

**ENCLOSURE 2**

DOCKET NO.: 030-05004  
LICENSE NO.: 22-08799-02  
FACILITY: PATHFINDER, SOUTH DAKOTA  
SUBJECT: SAFETY EVALUATION REPORT FOR LICENSE AMENDMENT TO  
AUTHORIZE DECOMMISSIONING OF XCEL ENERGY'S PATHFINDER  
SITE IN SIOUX FALLS, SOUTH DAKOTA

## **1.0 Executive Summary**

The Pathfinder site is owned by Northern States Power Company, a wholly owned subsidiary of Xcel Energy (the licensee). On February 17, 2004, the licensee submitted the Pathfinder Decommissioning Plan (DP) (See ADAMS ML040630549) for U.S. Nuclear Regulatory Commission (NRC) approval. On September 30, 2004, the NRC staff requested additional information (See ADAMS ML042660547) in support of its review of the DP. On December 21, 2004, the licensee responded to the staff's request for additional information which included revisions to the DP (See ADAMS ML050100054). The licensee proposes to decommission the Pathfinder site to permit the release of the site for unrestricted use as defined in the License Termination Rule (LTR), as Subpart E to 10 Code of Federal Regulations (CFR) Part 20.1402. A dose objective of 25 millirem per year (mrem/y) above background is the basis for demonstrating the site can be released for unrestricted use.

The purpose of this safety evaluation report (SER) is to evaluate the licensee's proposed action described in the Pathfinder DP and determine whether NRC's unrestricted use criteria will be met in accordance with NRC regulations. This SER has been developed in conjunction with an environmental assessment (EA) (See ADAMS ML050960256). On May 25, 2005, the EA was published in the *Federal Register* (70 FR 30150) with a Finding of No Significant Impact (FONSI). The approval of this license amendment will authorize the licensee to remediate the site in accordance with the Pathfinder DP as submitted in February 2004, and supplemented in December 2004.

Upon completion of the proposed decommissioning activities, the licensee will conduct a Final Status Survey to demonstrate compliance with the dose criteria for unrestricted use. The licensee will then submit a request to terminate the Pathfinder byproduct materials license in accordance with NRC's regulatory requirements.

## **2.0 Facility Operating History**

### **2.1 Licensing History**

Northern States Power Company obtained an operating license (DPR-11) for the Pathfinder Atomic Power plant in 1964. Economic and other factors resulted in the licensee's decision to shutdown the nuclear plant in September 1967. The nuclear fuel was shipped offsite in 1970, the operating license was terminated, and Byproduct Materials License No. 22-08799-02 was issued in August 1972. This license was subsequently amended to allow for the decommissioning of the reactor building and fuel storage facilities. This decommissioning activity included the removal of the reactor vessel and all nuclear equipment from the Pathfinder

site. The current license authorizes the possession of fixed activation products in quantities not to exceed 41 millicuries (mCi).

## 2.2 Nuclear Operating History

The Pathfinder Atomic plant was designed to generate 66 megawatts of electrical energy. In its short period of operation, most operational activities involved phased testing, and sustained full power operation of the reactor was never achieved. All radioactive releases during this period were within regulatory limits and there were no indications of fuel failures during plant operations. In 1967, a condenser tube leak occurred with the final shutdown of the facility. The main contribution of radioactivity from this event was from radionuclides with short half lives (Zn-65 and Na-24). This leak resulted in contamination of a portion of the service water system and the cooling tower basin located in the secondary (non-reactor) side of the plant also referred to as the Balance of Plant (BOP).

## 2.3 Past Decommissioning Activities

In 1968, the BOP was decontaminated and disconnected from the reactor side of the plant. This decontamination effort resulted in the removal of 500 mCi from the turbine and condenser (mostly Zn-65), 300 mCi from turbine parts, and 500 mCi from the feedwater heaters. A total of 1300 mCi of waste was packaged and shipped offsite for disposal. The nuclear reactor plant and associated systems were isolated from the Turbine Building, steam, reactor feedwater, and other nuclear process lines were cut and capped. The BOP was then integrated into a fossil-fuel plant for generating electricity to meet peak electrical demands. Three fossil-fueled boilers supplied steam to the BOP to operate the turbine. Commercial operation of the Pathfinder Peaking Plant started in May 1969 and continued until July 2000.

In 1991, the reactor plant and fuel storage facilities were decommissioned in accordance with an NRC approved DP. The radiological release criteria for the 1991 decommissioning was based on NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." NRC staff reviewed the licensee's final radiation survey results, performed confirmatory surveys and determined that these facilities could be released for unrestricted use. On November 10, 1992, NRC authorized the unrestricted release of the reactor building, fuel handling building, and waste storage building as well as the demolition of the reactor building.

## 2.4 Ongoing Non-Nuclear Operations

Northern States Power Company subsequently constructed three fossil-fueled combustion turbines on the Pathfinder site to generate electricity from gas-fired turbines to meet peak electrical demands. This plant, referred to as the Angus Anson fossil plant, started commercial operations in September 1994 and is expected to continue operating for the next 30 years.

## 2.5 Evaluation Summary

The NRC staff has reviewed the information in the "Facility Operating History" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 16.2 (Facility Operating History). Based on this review, the NRC staff has determined that the licensee has provided sufficient information to aid NRC staff in evaluating the licensee's assessment of the radiological status of the site and the licensee's planned decommissioning

activities to ensure that the decommissioning can be conducted in accordance with NRC requirements.

