CHAPTER 2

ENVIRONMENTAL IMPACT STATEMENT

Xcel Energy Prairie Island Nuclear Generating Plant
Additional Dry Cask Storage

PUC Docket No. E002/CN-08-510

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1.0 INTRODUCTION

On April 15, 2008, Xcel Energy applied to the United States Nuclear Regulatory Commission (NRC) for a license renewal for the Prairie Island Nuclear Generating Plant (PINGP). The renewal would allow the PINGP to operate through 2034. Operation through 2034 would require additional storage of spent nuclear fuel within the existing Prairie Island Independent Spent Fuel Storage Installation (ISFSI). Expansion of the ISFSI to accommodate additional spent fuel requires approval from the NRC and the Minnesota Public Utilities Commission (Commission).

On May 16, 2008, Xcel Energy applied to the Commission for a Certificate of Need (CON) to expand the existing Prairie Island ISFSI to accommodate an additional 35 casks of spent nuclear fuel. The docket number for the additional dry cask storage certificate of need is E002/CN-08-510. This chapter (Chapter 2) of this environmental impact statement (EIS) is required as part of the Commission CON process (Minn. Stat. § 116C.83, Subd 6).

The specific topics and extent of discussion in this chapter were outlined in the Prairie Island EIS Scoping Decision, approved by the Office of Energy Security (OES) director on November 14, 2008 (**Chapter 1, Appendix A**).

Section 2 of this chapter outlines the regulatory framework governing the Prairie Island ISFSI. Section 3 provides information on the proposed project. Section 4 discusses the non-radiological impacts that expansion of the Prairie Island ISFSI could have on humans and the environment. Section 5 discusses the radiological impacts that expansion of the ISFSI could have on humans and the environment. Section 6 discusses alternatives for storing spent nuclear fuel generated by the PINGP by operations through 2034. Section 7 discusses alternative methods of generating the electrical power currently produced by the PINGP and the human and environmental impacts of these alternatives. Section 8 summarizes the unavoidable impacts that would result from the proposed project.

1.1 SOURCES OF INFORMATION

Information in this chapter is drawn from multiple sources, which are footnoted throughout. Primary sources include Xcel Energy's Application for a Certificate of Need for additional dry cask storage, Xcel Energy's license amendment request to the Nuclear Regulatory Commission and associated safety analysis report (SAR), and correspondence with Xcel Energy. Select sources are noted here:

- Application to the Minnesota Public Utilities Commission for Certificates of Need for the Prairie Island Nuclear Generating Plant for Additional Dry Cask Storage and Extended Power Uprate, http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602
- License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) and enclosures, http://www.nrc.gov/reading-rm/adams/web-based.html >> "Begin

Adams Search" >> http://adamswebsearch.nrc.gov/scripts/securelogin.pl >> Search on the following accession numbers:
  - 081290197, Prairie Island ISFSI, LAR
  - 081290198, Enclosure 3
  - 081290199, Enclosure 5, Safety Analysis Report Addendum A
  - 081370151, Enclosure 5, Safety Analysis Report Addendum A
- Prairie Island Nuclear Generating Plant, Environmental Report for License Renewal Application, is Appendix J of the Xcel Energy's Application for Certificates of Need, http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602
- Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Update Qualifications and Analysis Report, EPRI, 2004, www.epri.com

2.0 REGULATORY FRAMEWORK

The U.S. Nuclear Regulatory Commission (NRC) regulates nuclear generating plants and spent fuel storage facilities to ensure that they are safely operated. The State of Minnesota decides as an economic and policy matter whether it is in the public interest to allow additional storage of spent nuclear fuel at the Prairie Island ISFSI such that the PINGP can continue operations until 2034.

In 2003, the Minnesota Legislature made the Public Utilities Commission (Commission) responsible for deciding whether to issue a certificate of need (CON) for spent nuclear fuel storage facilities, including expansion of such facilities (Minn. Stat. § 116C.83, Subd. 2). The legislature retained the option of reviewing Commission decisions regarding independent spent fuel storage installations (ISFSIs). In addition, the legislature required an environmental impact statement (EIS) be prepared prior to any Commission ISFSI decision (Minn. Stat. § 116C.83, Subd 6).

2.1 FEDERAL REGULATION

The U.S. Nuclear Regulatory Commission (NRC) has responsibility for regulating the nuclear fuel cycle and the use of radioactive materials, including source material (uranium and thorium), special nuclear material (enriched uranium and plutonium), and byproduct material (material made radioactive in a reactor and residues from the milling of uranium and thorium). Nuclear generating plants like the PINGP are considered part of the nuclear fuel cycle.

The NRC regulates PINGP and Prairie Island ISFSI operations through an overlapping series of federal regulations (**Table 2-1**). Section 10 of the Code of Federal Regulations (CFR) Part 20 provides "Standards for Protection Against Radiation." Part 20 includes requirements for dose limits for radiation workers and members of the public, monitoring and labeling radioactive materials, posting radiation areas, and reporting the theft or loss of radioactive material. It also includes penalties for not complying with NRC regulations.

Radiation dose limits are imposed in 10 CFR 20, 50, and 72. The NRC also enforces U.S. Environmental Protection Agency (EPA) rules on nuclear power operations (40 CFR 190 and 191) through a Memorandum of Understanding. The Minnesota Department of Health has identical requirements to the NRC for radioactive materials use (Minn. Rules Chapter 4731) and very similar requirements for x-ray machine use (Minn. Rules Chapter 4730).

Nuclear Generating Plant License Renewal

The NRC licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and NRC implementing regulations, including 10 CFR 51 and 10 CFR 54 (Requirements for Renewal of Operating Licenses for Nuclear Power Plants). NRC regulations provide for an operating license renewal period for up to 20 years beyond the initial 40-year license term.

The NRC license renewal process focuses on technical and engineering aspects of plant operations but also includes a federal environmental review component (both a generic EIS and a facility-specific supplemental EIS or ER). This federal process and these documents will cover, among other issues, the expected radiation safety and health impacts of continued operation of the plant and ISFSI, as well as a separate analysis of the impacts of generation alternatives to the continued operation of the Prairie Island plant itself. The NRC environmental review process includes a scoping process, public meetings, and opportunity for public comment.

Generic Environmental Impact Statement (GEIS) and Supplemental Environmental Impact Statement (SEIS). The NRC prepares a Generic Environmental Impact Statement (GEIS) to examine the possible environmental impacts of renewing any commercial nuclear power plant license, and, to the extent possible, establishes the significance of these potential impacts. For each type of environmental impact, the GEIS attempts to establish generic findings covering as many plants as possible.

