	0	1
46	Overhead Structures in Office	10	-2	3	2
46	Non Permanent Items in Office	10	-2	0	1
46	Floor in Storage Room	10	-1	3	2
46	Walls in Storage Room	10	-2	3	2
46	Overhead Structures in Storage Room	5	0	6	3
46	Non Permanent Items in Storage Room	5	-2	0	1
47	Water Treatment Building Overhead Structures in Larger Room on Bottom Floor	30	-1	0	1
47	Overhead Structures on Top Floor	45	-1	3	2
48	Inside Condenser Hotwell Floor	39	-1	2	1
48	Walls	28	0	5	2
48	Overhead Structures	30	-1	2	1
48	Large Diameter Pipe	10	0	2	1
48	Vertical Support Pipe	25	-1	2	1
49	Turbine Mezzanine Section A Floor	64	0	11	2
49	Walls	22	0	5	2
49	Overhead Structures	30	-1	2	1

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
50	Turbine Building Mezzanine Section B Floor	56	1	8	2
50	Walls	10	0	2	1
50	Overhead Structures	25	0	8	2
51	Turbine Building Mezzanine Section C Floor	70	-1	5	1
51	Walls	16	0	2	1
51	Overhead Structures	25	-1	-1	0
52	Turbine Building Mezzanine Section D Floor	77	0	5	1
52	Walls	44	0	5	2
52	Overhead Structures	20	1	8	2
53	Turbine Building Mezzanine Section E Floor	38	0	5	1
53	Walls	19	0	8	2
53	Overhead Structures	20	0	2	1
54	Turbine Building Basement Section A Floor	94	0	5	1
54	Walls	34	0	8	2
54	Overhead Structures	20	0	2	1
55	Turbine Building Basement Section B Floor	85	0	5	2
55	Walls	27	0	5	2
55	Overhead Structures	20	0	5	2
56	Turbine Building Basement Section C Floor	65	-1	4	2

Table 10.3.1
Summary of Removable Alpha Activity Measurement Results - Continued

Package Number	Survey Area Description	Number of Measurements	Mean dpm/100 cm^2	Maximum dpm/100 cm^2	Standard Deviation dpm/100 cm^2
56	Walls	16	-1	2	1
56	Overhead Structures	20	-1	1	1
57	Turbine Building Basement Section D Floor	82	-1	16	2
57	Walls	49	0	7	2
57	Overhead Structures	20	0	4	2
58	Turbine Building Basement Section E Floor	38	1	10	3
58	Walls	16	0	2	1
58	Overhead Structures	20	0	5	2
59	Floor Beneath Condenser	55	0	5	1

10.4 Exposure Rate Measurement Results

Table 10.4.1 provides a summary of the results of the exposure rate measurements collected during the final status survey listed by survey package number. Table 8.4.2 provides a list of survey packages, a brief description of the corresponding survey unit, and the classification of the survey unit. Appendix 4, *Exposure Rate Measurement Results*, contains the measurements from which Table 10.4.1 was derived.

The survey results presented in Table 10.4.1 shows, that with the exception of the exposure rate measurements collected at the base of the vertical support pipes within the condenser hotwell, no elevated exposure rates were identified. The elevated exposure rate measurements collected at the base of the vertical support pipes are addressed in Section 6.5 of this report.

Although not required by the Decommissioning Plan, exposure rate measurements were performed as part of the final status surveys in the condenser hotwell and in areas within the Turbine Building in which overhead piping was remediated.