### **3.0 Facility Description**

#### **3.1 Site Location and Land Use**

The Pathfinder site is located in Minnehaha County, South Dakota (SD). The Pathfinder facility is located at 7100 East Rice Street in Sioux Falls, SD. The facility is approximately 6.5 miles northeast of the Sioux Falls city center and 2 miles east of the town of Brandon. The population of Sioux Falls and the Town of Brandon are approximately 130,000 and 6,200 respectively. The Pathfinder site is bordered by Interstate 90 and the Big Sioux River to the north and Brandon Road to the south. The Pathfinder facility is principally situated within a 7 acre fenced and secured area. Four settling basins occupy another 5 acres outside of the secured area. The buildings and the areas enclosed within the secured area and the influent and effluent pathways to the Big Sioux River outside the secured area (e.g., settling basins and diversion ditch) are the subjects of this DP. The current land use in the area is primarily agricultural with some industrial and urban components. Residential use of the Pathfinder site in the near-future is considered unlikely given the expected operational period of the Angus Anson fossil-fuel generating plant.

#### **3.2 Meteorology**

The climate of the area is characterized by large seasonal and daily variations in temperature with normally ample spring and summer rainfall and lighter winter precipitation. There are frequent changes in weather, often daily, as the area is dominated by cold air masses from the north in the winter and by warm air masses from the south in the summer. The annual average number of tornadoes and strong-violent tornadoes (1950-1995) in the area are twenty five and five respectively (NOAA, 2005).

#### **3.3 Geology**

The geology of the Pathfinder site consists of a variety of rocks and sediments that range in age from Precambrian to Recent with extensive rock units that have been completely eroded. The Sioux Quartzite Formation (Precambrian) is the basement rock that underlies the site. The Sioux Quartzite is a metamorphosed orthoquartzite with extensive vertical and horizontal joints. At the Pathfinder site, the Sioux Quartzite is buried at depths ranging from 60 to 200 feet.

The Split Rock Creek (SRC) Formation overlies the Sioux Quartzite and consists of Cretaceous age clay, siltstone, shale, and sand units. At the Pathfinder site, the SRC is approximately 180 feet thick beneath the upper terrace, but it has been eroded to about 40 feet thick by the Big Sioux River. The full sequence of the SRC Formation beneath the upper terrace contains five identifiable units. However, the fourth unit, a partially cemented sand, is a confined water-bearing unit that is referred to as the SRC Aquifer.

The Kansan Till (Pleistocene) lies upon the SRC Formation at the site forming upland bluffs. The till ranges in thickness from 0 to 50 feet and is composed of boulder-rich clay. The Upper Terrace Sands (Recent) lie upon the SRC Formation and/or the Kansan Till depending upon

the amount Big Sioux River erosion. The Upper Terrace Sands were deposited by streams and are up to 20 feet thick at the Pathfinder site. The Upper Terrace Sands do not contain a permanent source of water thus, they are frequently de-watered.

The Big Sioux Aquifer (Recent) consists of clays and silts over coarse sands and gravels to weathered shale from the SRC Formation. This aquifer occupies the current flood plain and lower terrace of the Big Sioux River. The thickness of this aquifer, both the saturated and unsaturated portions, ranges from a few feet to 30 feet at the Pathfinder site (NSPC, 1992).

### 3.4 Surface Water Hydrology

The surface water features at this site are the Big Sioux River and the four onsite licensee-developed settling basins located on the Big Sioux River flood plain. The Big Sioux River meanders west to east across the northern portion of the Pathfinder site. The water uses of the Big Sioux River are livestock water and recharge to the Big Sioux Aquifer. The river is not used as a municipal water supply down stream from the site. The four settling basins, which are located northeast of the Pathfinder plant, were installed in the early 1960's to receive waste water from the plant operations. The waste water entering these basins either evaporates or infiltrates into the saturated zone.

River discharge past the site is affected by natural surface runoff, groundwater accretion, and discharges from the City of Sioux Falls. The average annual flow for the Big Sioux River is approximately 500 cubic feet per second (cfs) at Sioux Falls. The five-year 7-day low flow for the Big Sioux River at Sioux Falls is 12.5 cfs (SDPUC, 1993).

### 3.5 Groundwater Hydrology

The water-bearing units at the Pathfinder site that have been potentially impacted by the site-generated radionuclides are the surficial Big Sioux Aquifer and the deeper SRC Aquifer. The Sioux Quartzite is also a water-bearing unit in nearby areas where the shallower water-bearing units are not present and where this unit is exposed at or near the land surface. However, at the Pathfinder site the Sioux Quartzite is not an important water-bearing unit.

The groundwater monitoring of the two significant water-bearing units is based upon wells that were installed between 1957 and 1999. In 1991, the licensee installed six shallow monitoring wells in the Big Sioux Aquifer. These wells were screened in the saturated portion of the alluvial materials and weathered shale. Three additional shallow wells were installed in the Big Sioux Aquifer in 1999. Figure 1 in Donkers (1999) delineates the location of these nine shallow monitoring wells. Wells installed within the SCR Aquifer at this site are Test Well 2, which was installed within the Big Sioux flood plain in 1957, and Wells A and B, which are water supply wells that were installed in the uplands south of the Big Sioux River in 1965. Figure 2-22 in SDPUC (1993) shows the location of these wells.