While plant and site-specific information is used in developing generic findings, the NRC does not intend for the GEIS to be a compilation of individual plant environmental impact statements. Instead, this report may be incorporated by reference by an applicant into a license renewal application. The GEIS makes maximum use of environmental and safety documentation from original licensing proceedings and information available from state and federal regulatory agencies, the nuclear utility industry, scientific literature and plant operating experience. It allows the applicant to concentrate on those impacts that must be evaluated on a plant-specific basis. The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, is available on the NRC website:

http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/

The NRC prepares a Supplement Environmental Impact Statement (SEIS) to look potential environmental impacts that must be evaluated on a plant-specific basis. The NRC initiated development of an SEIS for the PINGP with the submission of Xcel Energy's application for a license renewal. The draft SEIS for the PINGP is scheduled to be issued in 2009. The SEIS preparation process and PINGP license renewal process is viewable on the NRC website:

http://www.nrc.gov/reactors/operating/licensing/renewal/applications/prairie-island.html#public

Environmental Report. Every facility applying to the NRC for license renewal is required to complete a plant and site-specific supplemental environmental report to deal with unique facility and location issues. NRC regulation 10 CFR 51.53(c) requires that an applicant for license renewal submit with its application a separate document entitled, *Applicant's Environmental Report - Operating License Renewal Stage*. The report is to include an assessment of the environmental consequences and potential associated mitigating actions and is to supplement the

GEIS. Appendix E to the Prairie Island license renewal application contains the environmental report for the PINGP operating license renewal.[82]

Independent Spent Fuel Storage Installation (ISFSI) License Renewals and Amendments
The NRC licenses the storage of spent nuclear fuel separately and independently of the licensing of nuclear generating plants under 10 CFR 72 (Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor Related Greater than Class C Waste). The license for spent fuel storage is a Special Nuclear Materials (SNM) license. License renewals must include technical specifications than ensure safety through design, monitoring, and administrative controls. The NRC reviews spent fuel storage systems by evaluating each design for resistance to accident conditions, e.g., earthquakes, tornadoes, and temperature extremes.

License renewals require a site-specific environmental report, similar to that for a generating plant license renewal. All spent nuclear fuel storage facilities must use storage casks that have been approved by the NRC. A list of NRC-approved spent fuel storage casks is available on the NRC website:

http://www.nrc.gov/waste/spent-fuel-storage/designs.html

Information on the NRC's licensing of spent fuel storage is also available on the NRC website:

http://www.nrc.gov/waste/spent-fuel-storage/licensing.html#public.

Prairie Island ISFSI Expansion. Three NRC licenses or license amendments will be required for the expansion of spent fuel storage at the Prairie Island ISFSI: (1) approval of the enhanced Transnuclear spent fuel storage cask (TN-40HT cask), (2) renewal of the current ISFSI license that is set to expire in 2013, and (3) an amendment to the current ISFSI license to increase the number of casks beyond the 48 currently authorized by the NRC.

The Prairie Island ISFSI is currently licensed to store spent fuel in up to 48 TN-40 vertical metal casks (24 on each of the two storage pads) under the existing site-specific license issued in October 1993 (License No. SNM-2506). The NRC license amendments to expand spent fuel storage at the ISFSI are further detailed here:

1) **Approval of the TN-40HT Cask.** The first license amendment requirement is certification that an enhanced version of the TN-40 cask, referred to as the TN-40HT cask, complies with the requirements of 10 CFR 72. The TN-40HT is very similar to the TN-40 cask in dimensions, storage capacity, and operation. It is designed to use the same handling, transfer and operating equipment as used for the TN-40 casks. The enhancements involve features that improve heat transfer and neutron absorption. These

[82] Applicant's Environmental Report – Operating License Renewal Stage, Prairie Island Nuclear Generating Plant, Nuclear Management Company, LLC, Docket Nos. 50-282 and 50-306, License Nos. DPR-42 and DPR-60, April 2008.

features will enable the TN-40HT casks to store fuel assemblies that have a higher uranium-235 enrichment and higher burn-up, i.e., energy per fuel assembly. The license amendment request was submitted March 28, 2008. The expected NRC approval date is **September** 2009.

2) **Renewal of ISFSI License**. The second license amendment requirement is renewal of the Prairie Island ISFSI license (No. SNM-2506). The license was issued in October 1993 with a 20-year term. Therefore, to continue operation beyond October 2013, the license must be renewed. Per 10 CFR 72.42, the application for renewal of a license must be filed at least two years prior to the expiration of the existing license. Thus, a submittal will be made prior to October 2011 and it is anticipated that the NRC will renew the license prior to October 2013.

3) **Increase Cask Authorization.** The third license amendment requirement is to increase the allowed number of storage casks at the ISFSI beyond the current NRC approved 48-cask limit. To house up to 35 additional casks, two new concrete storage pads would be constructed adjacent to the existing pads. Since the cask loading plans do not call for the utilization of these new storage pads until 2022, it is projected that the installation of the pads would not occur until 2020**.** To support this timeline, it is projected that the license amendment request would be submitted to the NRC sometime in 2018 with an anticipated NRC approval in 2019.

In anticipation of transporting the spent nuclear fuel stored at the ISFSI to a federal repository, Transnuclear, the designer of the TN-40 and TN-40HT casks, is requesting transportation licenses from the NRC for these casks (10 CFR 71). Transnuclear has submitted a request for the TN-40 cask. After the NRC has approved the TN-40 casks for transportation, Transnuclear plans to submit a license amendment request to license the TN-40HT cask design for transportation. It is anticipated that the NRC would approve that amendment some time in **2010**.

2.2 STATE REGULATION

In addition to federal requirements, nuclear power generating plants and independent spent fuel storage installations (ISFSIs) in Minnesota are governed by state statutes, rules, and regulatory processes.

Certificate of Need (CON) Application

The storage of spent nuclear fuel storage in Minnesota, including the expansion of an existing ISFSI, requires a certificate of need from the Minnesota Public Utilities Commission (Minn. Stat. § 116C.83, Subd. 2). The Commission determines the need for the expanded storage pursuant to Minn. Stat. § 216B.243 and rules adopted under this statute. The Commission "may make a decision that could result in a shutdown of a nuclear generating facility" (Minn. Stat. § 116C.83, Subd. 2). Prior to the granting of a certificate of need by the Commission, an environmental impact statement (EIS) must be developed for the proposed storage expansion (Minn. Stat. § 116C.83, Subd. 6).

Xcel Energy applied for a certificate of need (CON) for expansion of the Prairie Island ISFSI on May 16, 2008.[83] The application provides information on the economics and potential impacts of expanding the current ISFSI – thus allowing the PINGP to remain operating – as compared to the economics and environmental impacts of alternative storage options and energy sources. The application discusses potential human and environmental impacts from the proposed ISFSI expansion, including estimated radiation exposures and doses.