Table 10.4.1
Summary of Exposure Rate Measurement Results

Package Number	Survey Area Description	Number of Measurements	Mean uR/hr	Maximum uR/hr	Standard Deviation uR/hr
48	Inside Condenser Hotwell Floor	41	2.91	4.22	0.58
48	Base of Vertical Support Pipes	25	10.84	31.31	6.43
49	Turbine Building Section A Overhead Structures	20	3.32	5.14	0.65
50	Turbine Building Section B Overhead Structures	20	2.89	4.88	0.81
51	Turbine Building Section C Overhead Structures	20	2.71	4.70	0.70
52	Turbine Building Section D Overhead Structures	15	4.85	5.98	0.76
53	Turbine Building Section E Overhead Structures	15	3.32	5.47	0.90
54	Turbine Building Basement Section A Overhead Structures	16	3.31	4.96	0.72
55	Turbine Building Basement Section B Overhead Structures	15	3.49	5.55	0.94
56	Turbine Building Basement Section C Overhead Structures	15	2.99	3.35	0.21

10.5 Removable H-3 Results

Table 10.5.1 contains the sample analysis results of samples collected to assess removable H-3 contamination levels. Survey Package 41 was prepared to facilitate the collection of these samples. Table 10.5.1 lists the sample number, sample location, analysis results, associated error term, and MDA for the analysis.

Table 10.5.1
Removable H-3 Results

Sample Number	Sample Location	Analysis Result pCi/sample	Error pCi/Sample	MDA pCi/Sample
41-1	Inside Turbine Building hot side sump	3.96	7.10	12.00
41-2	Inside condenser	0.00	0.00	6.67
41-3	Inside Pipe 1 leading to hot side sump	0.00	0.00	6.76
41-4	Inside one of the condensate pump sumps	-2.08	3.58	6.32
41-5	Inside the Turbine Building cold side sump	0.00	0.00	6.65
41-6	In one of the Turbine Building cold side trenches	-2.18	3.75	6.60
41-7	On the Turbine Building basement hot side floor net to the Rx Building	0.00	0.00	6.29
41-8	Inside the Turbine Building elevator	-2.19	3.77	6.64
41-9	On the floor beneath the previous location of the hydrogen recombiner on the Turbine Building Mezzanine	-2.22	3.82	6.73
41-10	In the old rad waste storage room on the Turbine Building Mezzanine	-2.26	3.88	6.84
41-11	Inside the remaining sections of the turbine	3.95	6.79	11.50
41-12	On the floor on the lowest level of the Fuel Handling Building	2.19	3.77	6.38
41-13	Inside the sump on the lowest level of the Fuel Handling Building	2.20	3.79	6.40

Table 10.5.1
Removable H-3 Results - Continued

Sample Number	Sample Location	Analysis Result pCi/sample	Error pCi/Sample	MDA pCi/Sample
41-14	Inside one of the mud drums in the Boiler Building	2.14	3.68	6.23
41-15	In one of the Boiler Building trenches	0.00	0.00	6.75
41-16	In the Boiler Building sump	0.00	0.00	6.83
41-17	On the first floor of the Water Treatment Building	2.29	3.94	6.66
41-18	On the second floor of the Water Treatment Building	2.06	3.55	5.99
41-19	On the floor in the Temporary Loading and Storage Building	2.10	3.61	6.10
41-20	On the floor of the Warehouse	2.38	4.09	6.91

The H-3 samples did not identify any licensed activity.

10.6 Sample Analysis Results

Appendix 5 contains sample analysis results for the samples collected during the final status survey.

Appendix 5.1 contains the sample analysis results associated with samples collected based on the requirements of a specific survey package. Table 10.6.1 lists the survey packages, number of samples collected, number of QA samples collected and the types of analyses performed. Table 8.4.2 provides a list of survey packages, a brief description of the corresponding survey unit, and the classification of the survey unit.

Table 10.6.1
Samples Collected Based on Survey Package Requirements

Survey Package Number	Number of Samples Collected	Number of QA Samples Collected	Types of Analyses Performed
1	29	2	Gamma Spec
2	27	2	Gamma Spec
3	16	1	Gamma Spec
4	20	1	Gamma Spec
40	22	2	Gamma Spec

The sample analysis results did not identify any licensed activity with the exception of the sample analysis results associated with Survey Package 40. For Survey Package 40, Co-60 was identified in two of the samples. The Co-60 activity concentrations in these two samples were 0.464 pCi/g and 1.39 pCi/g. These activity concentrations were well below the radionuclide specific criteria for release for unrestricted use for Co-60 (3.80 pCi/g).