The potentiometric surface of the groundwater in the Big Sioux Aquifer is delineated in Figure 3 in Donkers (1999). The groundwater flow directions are north to northeast to the Big Sioux River, which is the discharge area for the Big Sioux Aquifer. The depth to groundwater in this aquifer ranges from 8 to 16 feet below the land surface depending upon climatic conditions.

In the Big Sioux River flood plain, the potentiometric surface of the SRC Aquifer rises above the

land surface (e.g., the uncapped Test Well 2 discharges groundwater). However, in the uplands south of the flood plain, the depth to the potentiometric surface ranges from a few feet to over 100 feet. The saturated thickness of this water-bearing unit varies across the site from about 14, 37, and 65 feet, respectively at Test Well 2, Well B, and Well A. The licensee indicates that the groundwater flow direction in the SRC Aquifer is southeastward horizontally, which is away from the Big Sioux River, and upward vertically because of hydraulic pressures of the confined system (Xcel Energy fax dated September 27, 2004).

The velocity of the groundwater movement through these two aquifers is dependent upon the hydraulic conductivity, hydraulic gradient, and porosity of the rock materials. The licensee has calculated the velocity of groundwater flow in the Big Sioux Aquifer between the western settling basin and monitoring Well P-4 as 400 to 700 ft/year. This will produce a time of travel of less than 4 years for groundwater near the western basin to reach the Big Sioux River. The licensee did not calculate a travel time for groundwater in the SRC Aquifer (Donkers, 1999 and SDPUC, 1993), because contamination of the SRC Aquifer is precluded by the upward groundwater flow from this aquifer into the overlying Big Sioux Aquifer.

The Big Sioux Aquifer is used for municipal, industrial, rural, and irrigation water in eastern South Dakota. However, based upon a survey of state registered wells, there are no wells screened in the Big Sioux Aquifer within a 1-mile radius of the site. Residents within 1-mile radius of the site receive water supplied by Minnehaha Rural Water District (NSPC, 1992).

Wells A and B provide domestic and industrial water for the existing staff and facilities on this site. The SRC Aquifer is used for municipal, industrial, rural, and irrigation water in eastern South Dakota.

### 3.6 Evaluation Summary

The NRC staff has reviewed the information in the "Facility Description" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 16.3 (Facility Description). Based on this review, the NRC staff has determined that the licensee has provided sufficient information on the characteristics of the site and environs to serve as a basis for evaluating the licensee's estimated dose to workers and the public, and the impacts of the proposed decommissioning actions on the site and surrounding areas.

## 4.0 Radiological Status of Facility

### 4.1 Structures, Systems, and Equipment

The largest portion of the radioactive material at the Pathfinder site was removed by previous decommissioning activities in accord with an NRC approved DP. Only a small fraction of the contamination from reactor operations is present at the site, and the radiological history of the site is well documented. Based on past characterization surveys, the licensee concludes that there is presently no indication of significant contamination of structures, systems and equipment other than surface contamination on building surfaces within portions of the Turbine Building and Boiler Building.

## 4.2 Soils

Based on recent characterization surveys and historical site assessments, the licensee concludes that there is presently no indication of radioactive contamination of soils at the Pathfinder site. Therefore, no remediation of soils is planned.

## 4.3 Hydrology

Based on recent characterization surveys and historical site assessments, the licensee concludes that there is presently no indication of radioactive contamination of surface waters and groundwater at the Pathfinder site, so no remediation of these media is planned. NRC staff's request for additional information (NRC letter to licensee dated September 30, 2004) and NRC-licensee split surface water and groundwater sampling and radiological analyses were pursued to obtain information pertaining to the occurrence of potential site-generated radionuclides in the surface water and groundwater at the Pathfinder site. The information in Sections 3 and 4 of this SER relating to groundwater hydrology was used to evaluate this potential situation.

## 4.4 Surface Water Hydrology

On October 12, 2004, NRC and the licensee collected split surface water (the Big Sioux River) and groundwater samples. One sample was field-filtered and preserved with dilute nitric acid, and another sample, collected for tritium analysis, was not preserved. ORISE and Eberline Services, the NRC's and licensee's contract radiological laboratories, respectively, analyzed the samples for gross alpha, gross beta, tritium, and gamma spectroscopy for the other radionuclides of concern (that is, Ag-108m, Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, and Zn-65). The analytical results from both laboratories indicate that all radionuclides of concern were below the minimum detectable activity. Also, the gross alpha and gross beta levels were all below the U.S. Environmental Protection Agency's maximum concentration limits (MCL) [ORISE, 2004 and Eberline Services, 2004]. The analysis of water samples indicates that site-generated radionuclides have no current impact on the surface water, and there is no reason to anticipate that site-generated radionuclides will impact the surface water in the future.

## 4.5 Groundwater Hydrology

Two radiological groundwater sampling events have been conducted at the Pathfinder site. For both sampling events, the Characterization Study sampling on October 13, 2003 and the NRC-licensee split sampling on October 12, 2004, all samples were analyzed for the radionuclides of concern. Analytical results for the Characterization Study sampling event indicated that all radionuclides of concern were below the minimum detectable activity. Also, the only monitoring wells sampled during this sampling event were screened in the Big Sioux Aquifer.