Environmental Impact Statement

An environmental impact statement (EIS) must be prepared prior to the Commission decision on a certificate of need for expanded dry cask storage (Minn. Stat. § 116C.83, Subd. 6). The EIS must discuss the potential human and environmental impacts of the proposed project and compare the impacts of the proposed project with reasonable alternatives to the project (Minn. Rules Chapter 4410.2300). Its purpose is to inform the Commission of potential human and environmental impacts, and possible mitigative measures, as it considers the CON determination.

The Minnesota Department of Commerce is the responsible governmental unit for preparation of the EIS. The Commissioner of the Department of Commerce must determine the adequacy of the final EIS (Minn. Stat. § 116C.83, Subd. 6). With respect to this document, the Commissioner must find Chapter 2 adequate in addressing those issues and potential impacts described in the scoping decision for the EIS.

Environmental Review Process

As discussed in Chapter 1, Sections 1 and 2, the EIS for the proposed Prairie Island ISFSI expansion and the EIS development process (e.g., public meeting, scoping, comment period) have been consolidated with the EIS requirements for the proposed PINGP power uprate. Chapter 1 of this document covers the proposed power uprate; Chapter 2 covers the proposed expansion of dry cask storage at the ISFSI.

When the draft EIS (DEIS) is completed, it will be issued for public review and comment, including a public meeting. Timely, substantive comments on the DEIS will be responded to and included in a final EIS (FEIS) (Minn. Rules 4410.2700). The Commissioner of the Department of Commerce must determine the adequacy of Chapter 2 of the FEIS. Concurrent with development of the FEIS, the DEIS will be entered in the record of the contested case hearing for the ISFSI expansion CON. The Commission has consolidated the hearing for the ISFSI expansion with that of the proposed PINGP power uprate.[84] Upon issuance of the report of the Administrative Law Judge from the contested case, the docket will come before the Commission for a decision on the issuance of a CON for the proposed ISFSI expansion.

[83] Certificates of Need Application, Prairie Island Nuclear Generating Plant, May 16, 2008, http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602

[84] Minnesota Public Utilities Commission, Notice and Order for Hearing, https://www.edockets.state.mn.us/EFiling/ShowFile.do?DocNumber=5373456

3.0 PROJECT DESCRIPTION

Xcel Energy is proposing to extend the concrete storage pads within the current Prairie Island ISFSI to accommodate additional dry storage casks of spent nuclear fuel. The ISFSI currently has state authorization for 29 casks. In order to operate the Prairie Island nuclear generating plant (PINGP) an additional 20 years, Xcel Energy is seeking state authorization for storage of an additional 35 casks. Thus, the total number of casks required for operations through 2034 would be 64.

The current ISFSI is constructed with concrete storage pads sufficient to place 48 casks. To place 64 casks, the concrete storage pads need to be expanded to accommodate 16 additional casks. This expansion would allow the PINGP to operate through 2034. The ISFSI is designed to accommodate storage casks necessary for decommissioning the Prairie Island plant. Additional concrete storage pads would be needed to place these casks in the ISFSI at decommissioning.

In addition, Xcel Energy is proposing to use an enhanced version (TN-40HT) of the current Transnuclear dry storage cask used at the PINGP for the expansion. The proposed project can be summarized as: (1) extending the concrete storage pads within the current ISFSI, (2) placing spent nuclear fuel from PINGP operations into the TN-40HT casks, (3) transporting and placing the casks on the storage pads within the ISFSI, and (4) monitoring the casks until removed to a federal repository.

3.1 PROJECT SETTING

The Prairie Island Nuclear Generating Plant (PINGP), including its associated Independent Spent Fuel Storage Installation (ISFSI), is located on the west bank of the Mississippi River in Goodhue County within the city limits of Red Wing, MN. The PINGP is situated on the southeastern portion of Prairie Island, an outwash terrace above the Mississippi River. The plant site is located at an elevation of 690 feet above mean sea level (MSL), about 15 feet above the normal pool elevation of the river. The general area is nearly level, with a local relief ranging from about 675 feet above MSL (along the river frontage) to about 700 feet above MSL.

At the plant location, the Mississippi River serves as the state boundary between Minnesota and Wisconsin. The Mississippi River at this location is known as Sturgeon Lake, a backwater area located approximately one mile upstream from the U.S. Army Corps of Engineers (USACE) Lock and Dam 3. The Vermillion River lies just west of the PINGP and flows into the Mississippi River approximately two miles downstream of Lock and Dam 3.

The PINGP site comprises approximately 578 acres of land, owned in fee by Northern States Power, a subsidiary of Xcel Energy. Access to the site is controlled and there is an enforced exclusion zone. On Prairie Island, access to the exclusion zone is restricted by a perimeter fence with “No Trespassing” signs. East of the plant the exclusion zone boundary extends to the main channel of the Mississippi River. Islands within this boundary as well as a small strip of land northeast of the plant are owned by USACE. An agreement exists with USACE such that no residences will be built on that strip of land or islands within the exclusion zone for the life of the plant.

The Prairie Island Indian Reservation is located directly north of the Prairie Island site. The Prairie Island Indian Community (PIIC) is a Federally Recognized Indian Tribe organized under the Indian Reorganization Act (25 USC 476). The reservation population is approximately 250 persons; the total enrollment of the tribal community is approximately 760 persons. The Prairie Island Indian Community owns and operates the Treasure Island Resort and Casino, which includes a hotel and convention center.

ISFSI Setting

The Prairie Island ISFSI is located approximately 300 yards west of the main generating plant at an elevation of 694 feet above MSL (**Figure 3-1**).

The ISFSI consists of a lighted area, approximately 720 feet long and 340 feet wide, roughly 5.5 acres in size. The tallest structures are the light poles that are approximately 40 feet tall. Two fences surround the facility with a monitored, clear zone between the two fences. Within the storage area, the casks are currently stored on two reinforced concrete pads, 36 ft. x 216 ft. x 3 ft. The additional casks necessary to support PINGP operations through 2034 would reside on new 18 ft. concrete pads to be located immediately south of each of the existing concrete pads (**Figure 3-2**, proposed new concrete pads shaded).

The approach to the pads consists of 14 inches of compacted Class 5 aggregate with a 2% slope. A 30 ft. x 50 ft. steel frame equipment storage building approximately 30 feet high is located on the ISFSI site. The primary purpose of this building is to store the cask transport vehicle. A smaller block building within the ISFSI houses the security equipment while one outside the ISFSI houses the pressure monitoring equipment. A 17 ft high earthen berm surrounds the ISFSI. The site is monitored with cameras and other security devices. An access road connects the ISFSI to the rest of Prairie Island.