Appendix 5.2 contains the sample analysis results associated with the investigation into the elevated activity at the outfall to one of the settling basins. The elevated activity was identified during the gamma scans of the accessible land areas around the four settling basins discussed in Section 11.1.

Appendix 5.2 also contains the sample analysis results associated with the investigation into the elevated activity within the effluent pathway behind the Boiler Building. This was identified during the gamma scans of the effluent pathway discussed in Section 11.

The sample analysis results associated with the samples collected to investigate the areas of elevated activity at the outfall to the settling basin and within the effluent discharge pathway did not identify any licensed activity.

Appendix 5.3 contains the sample analysis results associated with three samples collected to investigate areas of elevated activity identified during the performance of the total beta activity measurements. Samples were collected on the roofs, within the Water Treatment Building, and within the Fuel Handling Building. None of the sample analysis results associated with these three samples identified any licensed activity. The investigations into these areas of elevated activity are discussed in Sections 11.3, 11.5, and 11.7.

Appendix 5.4 contains the sample analysis results associated with two samples collected to verify the radionuclides of interest which are discussed in Section 4.1 of this report. In each of the samples, Co-60 and Ni-63 were identified.

Appendix 5.5 contains the sample analysis results associated with the investigation into the source of the elevated activity within the vertical support pipes in the condenser hotwell. The investigation into the source of the elevated activity within the vertical support pipes is discussed in Section 6.5 of this report. Although Ag-108m was identified in one of the samples (Cond Pipe Debris), it was not considered a radionuclide of interest since the relative fraction of Ag-108m in the sample was less than 0.02 when compared to Co-60 and none of the sample analysis results associated with the two samples collected to verify the radionuclides of interest identified Ag-108m.

Appendix 5.6 contains the sample analysis results associated with the NRC confirmatory survey conducted October 2006. Split samples were collected at most of the locations at which the NRC collected a sample. All sample analysis results associated with the NRC split samples failed to identify any licensed activity. However, several of the sample analysis results identified significant levels of naturally occurring radioactive materials.

10.7 Analysis of Quality Control Samples

Quality control samples used to assess the quality of sampling and subsequent analysis were collected during all sampling except for the collection of smears for accessing removable activity. The quality control samples consisted of duplicate samples collected with a frequency of approximately 5%. The duplicate samples collected from a given survey area were handled and analyzed in the same manner as all the other samples from that survey area.

Duplicate samples were taken at 5% of the sample locations. The locations for the duplicate samples were defined in the survey package. The samples were collected and analyzed using the same collection, preparation and analysis protocols. The results of the QC sample analysis are shown in Appendix 5.1.1 through 5.1.5 with a suffix "QC."

The results of the duplicate samples were compared using guidance from NRC Inspection Manual Inspection Procedure 84750, "Radioactive Waste Treatment, and Effluent and Environmental Monitoring". Comparison of low level activity samples where the quantified activity is less than 5 times the detection level is difficult. Although the sample activity on each of the samples was generally very low, and in some cases the measured activity did not exceed the MDA, the results for those samples with results exceeding the MDA were reasonably close. Using the NRC method, the comparison of the samples showed good agreement, and was within the criteria for accepting the measurements.

Eberline Services also prepared a split sample from 5% of the samples. The sample results for the split samples were reported as "dup" and the comparison of the results was evaluated in the case narratives (see Appendix 5.7) as "within acceptable limits for the analytical technique."

11.0 Investigations

This section of the report discusses several investigations that were performed to validate the results of the final status survey.