During the NRC-licensee split sampling on October 12, 2004, the NRC and the licensee collected 13 water samples from Wells P-1 through P-9, Well A, Well B, Test Well 2, and a duplicate of Well P-9 labeled as Well P-10. All samples were field-filtered and preserved with dilute nitric acid except for the tritium samples, which were not preserved. ORISE and Eberline Services analyzed the samples for gross alpha, gross beta, tritium, and gamma spectroscopy for the other radionuclides of concern. Analytical results from both laboratories indicate that all radionuclides of concern were below the minimum detectable activity. The gross alpha and

gross beta levels were all below the U.S. Environmental Protection Agency's MCL (ORISE, 2004 and Eberline Services, 2004).

#### 4.6 Evaluation Summary

NRC staff has reviewed the information in the "Radiological Status of the Facility" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 16.4 (Radiological Status of the Facility). Based on this review, NRC staff has determined that the licensee has described the types and activity of radioactive contamination sufficiently to allow the NRC staff to evaluate the appropriateness of the proposed remediation activities, the radiological control measures, and waste management practices.

Based upon the analytical results and upon the surface water and groundwater hydrology at the Pathfinder site, the NRC staff further concludes: (1) the analysis of water samples indicates that site-generated radionuclides do not currently impact the groundwater or the surface water; (2) the groundwater flow directions in the Big Sioux Aquifer indicate that any potential radionuclides dissolved in the groundwater will be discharged directly into the Big Sioux River where the radionuclides will be significantly diluted by the surface water; (3) the hydrogeology of the site indicates that no site-generated radiological contamination of the groundwater in SRC Aquifer has occurred; and (4) there is no need for post-decommissioning monitoring of surface water and groundwater for licensed materials.

### 5.0 Dose Analysis

#### 5.1 Site Release Criteria

For the Pathfinder site, the licensee proposed to remediate contaminated areas to permit unrestricted use of the site in compliance with the requirements of 10 CFR 20.1402. Thus, the residual radioactivity that is distinguishable from background must not cause the total effective dose equivalent (TEDE) to an average member of the critical group to exceed 25 mrem/year. Residual radioactivity must also be reduced to levels that are as low as reasonably achievable (ALARA). As required under 10 CFR 20.1402, expected doses are to be evaluated for the average member of the critical group, which is not necessarily the same as the maximally exposed individual. The use of the "average member of the critical group" acknowledges that any hypothetical "individual" used in the dose assessment is based, in some manner, on the statistical results from data gathered from groups of individuals. Calculating the dose to the critical group is intended to bound the individual dose to other possible exposure groups because the critical group is a relatively small group of individuals, due to their habits, actions, and characteristics, who could receive among the highest potential dose at some time in the future. By using the hypothetical critical group as the dose receptor, it is unlikely that any individual would actually receive doses in excess of that calculated for the average member of the critical group.

Derived concentration guideline levels (DCGLs) were developed as acceptable levels of residual radioactivity that can be left at the site in compliance with the unrestricted release criteria. The licensee has developed two sets of DCGLs for radionuclides found at the Pathfinder site. These include a set of DCGLs for residual radioactivity remaining on interior building surfaces and another set for residual radioactivity remaining in soil around the site.



These DCGLs were used to demonstrate compliance with the regulations. The derivation of these DCGLs is provided in Section 3 of the Pathfinder DP.

The dose contribution from past decommissioning activities at the Pathfinder site was considered in the development of the DCGLs. The 25 mrem per year dose criterion is applicable to the entire Pathfinder site, including residual radioactivity from past decommissioning activities of the site. The licensee has provided a bounding dose analysis to conservatively estimate the annual dose to a hypothetical individual potentially exposed to residual radioactivity from past decommissioning activities of the Pathfinder Reactor Building. Following the decommissioning activities performed in 1992, the above grade portion of the Pathfinder Reactor Building was removed and the below grade portion was backfilled and capped with concrete. At the time of decommissioning, the radionuclides of concern were Co-60 and Cs-137. Using these two radionuclides, the dose analysis performed by the licensee resulted in an annual dose of 0.04 mrem. However, the licensee only considered external exposure, using Microshield Version 5.05 to determine the exposure to a hypothetical individual. Considering other exposure pathways, staff performed a bounding analysis, using RESRAD Version 6.22, to investigate the potential dose to an individual resulting from the residual radioactivity leaching into the groundwater. The staff analysis demonstrated that the potential dose from the groundwater pathway is below the 25 mrem per year dose criterion. In addition, the radioactive decay of Co-60 and Cs-137 over a 1000 year period will yield an insignificant source term.

The dose analysis performed by the licensee to determine the dose contribution from past decommissioning activities is acceptable. The dose contribution is relatively small with no cumulative effect when compared to the 25 mrem per year dose criterion for unrestricted release of the site.

## 5.2 Contaminant Characteristics

A total of eight radionuclides listed in Table 5.0 of the DP were identified as relevant to the decontamination activities at the Pathfinder site. DCGLs for these radionuclides were developed and are consistent with the suite of radionuclides identified as part of the characterization effort documented in Section 2 of the DP. Based on the characterization survey, the licensee determined that the amount of residual radioactivity remaining at the Pathfinder site is "...relatively small and largely confined to several well-defined areas within the plant."

Table 5.0 Radionuclides for which DCGLs are developed for the Pathfinder site

H-3	Cs-137
Co-60	Eu-152
Zn-65	Eu-154
Ag-108m	Eu-155

The licensee established a screening level of 5,000 dpm/100 cm<sup>2</sup> for building surfaces to identify those radionuclides which contribute to site contamination. In Section 2 of the DP, Table 2-1 identifies areas in which fixed activity were in excess of the licensee's established screening levels for building surfaces.