The current NRC licensed capacity of the ISFSI is 48 TN-40 storage casks. The proposed extension of the storage pads will be sufficient to accommodate an additional 16 casks. The storage facility is laid out so that the storage pads could be extended to the north and south to accommodate a total of 100 casks without having to change the security perimeter. The extra space could be used for casks to decommission the Prairie Island plant.

3.2 INDEPENDENT SPENT FUEL STORAGE INSTALLATION EXPANSION

The proposed Prairie Island ISFSI expansion project consists of: (1) extending the concrete storage pads within the current ISFSI, (2) placing spent nuclear fuel from PINGP operations into Transnuclear TN-40HT casks, (3) transporting and placing the casks on the storage pads within the ISFSI, and (4) monitoring the casks until removed to a federal repository.

Extending the Concrete Storage Pads within the ISFSI

The Prairie Island ISFSI was granted a federal operating license in October 1993. In 1994, the Minnesota Legislature granted Xcel Energy permission to store a limited amount of spent nuclear fuel in dry storage casks at an on-site ISFSI. ISFSI construction was completed in 1995; the first cask was loaded and placed on the ISFSI pad in May 1995. There are currently (2008) 24 casks on the ISFSI pad.

In order to store an additional 16 casks, two new pads will need to be constructed. Construction of each new pad will consist of pouring an 18 ft. wide x 216 ft. long x 3 ft. thick slab. In addition, underground concrete duct banks and associated electrical conduit will need to be installed from the cask monitoring building to the new pads. The work will include excavation of the pad area, trenching of the duct bank path, pouring the concrete pad and duct bank, and replacing the structural fill. Site preparation will involve using earth moving equipment such as bull dozers, scrapers, backhoes, and graders to excavate and level the pad and duct bank areas. Following the leveling of the area, reinforced steel, conduit, and forms will be put in place and concrete will be poured forming the storage pads and duct banks. Concrete trucks will deliver concrete to the site and pumping trucks will place it. The area around the pad and trench over the duct bank will be back-filled and returned to the 2% grade when complete.

During construction it is anticipated that storm water will drain into the existing structural fill within the ISFSI and into drainage ditches. Construction measures will be taken to ensure that there are no point discharges from the site into flow routes that discharge into the Mississippi River. Sediment controls such as geo-textiles will be used to minimize soil sediment runoff into drainage ditches.

Prior to any construction activities, a radiation survey of the work area near the existing dry storage casks will be performed. A plan to limit radiological doses to construction workers will be developed based dose rates in these areas. The plan will utilize standard radiation practices, e.g., time, distance and shielding. It is not anticipated that excavated fill (aggregate) will become activated or contaminated by radioactive materials. If monitoring of the ISFSI reveals ground water or soil contamination at the site, the fill would be tested prior to its removal from the site and disposed of properly.

The primary function of the concrete storage pads is to provide a uniform level surface for storing the casks. The pads are designed to prevent unacceptable levels of cracking or settlement under normal and off-normal loads. Since the cask loading plans do not call for the utilization of these new storage pads until 2022, it is projected that the installation of the pads would not occur until 2020.

Loading and Transporting Dry Storage Casks to the ISFSI

The loading of spent nuclear fuel into dry storage casks and the transportation of these casks to the ISFSI will utilize processes and safeguards very similar, if not identical, to those currently used at the PINGP. The process will use the same fuel source (the spent nuclear fuel pool at the PINGP), the same lifting and handling devices, the same transport vehicle, and the same ancillary equipment. The primary difference will be the use of the enhanced Transnuclear cask (TN-40HT) and the loading of spent fuel with a higher fuel loading and burnup.

Operations. When it is time to load spent fuel assemblies, a TN-40HT cask is placed in the PINGP auxiliary building and lowered into the spent fuel pool. Fuel assemblies (40 assemblies per cask) are loaded into the cask and the lid for the cask is installed underwater. The cask is lifted from the pool, drained, and moved to a cask decontamination area. In the decontamination area, the outer surface of the cask is decontaminated. The cask is vacuum dried, backfilled with helium, and a helium leak test of the cask seals is performed.

The decontaminated cask is placed into a specialized cask transport vehicle (CTV). A neutron shield is placed on the cask top. The cask's overpressure system is pressurized and tested. A final protective weather cover is attached, and the cask is moved via the CTV to the ISFSI and placed on the pad.

Dry Storage Cask, TN-40HT. All spent nuclear fuel storage casks must be licensed by the NRC and meet design criteria established by 10 CFR 72. Storage casks are designed to ensure that: (1) fuel critically is prevented, (2) cask integrity is maintained, and (3) fuel is not damaged so as to preclude its removal from the cask. These design criteria must be met for normal operations and for off-normal events including natural phenomena (e.g., tornadoes, floods) and man-made accidents (e.g., missiles).[85]

The Prairie Island ISFSI currently uses the Transnuclear TN-40 cask. Xcel Energy proposes using this cask for storage of spent fuel in casks number 1 through 29 at the ISFSI. Starting with cask number 30, Xcel Energy proposes using an enhanced version of the Transnuclear cask, the TN-40HT. Use of the TN-40HT cask is dependent upon approval by the NRC of the cask for use at the Prairie Island ISFSI. A license amendment application was submitted to the NRC on March 28, 2008, requesting that the enhancements to the TN-40HT cask be found to comply with the requirements of 10 CFR 72. It is anticipated the NRC will issue the amendment to the license in 2009.

The TN-40HT cask is an enhanced version of the TN-40 dry fuel storage cask (**Figure 3-3**). The TN-40HT cask is designed to hold 40 fuel assemblies and will allow for storage of relatively more highly enriched fuel and greater burnups. A cask consists of an internal basket, containment vessel, lid, outer shell, neutron radiation shields, and a weather cover.

The cask is designed to be an independent, passive storage system which does not rely on other systems or components for operation. Individual casks are approximately 8 ft. in diameter, 16 ft. tall, and weigh approximately 240,000 lbs. when loaded.

[85] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section 3.2

The TN-40HT cask consists of two concentric shells. The containment vessel is the inner most cask shell and is a 1.5-inch thick carbon steel cylinder with a welded carbon steel plate at the bottom. The vessel includes stainless steel boxes (fuel basket) separated by heat conduction and neutron absorption plates. The stainless steel box geometry provides structural rigidity to support the fuel assemblies. At the top of the containment vessel is a flange, which provides the positioning and sealing surface for the bolted carbon steel lid. The lid is 10 inches thick and is attached to the upper vessel flange by 48 bolts. Two metallic O-rings are installed on the lid to provide a redundant seal, capable of being monitored, between the flange and the lid.