11.1 Outfall to Settling Basin

During the gamma scans of the accessible land areas around the four settling basins an area of elevated activity was identified at the outfall to one of the settling basins. As a result soil/sediment samples were collected at four locations surrounding the outfall. At each sampling location soil/sediment samples were collected at depths of 0-6 inches, 6-12 inches, and 12-24 inches. While none of the sample analysis results identified licensed activity the results did indicate the presence of significant Ra-226 activity. The sample analysis results which are presented in Appendix 5 show activity concentrations of Bi-214 and Pb-214 of up to 54 pCi/g each.

These sample analysis results agree reasonably well with NRC split samples collected from the same general location. NRC split samples (NRC-1, NRC-2, NRC-3) were collected from three different depths at a single location. The NRC split sample analysis results did not identify any licensed activity but did identify Ra-226 activity concentrations ranging from 89 pCi/g to 123 pCi/g.

Following the receipt of all of the analysis results it was determined that the area of elevated activity adjacent to the settling basis was due to Technically Enhanced Naturally Occurring Radioactive Material (TENORM) associated with the operations of the water treatment facilities. As a result of these findings Xcel Energy has notified the State of South Dakota and has committed to preparing a detailed plan to further investigate the extent of TENORM contamination at the site.

11.2 Effluent Discharge Pathway

During the gamma scans associated with the final status survey of the effluent pathway an area of elevated activity was identified within the effluent pathway behind the Boiler Building. As a result, soil/sediment samples were collected from the area that exhibited the highest exposure rate. A soil/sediment sample was collected at depths of 0-6 inches, 6-12 inches, and 12-24 inches. While none of the sample analysis results identified licensed activity the results did indicate the presence of significant Ra-226 activity. The sample analysis results which are presented in Appendix 5 did show slightly elevated activity concentrations of several naturally occurring radionuclides.

These sample analysis results agree reasonably well with the NRC split sample (NRC-1) collected from the same general location. The NRC split sample analysis results did not identify any licensed activity but did identify Ra-226 with an activity concentrations of 60.4 pCi/g.

11.3 Fuel Handling Building

Initially the entire Fuel Handling Building was surveyed as a Class 3 survey unit. The initial total beta activity measurement results indicated that there were areas of elevated activity on the floor of the lowest level of the building that exceeded 25% of the criteria for release for unrestricted use. The floor of the lowest level was resurveyed as a Class 2 survey unit.

As a result of identifying several areas of elevated activity, a sample (Fuel Bldg-03) was collected for off site analysis. The results of this analysis did not identify any activity attributed to licensed activities but did indicate the presence of significant Ra-226 activity levels. The sample analysis results presented in Appendix 5, *Sample Analysis Results*, show activity concentrations of Bi-214 and Pb-214 of 145 pCi/g and 139 pCi/g, respectively.

The sample analysis results for the sample collected within the Fuel Handling Building agree with the NRC split sample collected from the sump located on the lowest level of the Fuel Handling Building. The sample analysis for the NRC split sample (NRC-10) did not identify any activity that could be attributed to licensed activities but did identify 175 pCi/g of Ra-226.

Based on the results of these two samples it was determined that the identified areas of elevated activity within the Fuel Handling Building were not due to licensed activity. The areas of elevated activity are most likely TENORM associated with past operations of an old water treatment facility. Regardless, none of the total beta activity measurement results collected within the Fuel Handling Building exceeded the criteria for release for unrestricted use.

11.4 Concrete Block Walls

During the performance of the final status survey it was revealed through the total beta activity measurement results that the concrete blocks used throughout the Turbine Building contained elevated levels of natural radioactivity. The total beta activity measurement results collected on the block walls were all slightly elevated when compared to the measurement results collected on the poured concrete walls. Investigations of the concrete blocks using a portable gamma spectroscopy system did not identify any licensed activity associated with the blocks. Exposure rate measurements collected on contact with the concrete blocks revealed exposure rate measurements 5 to 6 uR/hr above ambient background levels.

Although the total beta activity measurement results collected on the concrete blocks used throughout the Turbine Building were slightly elevated none exceeded the criteria for release for unrestricted use.