As a part of the characterization survey, the licensee collected biased samples throughout the Pathfinder Peaking Plant. The DP identifies those areas as well as the eight radionuclides (Table 5.0) in which residual activity is attributable to licensed activities above the Minimum Detectable Activity (MDA).

### 5.3 Scenario Definition and Exposure Pathways for Building Surfaces

The building occupancy scenario is used to evaluate potential exposure to fixed and removable surface radioactivity within structures that will be left on the site after license termination. It is assumed that a light industrial worker occupies the structure in a passive manner without deliberately disturbing the residual radioactivity on building surfaces. A light industrial worker, which is assumed to be an adult, is considered the average member of the critical group. The worker is assumed to be exposed to penetrating radiation from surface sources, inhalation of resuspended surface contamination, and inadvertent ingestion of surface contamination.

### 5.4 Building Surface DCGLs

For building surfaces, the licensee provided surface contamination DCGL values for unrestricted release for all eight of the radionuclides identified as contaminants for the Pathfinder site, as shown in Table 5.1 in the DP.

Table 5.1 Pathfinder DCGLs for Building Surfaces

<b><i>Radionuclide</i></b>	<b><i>DCGL (dpm/100 cm<sup>2</sup>)</i></b>
<i>H-3</i>	<i>1.2E+8</i>
<i>Co-60</i>	<i>7.1E+3</i>
<i>Zn-65</i>	<i>4.8E+4</i>
<i>Ag-108m</i>	<i>1.7E4</i>
<i>Cs-137</i>	<i>2.8E+4</i>
<i>Eu-152</i>	<i>1.3E+4</i>
<i>Eu-154</i>	<i>1.1E+4</i>
<i>Eu-155</i>	<i>1.6E+5</i>

Using the screening analysis approach, the DCGLs for Co-60, H-3, and Cs-137 were taken directly from Table B.1 of Appendix B in NUREG-1757, Vol. 1. In accordance with guidance

provided in NUREG-1757, DCGLs developed through a screening analysis are acceptable provided the following conditions are met:

- 1) The assumption of the screening analysis are not violated. Specifically, (a) the residual radioactivity is on wall surface (i.e., non-volumetric); and (b) the residual radioactivity on the surface is mostly fixed with the fraction of loose radioactivity not to exceed 10% of the total surface activity.
- 2) Only default parameters within the DandD code are used in the dose analysis.

When using the DCGLs to determine compliance, the sum of fractions rule must be used when multiple radionuclides are present so that the total dose will not exceed the dose criterion of 25 mrem per year. The residual concentration of a radionuclide divided by its corresponding DCGL, summed over all radionuclides must be less than 1. The DCGLs for building surfaces and soil represent the total 25 mrem quantity when applying this rule. Mathematically, the sum of fractions is represented by the following equation:

$$\sum_{i=1}^N \frac{Conc_i}{DCGL_i} \leq 1$$

where:

Conc<sub>i</sub> ≡ concentration of radionuclide i

DCGL<sub>i</sub> ≡ derived concentration guideline level for radionuclide i

N ≡ total number of radionuclides

Surface contamination DCGL values for Zn-65, Eu-152, Eu-154, Eu-155 were developed through the use of DandD computer Code, Version 2.1 using all default parameters. Screening values for these radionuclides are not listed in Appendix B of NUREG-1757, Vol. 1. However, screening values for these radionuclides are listed in Table 5.19 (P<sub>crit</sub> = 0.90) of NUREG/CR-5512, Vol. 3. The licensee compared the results from DandD runs to the screening values published in NUREG/CR-5512, Vol. 3. The results from the DandD code for each of the 4 radionuclides using an input of 1 mrem per 1000 dpm/100 cm<sup>2</sup> were scaled to the 25 mrem TEDE limit to determine an acceptable DCGL value.

For verification of results, the DandD results for Co-60 were compared to the screening values published in Appendix B of NUREG-1757, Vol. 1 and NUREG/CR-5512, Vol. 3. Staff has confirmed that only default parameters were used in the analysis. The DP states that the DCGLs for building surfaces will be applied to building surfaces, which includes permanent structures (i.e., embedded piping, large steam lines, the main condenser, and package boilers). Further, the DP states that the removable activity for building surfaces will not exceed 10% of the total activity.

RESRAD-BUILD, Version 3.21 was used to develop the surface contamination DCGL for Ag-108m because it was not identified in either Appendix B of NUREG-1757, Vol.1, NUREG/CR-5512, Vol. 3, or available within the DandD Code. To appropriately evaluate the DCGL value of Ag-108m, the staff made confirmatory runs using RESRAD-BUILD Version 3.21 with the licensee's parameter values. The staff was able to verify the licensee's results. The

staff also evaluated the parameter values used in the licensee's analysis by comparing them against values recommended in NUREG/CR-6755. Staff found that in general the parameter values used by the licensee were consistent with those recommended in NRC guidance (NRC, 2002) for evaluating exposure to an occupant under a light industrial land-use scenario. However, the licensee selected conservative parameters for the area of the building (1000 m<sup>2</sup>) as well as the source area (1000 m<sup>2</sup>) to model an infinite source and building area condition. To evaluate the effect of these parameters on the calculated DCGL value, staff calculated the dose that would have been obtained had smaller values for the area of the building (64 m<sup>2</sup>) and source area (64 m<sup>2</sup>) were used. The staff assessment shows that the DCGL value would increase by a factor of 1.5 with the use of smaller source and building area parameter selections. Thus, while these parameter values by the licensee are more conservative rather than realistic, the use of the more conservative values by the licensee would not significantly change the DCGL values. Therefore, staff considers the DCGL value for Ag-108m reasonable and acceptable.