The outer cask shell is a 7.25-inch thick steel cylinder. It is welded to a 7.25-inch bottom shield plate and to the containment vessel closure flange, thereby enclosing the containment vessel inner shell and bottom plate. Attached to the shell are resin filled containers arrayed vertically and surrounding the shell. The resin contains neutron-absorbing material to reduce neutron radiation levels. A circular neutron shield disk provides neutron shielding on the lid during storage. In order to keep the cask lid clean and to avoid the accumulation of water in recesses of the cask lid, a weather cover is provided above the cask lid. The resultant overall dimensions of a cask are an outer diameter of 101 inches and a height of approximately 200 inches.

The TN-40 cask is currently licensed to store spent fuel assemblies with a maximum burnup of 45 giga-watt days/metric ton of uranium (GWD/MTU), maximum enrichment of 3.85 wt. % U235, and a minimum cooling time of 10 years after reactor discharge. The TN-40HT cask is expected to be licensed to accommodate a maximum burnup of 60 GWD/MTU, maximum enrichment of 5.0 wt. % U235, a minimum cooling time of 12 years after reactor discharge, and a thermal capacity of 32 kW (0.8 kW per fuel assembly).

Though the TN-40HT cask is nearly identical to the TN-40 cask, the TN-40HT cask includes enhancements to safely accommodate higher enrichment and burnup fuel. These enhancements include: (1) making the fuel basket structurally stronger by increasing the thickness of fuel cell compartment walls, (2) improving heat transfer capability by utilizing aluminum plates between fuel compartments that improve heat conduction from the center of the cask to the cask body, and (3) increasing the concentration of neutron absorbing material in the fuel basket itself.

Monitoring, Inspection, and Maintenance

The Prairie Island ISFSI is designed to be a passive storage system. However, there is monitoring and maintenance that is required to ensure the casks are operating properly and that they can maintain proper functioning throughout the life of the ISFSI.

The double seal (O-ring) system on the TN-40HT cask is pressurized with helium to approximately 5.5 atmospheres (80 pounds per square inch, psi). This pressure is monitored by a transducer which, via a pressure transmitter mounted on the side of cask, sends an electronic signal to the ISFSI monitoring system. The monitoring system is checked daily. Should the pressure in the seal drop, it would indicate that either: (1) the inner seal may have failed and helium is leaking into the cask, or (2) the outer seal may have failed and helium is leaking into the space between the lid and protective cover. Additionally, it could be that there is a malfunction in the monitoring system. PINGP personnel would immediately investigate the cask and indicated pressure drop. If necessary, the cask would be returned to the auxiliary building and the cask seals repaired or replaced.

The first dry storage cask was placed in the Prairie Island ISFSI in 1995. Since that time, there have been eight low-pressure alarms at the ISFSI. All eight alarms were due to a leak in the monitoring system tubing or pressure transmitter. None of the alarms were caused by a cask seal leak. Accordingly, no casks, to date, have been removed to the auxiliary for cask seal repair. Casks are visually inspected periodically for signs of weathering. The casks are painted with a corrosion-inhibiting coating. This coating is inspected and touched up as necessary.

The minimum design life for the TN-40 series of Transnuclear casks is 25 years.[86] However, due to the passive nature of the dry storage casks and the robustness of their components, it is anticipated that the ISFSI could physically be operated for several hundred years. The extent and possible impacts of temporary, long-term storage of spent nuclear fuel at the Prairie Island ISFSI are discussed further in Sections 4 and 5 of this chapter.

Security for the Prairie Island ISFSI is provided by the PINGP security force. Access to the ISFSI is controlled. The ISFSI is surrounded by two security fences with an intrusion detection system and a monitored clear zone. The intrusion detection system would alert the PINGP security force in the event of an unauthorized attempt to enter the ISFSI. Lighting and video cameras will provide video monitoring to assist the security force. The ISFSI perimeter is patrolled by plant personnel at least once per shift. The ISFSI (including casks and berm) are inspected quarterly to ensure proper functioning of the ISFSI. Any maintenance indicated by these inspections is then performed.

Project Costs

The estimated installed cost of the ISFSI in 2008 dollars is $155.7 million. The estimate includes the following component costs:

Component	Cost (millions)
State Regulatory Processes	$2.0
Cask Licensing	$4.6
ISFSI Construction	$3.0
ISFSI Re-licensing	$2.8
35 TN-40HT casks	$143.3
TOTAL	**$155.7**

[86] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Table 3.4-1, Design Criteria for the TN-40 Casks.

3.3 SPENT FUEL INVENTORY

Spent nuclear fuel from PINGP operation is temporarily stored in the spent nuclear fuel pool in the PINGP auxiliary building. The pool provides the means to safely handle and manage the spent fuel assemblies. Additionally, storage in the pool allows the fuel assemblies to cool with respect to thermal and radioactive emissions so that they can be safely stored in dry casks.

The spent nuclear fuel pool is filled with storage racks that hold the spent fuel assemblies and other irradiated reactor components. The depth of water in the pool is approximately 37 feet The spent fuel pool is equipped with redundant cooling systems to remove heat that continues to be generated by the assemblies. The filtering portion of the system maintains pool water chemistry and removes suspended particles. The water above the spent fuel also provides radiation shielding. The spent fuel pool also provides an area for cask loading operations (**Figure 3-4**). Space is set aside so that a cask may be lowered into the pool and assemblies transferred to it for dry storage or transport ("cask lay down area"). Spent fuel assemblies are placed in the pool for between 10 and 12 years to cool before they can be placed in dry casks for storage.

Xcel Energy's NRC operating licenses allow for long-term storage of up to 1,386 spent fuel assemblies in the spent fuel pool. As of April 2008, there were 1,149 spent fuel assemblies in the spent fuel pool. Four storage racks, with a combined capacity of 196 assemblies, may be installed in the cask lay down area to provide additional temporary storage. The PINGP maintains the ability to temporarily remove all of the fuel from both reactors (referred to as full core offload capability) with the use of these temporary storage racks.

Refueling of the PINGP reactor cores takes place every 18 to 20 months. Approximately one third of the fuel assemblies in the core are replaced with new assemblies at each refueling. As of April 2008, 2,109 spent fuel assemblies had been discharged from the PINGP, of which 1,149 reside in the spent fuel pool and 960 in 24 dry casks. Xcel Energy estimates that 1,786 spent fuel assemblies will be discharged from Prairie Island's reactors during operation between April 15, 2008 and 2034 (**Table 3-1**).