11.5 Building Roofs

The total beta activity measurements collected on the roofs of the Boiler Building, Fuel Handling Building, and Turbine Building appeared to be slightly elevated. To confirm that the elevated measurements were not due to licensed activity a composite sample was collected from the three roofs. The sample analysis results which are presented in Appendix 5 did not identify any licensed activity.

Although the total beta activity measurement results collected on the roofs were slightly elevated none exceeded the criteria for release for unrestricted use.

11.6 Administration Building

During the performance of the final status survey it was revealed through the total beta activity measurements that the exterior tile used around the entrance to the Administrative Building and tile within the Administrative Building contained elevated levels of natural radioactivity. The total beta activity measurement results collected on the tiles were all slightly elevated. Investigations of the tiles using a portable gamma spectroscopy system did not identify any licensed activity associated with the tiles. Exposure rate measurements collected in contact with the tiles revealed exposure rate measurements 10 to 15 uR/hr above ambient background levels.

11.7 Water Treatment Building

During the performance of the final status survey it was revealed through the total beta activity measurements that many of the structures within the Water Treatment Building contained materials with elevated concentrations of natural radioactivity.

Investigations of the structures using a portable gamma spectroscopy system did not identify any licensed activity associated with these structures. Exposure rate measurements collected on contact with these structures revealed exposure rate measurements as high as 40 uR/hr above ambient background levels.

To confirm that the elevated measurements were not due to licensed activity a composite sample was collected from several drums within the Water Treatment Building. The sample analysis results, which are presented in Appendix 5, did not identify any licensed activity. However, the activity concentration of K-40 in the sample was 187 pCi/g.

12.0 Conclusion

The results of the Final Status Survey of the Pathfinder Site documented within this report demonstrates that the site meets the criteria for unrestricted use and justifies the termination of the site's NRC Byproduct Material License, license number 22-08799-02. None of the measurements or sample analysis results identified licensed activity in excess of the criteria for release for unrestricted use.

13.0 References

13.1 Final Status Survey Plan for the Pathfinder Plant in Sioux Falls, SD, Revision 0, December 2004.

13.2 Pathfinder Decommissioning Plan, Revision 1, December 2004.

13.3 Free Release Survey of the Turbine/Generator Within the Pathfinder Plant in Sioux Falls, South Dakota, Revision 0, December 2005.

13.4 Characterization Survey Report for the Pathfinder Plant in Sioux Falls, South Dakota, Revision 0, December 2003.

13.5 NUREG-1757, Consolidated NMSS Decommissioning Guidance, Volume 1, Decommissioning Process For Material Licenses, Final, September 2002.

13.6 NUREG-1757, Consolidated NMSS Decommissioning Guidance, Volume 2, Characterization, Survey, and Determination of Radiological Criteria, Draft for Comment, September 2002.

13.7 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual, (MARSSIM) Rev 1, August 2000.

13.8 NUREG-1507, Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminates and Field Conditions, June 1998.

13.9 Confirmatory Radiological Survey of Portions of the Pathfinder Generating Station, Sioux Falls, South Dakota Prepared for the Division of Low-Level Waste Management and Decommissioning Headquarters Office, USNRC, November 1992.

13.10 ISO 7503-1, Evaluation of Surface Contamination – Part 1: Beta Emitters (maximum energy greater than 0.15 MeV) and Alpha Emitters, 1988.

13.11 NRC Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, 1974.

13.12 ANSI N42.17A, American National Standard for Performance Specifications for Health Physics Instrumentation – Portable Instrumentation for Use in Normal Conditions, 2003.

13.13 ANSI/ANS – 3.1, Selection, Qualification, and Training of Personnel for Nuclear Power Plants, 1999.

13.14 ANSI N323, American National Standard for Radiation Protection Instrumentation Test and Calibration, 1978.

13.15 NRC Inspection Manual, Inspection Procedure 84750, Radioactive Waste Treatment, and Effluent and Environmental Monitoring, 1994.