### 5.5 Scenario Definition and Exposure Pathways for Soil

The residential farming scenario was used by the licensee to evaluate potential exposure from surface soil residual radioactivity that will be left on the site after license termination. The DP states that DCGL values derived from this scenario will be applied to open land areas surrounding the Pathfinder site and to soil that may be encountered within the plant during remedial activities. The DP also states that the DCGLs for soil may apply to volumes of less than 100 ft<sup>3</sup> of volumetrically contaminated concrete. If more than 100 ft<sup>3</sup> of volumetrically contaminated concrete is encountered, and if the contaminated concrete will remain following remediation, the licensee will provide a site-specific dose evaluation for NRC approval.

For the residential farming scenario, the residual radioactivity is assumed to be distributed in a surface soil layer (less than 15 cm below the ground surface). The residential farming scenario in general assumes light farming activities resulting in continuous exposure to residual radioactivity remaining at the site via multiple exposure pathways. Potential exposure pathways considered include direct external exposure from residual radioactivity in soil material, internal exposure from inhalation of airborne radionuclides, and internal exposure from ingestion of (1) plant foods grown in the soil with residual radioactivity and irrigated with contaminated water, (2) meat and milk from livestock fed with contaminated fodder and water, (3) drinking water from a contaminated well, (4) fish from a contaminated pond, and (5) soil with residual radioactivity. The choice of a resident farmer scenario is considered to be reasonable and consistent with the generic scenario used for screening analyses described in Appendix B of NUREG-1757, Vol. 1. Because the exposure pathways considered for the resident farmer scenario cover all the likely routes of exposures, it is unlikely that any other set of reasonably plausible human activities postulated for the site would result in a dose exceeding that calculated for the hypothetical farmer.

### 5.6 Surface Soil DCGLs

For surface soil, the licensee provided DCGL values for seven radionuclides identified as potential soil contaminants for the Pathfinder site, as shown in Table 5.2 in the DP. Using the screening analysis approach, the DCGLs for Co-60, H-3, Cs-137, Eu-152, and Eu-154 were taken directly from Table B.2 of Appendix B in NUREG-1757, Vol. 1.

Table 5.2 Pathfinder DCGLs for Soil

<b>Radionuclide</b>	<b>DCGL (pCi/g)</b>
<i>H-3</i>	110
<i>Co-60</i>	3.8
<i>Zn-65</i>	11
<i>Cs-137</i>	11
<i>Eu-152</i>	8.7
<i>Eu-154</i>	8.0
<i>Eu-155</i>	280

As with the building surface DCGL values, each derived DCGL value listed in Table 5.2 represents the activity equivalent to a dose of 25 mrem/year. Accordingly, the sum of fractions rule must be used to apportion the concentrations when multiple radionuclides are present so that the total dose will not exceed 25 mrem/year.

Surface soil DCGLs were developed for Zn-65 and Eu-155 through use of the DandD Code Version 2.1 using all default parameters. Screening values for these radionuclides were not listed in Appendix B of NUREG-1757, Vol. 1. However, screening values were listed for these radionuclides in Table 6.91 ( $P_{crit} = 0.10$ ) of NUREG/CR-5512, Vol. 3. The licensee compared the results from DandD runs to the screening values published in NUREG/CR-5512, Vol. 3. The results from the DandD code for each of the 2 radionuclides, using an input of 10 pCi/g, were scaled to the 25 mrem TEDE limit to determine an acceptable DCGL value. For verification of results, the DandD results for Co-60 were compared to the screening values published in Appendix B of NUREG-1757, Vol. 1 and NUREG/CR-5512, Vol. 3. Staff has confirmed that only default parameters were used in the analysis.

#### 5.7 Elevated Measurement Comparison DCGL values

Table 5-1 and Table 5-2 list the DCGL values for demonstrating compliance with the release criteria for building surfaces and surficial soil. The listed DCGL values assume a relatively uniform distribution of residual radioactivity within a survey unit. However, smaller areas of the survey unit with concentrations exceeding the DCGL values will be tested by the licensee to ensure that the release criteria will be met for these elevated areas of the site. According to Appendix B of NUREG-1757, Vol. 1, elevated measurement comparison values,  $DCGL_{emc}$  values, should be developed for each radionuclide over a range of smaller limited areas. In addition, area factors are needed to develop the maximum detectable concentration required by the scan procedure.

The licensee calculated area factors for both the building occupancy and the resident farmer scenarios. Area factors for these scenarios were computed by running the DandD, Version 2.1

code repeatedly changing only the "area of contamination" parameter. No other changes to the DandD default values were made. Since Ag-108m is not available in the DandD code, the licensee assumed that Ag-108m would have the same resulting area factors as those calculated for the other radionuclides. The area factors for the building occupancy scenario and the resident farmer scenario are listed in Table A.1 and Table A.2 of Addendum A of the Final Status Survey Plan contained in the DP. Staff independently verified area factors using DandD Version 2.1 for both scenarios and found no discrepancies.