3.4 PLANT CLOSURE and DECOMMISSIONING

When the operating license for the PINGP expires, the plant will be removed from service, decontaminated, and dismantled. Non-radioactive deconstruction would be handled in a conventional fashion, with extra precautions for workers handling low-level radioactive waste and contaminated debris. Spent nuclear fuel will be managed and stored based on storage alternatives available at the time the plant is removed from service.[87] It is anticipated and most likely that spent fuel would be stored in the spent nuclear fuel pool until such time as it could be transferred to dry casks and transported to the Prairie Island ISFSI.

[87] See Section 6.0 for a discussion of spent fuel storage alternatives.

The Prairie Island ISFSI will be decommissioned once all spent fuel stored in dry casks has been transported to an off-site facility. It is anticipated that the TN-40 and TN-40HT casks will be licensed for transportation by the NRC[88]. The federal government will take title to the casks when they are transported to a federal repository. This leaves only the concrete storage pads and supporting infrastructure to be disposed of by Xcel Energy. Since the casks are sealed, no radioactive materials will be present once the casks and spent fuel have been shipped. No activation of the concrete in the storage pads is expected. A survey will be conducted to ensure that no activation has occurred. Once it is confirmed that no activation has occurred, the concrete storage pads and infrastructure will be dismantled, and the site will be returned to a green field state. If limited activation has occurred, deconstruction of the storage site would be handled appropriately, with precautions and mitigation measures for dealing with any low-level radioactive components (e.g., reinforcing steel).

Funding for Decommissioning

A nuclear decommissioning trust fund (NDT) has been established per NRC regulations to cover the costs of decommissioning the PINGP and Prairie Island ISFSI. The NDT for Prairie Island includes funds for radiological removal of the plant, site restoration, and ISFSI operations. ISFSI operations included in the fund are for operating the ISFSI after plant shutdown until all fuel is removed from the site and then the removal of the ISFSI structures.

The monies placed in the NDT are recovered through rates from Xcel Energy customers. The Minnesota Public Utility Commission reviews the funds collected from ratepayers and placed into the NDT triennially. A triennial review is currently underway for 2009 accruals (Commission docket number: E002/M-08-1201).

In 2008 dollars, the current cost estimates for decommissioning are: $1.026 billion for radiological removal, $83.7 million for site restoration, and $404 million for ISFSI operations. Recognition of these ISFSI operating costs in the NDT is not intended to acknowledge that these costs will ultimately be borne by Xcel Energy or its ratepayers, as some costs (or all) are expected to be the responsibility of the U.S. Department of Energy as a result of the breach to the Standard Contract of Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste.[89] The NRC reviews the level of funding every 2 years and by the Minnesota Public Utility Commission every 3 years to ensure that the NDT has sufficient funds.

[88] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 2.5.1.2. On August 7, 2006, Transnuclear Inc. requested from the NRC a transportation license for the TN-40 casks pursuant to 10 CFR 71.

[89] Under federal court decisions, the U.S. Department of Energy (DOE) has been found liable for damages attributable to delays in accepting spent nuclear fuel for placement in a federal repository; *Maine Yankee Atomic Power Company v. United States*, 225 F.3d 1336 (Fed. Cir. 2000), *Northern States Power Company v. United States*, 224 F.3d 1361 (Fed. Cir. 2000).

4.0 HUMAN AND ENVIRONMENTAL IMPACTS (NON-RADIOLOGICAL)

This section addresses the non-radiological impacts on human economies and the environment resulting from the proposed 35-cask expansion of the Prairie Island ISFSI. In addition, it discusses non-radiological impacts from two related actions – the continuing operation of the Prairie Island Nuclear Generating Plant (PINGP), and the continuing operation of the ISFSI. Radiological impacts are discussed in Section 5 of this chapter.

4.1 GEOLOGY and SOILS

The expansion of the ISFSI will not have a significant impact on the geology or soils of the area. The ISFSI expansion will occur entirely within the confines of the existing ISFSI. No geologic or soil resources within the PINGP site are anticipated to be disturbed.

The Prairie Island ISFSI is constructed on alluvial soils (loamy sands) which are supported by sedimentary rock of the St. Lawrence and Franconian formations. The existing concrete storage pads within the ISFSI are three feet thick. The area within the ISFSI that is not currently used for storage pads is covered with compacted aggregate. Thus, within the ISFSI there are no undisturbed soils which could be impacted by the expansion of the concrete storage pads. Movement of equipment used for construction of the new concrete pads within the ISFSI may cause some erosion to unpaved roads within and near the PINGP site. This erosion is anticipated to be minimal.

4.2 BIOLOGICAL and ECOLOGICALLY SENSITIVE RESOURCES

Expansion of the Prairie Island ISFSI will not have a significant impact on biological and ecologically sensitive resources. The ISFSI expansion will occur entirely within the confines of the existing ISFSI. Neither the construction of the new concrete storage pads, nor the pads and dry storage casks themselves will impact high quality habitat for flora or fauna.

Fauna

The PINGP and Prairie Island ISFSI are located near the Mississippi River and its associated riparian and wetland habitats. There are numerous wetlands within five miles of the Prairie Island ISFSI, all associated with the floodplains of the Mississippi, Cannon, and Vermillion rivers. These wetland habitats and nearby upland habitats support a diversity of fauna, including fish, mollusks, turtles, frogs, birds, waterfowl, muskrats, and raccoons.[90] The habitats are also part of the larger Mississippi River flyway ecosystem that supports migration of birds and waterfowl between the Americas. The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact these habitats. Construction will occur within the current ISFSI, which provides little or no habitat for fauna.

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[90] Prairie Island Nuclear Generating Plant, License Renewal Application, Appendix E – Environmental Report, Section 2.3 Biological Resources.

The new concrete pads will add approximately one acre of impervious surface to the ISFSI. This surface will not impact the quality of water runoff from the ISFSI, but will slightly increase the quantity of runoff from the ISFSI. This additional runoff is anticipated to be minor such that it will not impact habitat for regional or migratory fauna. The energy in the additional runoff water will be mitigated by physical barriers that are part of the existing ISFSI, e.g. berm, rip-rap.

Noise due to construction activities at the ISFSI may be intrusive to some fauna. However, noise levels during construction will be only slightly higher than ambient levels (local traffic, trains) and will remain below the Minnesota daytime code limit of 60 dBA.[91] Noise impacts are discussed further in section 4.6.