## 5.8 Evaluation Summary

The staff has reviewed the dose modeling analyses in the Pathfinder DP in accordance with the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 6 (Radiological Criteria for Decommissioning). Based on its review, the staff concludes that the dose estimates calculated using the default screening analysis are appropriate for the decommissioning option and exposure scenario assumed. In addition, these dose estimates provide reasonable assurance that the dose criterion in 10 CFR 20.1402 will be met. This conclusion is based on the modeling effort performed by the staff in initially developing the default screening analysis. In determining the dose to the average member of the critical group, the licensee has used the assumptions inherent in the screening analysis and the parameter uncertainties have been previously evaluated on a generic basis by the staff as a part of establishing the default screening analysis.

## 6.0 Planned Decommissioning Activities

The three principal decommissioning activities are remediation, shipment of low level radioactive waste, and final status surveys. Based on past radiological surveys, the licensee concludes that there is presently no indication of significant radioactive contamination from reactor-originated sources other than surface contamination within certain portions of the Turbine Building and Boiler Building. Therefore, planned remediation activities will be largely confined to certain well-defined areas within the Turbine and Boiler buildings. These decommissioning activities are currently scheduled to begin in late 2005 and end in late 2006. There are no planned remediation activities for soil, surface water or groundwater since there is no indication of radiological contamination from licensed materials in these media.

NRC staff has reviewed the information in the "Planned Remediation Activities" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 17.1 (Planned Decommissioning Activities). Based on this review, NRC staff has determined that the licensee has provided sufficient information to allow the NRC staff to evaluate the licensee's planned decommissioning activities to ensure that decommissioning can be conducted in accordance with the NRC requirements.

## 7.0 Project Management and Organization

NRC staff has reviewed the information in the "Decommissioning Organization and Administration" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 17.2 (Project Management and Organization). Based on this review, NRC staff has determined that the licensee has provided sufficient information to allow the NRC staff to evaluate the licensee's decommissioning project

management organization and structure. The NRC staff concludes that the licensee's project management and organization is adequate to decommission the site in accordance with NRC requirements.

## **8.0 Radiation Safety and Health Program**

The NRC Staff has reviewed the Radiation Safety and Health Program described in the Pathfinder DP. The licensee provided descriptions on when air samples will be taken in work areas, the types of air sampling equipment to be used and where they will be located in the work areas. The licensee provided technical information on the minimum detectable activities of equipment to be used for analyses of radionuclides collected during sampling, and action levels for airborne radioactivity for the protection of workers and the environment. The licensee provided sufficient information to implement an acceptable program to determine internal dose of a worker based upon measurements from air samples or bioassay samples, including the use of respiratory protection equipment for the protection of workers. The licensee also described the methods to measure the external dose of workers and that the licensee will sum the internal and external exposures for determining the workers total exposure.

A Radiation/Hazardous Work Permit (RHWP) will be employed to inform workers of radiological and industrial safety conditions in the work areas. The RHWPs will specify worker requirements, precautions and actions to be performed to safely perform decommissioning activities. The licensee contamination control program described in sufficient detail the methods to control contamination on skin, protective and personnel clothing, fixed and removable contamination on work surfaces, transport vehicles, equipment, and on packages. The licensee's radiological instrumentation program ensures that the sensitivity and the calibration of instruments and equipment to be used to make quantitative measurements of ionizing radiation during surveys are appropriate. The licensee's health physics audits and recordkeeping program described the executive management and Radiation Safety Officer audits that ensure that decommissioning can be conducted safely and that records will be maintained in accordance with licensee and NRC requirements.

The NRC staff has reviewed the information in the "Radiation Safety and Health Program" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 17.3 (Radiation Safety and Health Program During Decommissioning). The information provided in the Pathfinder DP describes the methods to be used for the protection of workers and the environment and states that decommissioning activities will be conducted in accordance with NRC requirements in 10 CFR 20 and regulatory guidance, such as Regulatory Guide 8.25. Based on this review, the NRC staff has determined that the licensee provided sufficient information to conclude that the licensee's radiation safety and health program will be conducted in accordance with NRC requirements in 10 CFR 20 ensuring the protection of workers and the environment during decommissioning activities.

## **9.0 Environmental Monitoring**

NRC staff has reviewed the information in the "Environmental Monitoring Program" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 17.4 (Environmental Monitoring and Control Program). Based on this review, NRC staff has determined that the licensee has provided sufficient information on its

environmental ALARA evaluation program, effluent monitoring and control program. The NRC staff concludes that the licensee's program complies with 10 CFR Part 20 requirements.

### **10.0 Radioactive Waste Management**

NRC staff has reviewed the information in the "Radioactive Waste Management" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 1, Section 17.5 (Radioactive Waste Management Program). Based on this review, NRC staff has determined that the licensee's program for the management of radioactive waste generated during the decommissioning operations ensure that the waste will be managed in accordance with NRC requirements and in a manner that is protective of the public health and safety.

### **11.0 Quality Assurance Program**

NRC staff has reviewed the information in the "Quality Assurance" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Volume 1, Section 17.6 (Quality Assurance Program). Based on this review, NRC staff has determined that the licensee's Quality Assurance program is sufficient to ensure that information submitted to support decommissioning of the site will be of adequate quality to allow the NRC staff to determine if the licensee's planned decommissioning activities are conducted in accordance with NRC requirements.

### **12.0 Facility Radiation Surveys**

In Appendix D "Characterization Survey Report" of the Pathfinder DP, the licensee provides detailed radiological characterization information of the site that was utilized for planning decommissioning remediation activities and serves as the bases for the development of the final status survey design. The characterization report ensures that the planned decommissioning activities will be effective and will not endanger the remediation workers. Additionally, the report demonstrates that significant quantities of radioactivity has not gone undetected, and provides information that will be used to design the final status survey.

In the "Facility Radiation Survey" section and "Final Status Survey Plan" (Appendix F) of the Pathfinder DP, the licensee summarized the DCGLs and area factors used for the final status survey design to ensure compliance with the radiological criteria for license termination. Based on the staff's review, the DCGLs and area factors are consistent with the NRC dose modeling criteria and the guidance in NUREG 1575, Mutli-Agency Radiological Survey and Site Investigation Manual (MARSSIM). The licensee provided technical information, such as instrumentation to be used for final status surveys as well as detailed instrument performance calculations demonstrating the minimum detectable count rates for scan surveys and the minimum detectable activities for static measurements. The instruments selected by the licensee are appropriate for the measurements of the residual radioactive contamination at the Pathfinder site. The Final Status Survey Plan describes methods to be employed that are consistent with MARSSIM and are adequate to demonstrate compliance with the release criteria in 10 CFR 20.1402.



## **13.0 Financial Assurance**

### 13.1 Cost Estimate

The NRC staff has reviewed the cost estimate in the "Financial Assurance" section of the Pathfinder DP according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 3, Section 4.1 "Cost Estimate (as Contained in a Decommissioning Funding Plan or Decommissioning Plan)". The licensee submitted its cost estimate in the amount of \$2,800,000. Based on this review, the NRC staff has determined that the cost estimate submitted by the licensee adequately reflects the costs needed to carry out all required decommissioning activities prior to license termination.

### 13.2 Evaluation Summary

The NRC staff has reviewed the financial assurance mechanism for the Pathfinder reactor, license number 22-08799-02 located at Sioux Falls, South Dakota according to the NRC's Consolidated NMSS Decommissioning Guidance, Vol. 3, Section 4.3 (Financial Assurance Mechanisms). The licensee submitted a letter of credit in the amount of \$3,000,000. Based on this review, the NRC staff has determined that the financial assurance mechanism submitted by the licensee is adequate to ensure that sufficient funds will be available to carry out all required decommissioning activities prior to license termination.

## 14.0 Conclusions

Based on the considerations discussed above, the NRC staff concludes that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed decommissioning activities; and (2) such activities will be conducted in compliance with NRC regulations.

## **References**

Donkers, Chuck, "Pathfinder Remedial Investigation September," 1999.

Eberline Services, "Analytical Results For Water Samples Collected October 12, 2004 From Northern States Power Company, DBA Xcel Energy - Angus Anson Generating Facility, Sioux Falls, South Dakota," [Work Order # 04-10082-OR0], Letter Report to Doug Schult, November 10, 2004.

National Oceanic and Atmospheric Administration,  
<http://www.ncdc.noaa.gov/img/climate/severeweather/small/avgt5095.gif> and  
<http://www.ncdc.noaa.gov/img/climate/severeweather/small/avgf2.gif>, May 10, 2005

Northern States Power Company (NSPC), "Groundwater Discharge Plan Application For Proposed Combustion Turbine Generator Facility Pathfinder Site Minnehaha County, South Dakota," 1992.

ORISE, "Analytical Results for Water Samples Collected October 12, 2004 From Northern States Power Company, DBA Xcel Energy - Angus Anson Generating Facility, Sioux Falls,

South Dakota," (Docket No. 30-05004) [RFTA NO. 05-001], Letter Report to Robert Evans, November 15, 2004.

South Dakota Public Utilities Commission (SDPUC), "Final Environmental Impact Statement - For A Proposed Combustion Turbine Generator Facility Northern States Power Company Pathfinder Site Minnehaha County, South Dakota," 1993.

U.S. NRC, "Consolidated NMSS Decommissioning Guidance, Decommissioning Process for Materials Licensees," NUREG-1757, Vol. 1, 2, and 3, September 2003.

U.S. NRC, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," NUREG-1575, Revision 1, August 2000.

U.S. NRC, "Residual Radioactive Contamination From Decommissioning, Parameter Analysis," NUREG/CR-5512, Vol. 3, October 1999.

U.S. NRC, "Technical Basis for Calculating Radiation Doses for the Building Occupancy Scenario Using the Probabilistic RESRAD-BUILD 3.0 Code," NUREG/CR-6755, February 2002.

Xcel Energy, "Pathfinder Decommissioning Plan," 2004a.

The following reports were included as Appendices to the DP:

- Characterization Survey Report For The Pathfinder Plant In Sioux Falls, South Dakota. Rev. 0. December 2003. Published by Duratek Commercial Projects.
- Attachment A to the Characterization Survey Report  
Off Site Sample Analysis Results
- Pathfinder Decommissioning Plan Environmental Information Addendum. February 17, 2004. Xcel Energy.

Xcel Energy, "Pathfinder Decommissioning Plan," (December 2004 supplement to the DP), 2004b.

The following reports were included as Appendices to the DP:

- Appendix F - Final Status Survey Plan For the Pathfinder Plant in Sioux Falls, SD
- Appendix G- Responses To NRC Request For Additional Information