Flora

Of the 578 acres that comprise the PINGP site, approximately 338 acres have been undisturbed by the construction of the PINGP and Prairie Island ISFSI. This acreage is covered with non-native herbaceous species (e.g. brome grass), shrubs, and trees. Common trees include elms, cottonwoods, ashes, box elders, and burr oaks. The PINGP site itself is surrounded by the Richard J. Dorer Memorial Hardwood State Forest. Wetland plant communities are found around, adjacent to, and, in some places, within the PINGP site. For example, the area roughly between the ISFSI and PINGP cooling towers includes portions of floodplain forest.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact the region's flora. Construction will occur within the current ISFSI, with little or no disturbance of acreage within the PINGP site.

Threatened and Endangered Species

Within counties near the PINGP site there are approximately 60 animal species and 30 plant species that are of special concern. These are species that are federally-listed or state-listed as threatened or endangered, species proposed for federal listing, candidates for federal listing, and species state-listed as species of special concern.[92] Of these, seven species are found within one mile of the PINGP site: Higgins Eye pearlymussel, peregrine falcon, Blanding's turtle, paddlefish, and mucket, washboard, and butterfly mussels. The Higgins Eye pearlymussel is federally listed; the other six species are state-listed.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not significantly impact these species. Construction and operation of the expanded ISFSI will not significantly impact water and wetland habitats upon which most of these species rely. Peregrine falcons have nested in a nest box on the PINGP Unit 1 containment dome since 1997. They are apparently habituated to activities at the PINGP and will likely not be impacted by construction or operations at the Prairie Island ISFSI.

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[91] Minn. Rules 7030.0040. The daytime limit is expressed as an L_{50} level of 60 dBA. L_{50} means the sound level is exceeded 50 percent of the time.
[92] Prairie Island Nuclear Generating Plant, License Renewal Application, Appendix E – Environmental Report, Section 2.3.3 Threatened or Endangered Species, Table 2.3-1.

4.3 WATER RESOURCES

Expansion of the Prairie Island ISFSI is not expected to have a significant impact on water resources. The expansion will not impact nearby riverine or wetland resources. It will withdraw a small amount of water from the Mississippi River for construction purposes. It will not impact groundwater resources.

Water Resources

There are bountiful water resources within five miles of the PINGP site, including the Mississippi River, local tributaries (Cannon, Vermillion, Trimbelle rivers), and associated wetlands. The PINGP site is located on Sturgeon Lake, a backwater area of the Mississippi River created by Lock and Dam Number 3. The Cannon, Vermillion, and Trimbelle rivers enter the Mississippi River near and just south of this dam.

The Mississippi National River and Recreation Area extends from north of Minneapolis, MN to just south of Hastings, MN. This recreation area is approximately 6 miles north of the PINGP site. The Cannon River is a designated State Wild and Scenic River. A large wetland complex, the Rice Lake Bottoms, is located at the confluence of the Cannon and Mississippi rivers, approximately 3 miles south of the PINGP site. There are numerous wetlands associated with Sturgeon Lake and Pool Number 3, the Mississippi River pool created by Lock and Dam Number 3.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not significantly impact these water resources. Construction will occur within the current ISFSI, with little or no disturbance of acreage within the PINGP site. Construction of the new storage pads will require the excavation of approximately 864 cubic yards (CY) of existing aggregate and subsoil within the ISFSI. Movement of these materials will occur within a facility with existing runoff controls, thus the possibility of impacting water resources is minimal. Practices to minimize run-off and erosion will be employed during construction – e.g., strategic placement of hay bales, silt fencing, geo-textiles, and in-situ vegetation. Xcel Energy will **coordinate** with the Minnesota Pollution Control Agency as to the permit(s) required, **e.g., construction stormwater permit,** for expansion of the ISFSI.

The new concrete pads will add approximately one acre of impervious surface to the ISFSI. This surface will not impact the quality of water runoff from the ISFSI, but will slightly increase the quantity of runoff from the ISFSI. The energy in the additional runoff water will be mitigated by physical barriers that are part of the existing ISFSI, e.g. berm, rip-rap.

Water Use

Water use due to the construction of new concrete storage pads and the operation of the casks and ISFSI will be minimal. Xcel Energy proposes drawing water from the Mississippi River for dust control purposes. This amount is estimated at approximately 53,000 gallons total over the course of construction. The ISFSI itself uses no water for operations. Expansion of the ISFSI will not change water use at the PINGP.

Groundwater Quality

Groundwater at the PINGP site moves generally toward the Mississippi River and its tributaries. On outwash terraces such as the one upon which the PINGP and Prairie Island ISFSI are situated, groundwater levels coincide closely with river elevation. Additionally, because the terraces are formed from permeable alluvial soils, the groundwater table responds quickly to changes in river elevation.

The approximate river elevation at the PINGP site is 675 ft. above mean sea level (MSL). The ISFSI is constructed at an elevation of 694 ft. MSL, with the top of the storage pad at **694.5** ft. MSL. Thus, it is approximately **19.5** feet to groundwater from the ISFSI surface; however, this distance varies readily with river elevation.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact groundwater resources. There are no effluents from the ISFSI. There are no borings, holes, or other channels within the ISFSI that could reach groundwater and commute surface pollutants. The requirements of Minn. Stat. § 116C.83, Subd. 6(b) regarding radiological groundwater standards are discussed in Section 5.

4.4 CULTURAL and HISTORICAL RESOURCES

Expansion of the Prairie Island ISFSI will not have a significant impact on cultural and historical resources. There are 60 properties on the National Register of Historic Places in Goodhue County. There are seven properties listed in Pierce County, WI, across the Mississippi River from the PINGP site. The Final Environmental Statement (FES, 1973) for the PINGP identified three sites with historical significance within six miles of the Prairie Island plant.[93] One of these, the Barton Site, was added to the National Register of Historic Places in 1970. The site appears to have been inhabited by people of the Oneota culture sometime between 1050 and 1300 A.D.

The Prairie Island Indian Community (PIIC) is located directly north of the PINGP site. The PIIC is home to the Mdewankanton Band of Eastern Dakota. The lands and waters of the PIIC are a cultural and historic resource. These lands and waters encompass over 3000 acres.

The Mississippi River and its associated parks, trails, and roads are cultural resources for the area. The Mississippi National River and Recreation Area is located upriver from the PINGP site. The Mississippi River corridor in the region is a scenic byway designated as the "Great River Road." The Road is comprised of U.S. Highway 61 in Minnesota and Wisconsin Route 35 in Wisconsin. Additional cultural resources include state wildlife management areas, state forest areas, and boating areas. The A. P. Anderson County Park is approximately 5 miles south of the PINGP. The Cannon Valley Trail, which follows the Cannon River, offers biking, hiking, skating, and skiing opportunities.

[93] Prairie Island Nuclear Generating Plant, License Renewal Application, Appendix E – Environmental Report, Section 2.10 Historic and Archaeological Resources.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact these cultural and historical resources. Construction will occur within the current ISFSI and will utilize existing facilities on the PINGP site (e.g., roads). No historic or cultural resources will be disturbed by the expansion of the ISFSI or ongoing ISFSI operations. Noise due to construction activities at the ISFSI may temporarily impinge on the enjoyment of some cultural resources. However, noise levels during construction will be only slightly higher than ambient levels (local traffic, trains).

4.5 TRAFFIC

Expansion of the Prairie Island ISFSI will not have a significant impact on local transportation resources and no traffic mitigation measures are warranted for construction of the project. No additional staff persons are required for operation of the expanded ISFSI. Operation of the ISFSI creates no new traffic impacts.

Construction of the new concrete storage pads within the ISFSI will create traffic impacts. These impacts are anticipated to be minimal. Construction of the new pads is expected to be completed in a 4 week period. Xcel Energy projects that during this time period 6 additional construction labor workers will be commuting to the ISFSI work site. Trucks will be used to deliver construction supplies to the work site, including structural fill, rebar, and concrete. During the weeks when supplies are delivered, Xcel Energy projects approximately 24 additional truck trips per day on roads leading to the ISFSI work site. These roads include U.S. Highway 61, Prairie Island Blvd., and Sturgeon Lake Rd. These are major roads in good condition such that they can easily handle the additional construction traffic or minor roads with very limited use such that they can accommodate a temporary increase in traffic.

4.6 NOISE

Expansion of the Prairie Island ISFSI will not create significant noise impacts. Impacts from operations of the ISFSI are minimal and primarily reflect ambient noise levels from operations at the PINGP. There will be additional noise impacts related to construction of the concrete storage pads within the ISFSI. These impacts are expected to be minimal.

Construction at the ISFSI site will generate noise. Noise will be generated primarily by the operation of heavy equipment, e.g., bulldozers, dump truck, backhoes, and concrete trucks. Xcel Energy has compared projected construction noises with ambient noise levels at six locations around the PINGP site.[94] Ambient noise levels are highly dependent on location. For example, daytime ambient noise levels at the Prairie Island Casino are in the range of 45 dBA, due primarily to casino related traffic. Daytime ambient noise levels at rural residences are in the range of 35 dBA.

[94] Prairie Island Nuclear Generating Plant, Certificates of Need Application, May 16, 2008. Section 7.3.9, Table 7-8.

Xcel Energy projects construction noises in the range of 40-55 dBA. Thus, some citizens will experience noise impacts of 10-20 additional dBA; other citizens will experience no increase in noise. For those citizens who are impacted, the additional noise impact is limited in extent and duration. The impact will be below the Minnesota daytime code limit (60 dBA). It will occur only during daytime hours, and only during the 4-6 weeks of construction.

The noise impacts from operation of the Prairie Island ISFSI will be the occasional placement of spent fuel casks on the ISFSI pad. Noise levels related to the transport of a cask are approximately equal to that of construction (use of heavy machinery) but of less duration (one or two days per year).

4.7 SOCIOECONOMICS

Expansion of the Prairie Island ISFSI will not have a significant impact on the socioeconomics of the region. The expanded ISFSI will require no additional workers for operations. There will be a small positive impact due to the need for laborers during construction of the concrete pads within the ISFSI. Xcel Energy projects employing 13 additional workers at the ISFSI site over the one-month construction period. Additionally, local companies that supply and transport materials for the construction project will experience a small positive economic impact. Construction of the ISFSI expansion is schedule for 2020. Thus, economic impacts related to construction activities will not occur until that year.

4.8 VISUAL IMPACTS and AESTHETICS

Expansion of the Prairie Island ISFSI will not create significant visual or aesthetic impacts. The ISFSI is situated within a wooded area on the PINGP site and surrounded by a 17 foot high earthen berm. It is not visible from the Mississippi River or adjacent properties. The ISFSI is illuminated for security purposes. However, the light fixtures are approximately 40 ft. high, which is lower than many of the trees surrounding the site.

The illumination of the ISFSI and that of the Prairie Island plant create a small visual impact for persons attempting to enjoy a dark night sky in the area (e.g., stargazing). It is difficult to mitigate this impact. However, this is an existing impact and independent of the ISFSI expansion. The expansion of the ISFSI will not create new or additional visual impacts.

4.9 HEALTH and SAFETY

The health of citizens is dependent upon the health of the ecosystems in which they live and work. The discussions in this section related to ecosystem health, e.g., biological resources and water resources, indicate that the expansion of the Prairie Island ISFSI will not have a significant non-radiological health impact on citizens.

There are very few aspects of health that can be extracted and considered outside of the natural environment. Two health concerns related to the built environment are considered here: (1) the possible impacts to the psychological health of citizens, and (2) the possible radiological health impacts to citizens. Psychological health impacts are discussed in Chapter 1, Section 4.5 of this EIS. Possible radiological impacts are discussed are discussed in Chapter 2, Section 5 of this EIS.

Expansion of the Prairie Island ISFSI will not pose significant non-radiological safety risks and all related possible impacts to citizens (e.g., fall, burn) are minimal. Pursuant to NRC regulations, Xcel Energy maintains an emergency plan for all activities at the PINGP site. As access to the PINGP site is controlled, non-radiological safety incidents involving the general populace are extremely rare. The far greater exposure to safety incidents is to plant personnel. The Prairie Island ISFSI is part of a large industrial facility. As such, there are risks to plant personnel typical of an industrial facility. Xcel Energy implements safety programs to reduce the impact of such risks, e.g., spill prevention plan. It is not anticipated that expansion of the Prairie Island ISFSI will increase risks or introduce new risks to plant personnel that are not well managed by these safety programs. The PINGP had no lost workdays to worker injuries in 2007 or 2008. In 2008, it received a Governor's Safety Award for its safety performance record. **If, however, elements of the emergency response plan for the PINGP are not effective, e.g, governmental entities with emergency responsibilities cannot adequately respond, risks may not be well managed.**

4.10 CUMULATIVE IMPACTS

Cumulative impacts are impacts on the environment that result from the incremental effects of a project in addition to past, present, and reasonably foreseeable future projects regardless of who undertakes these projects.[95] Two reasonably foreseeable future projects are considered here: (1) continued operation of the PINGP until 2034, and (2) use of the ISFSI to facilitate decommissioning of the PINGP after cessation of operations.

Operation of the PINGP Through 2034

If Xcel Energy is granted a certificate of need to expand the storage capacity of the Prairie Island ISFSI by 35 dry storage casks, it is foreseeable that the PINGP will continue operating an additional 20 years past its original license term. Xcel Energy has submitted an operating license renewal application to the NRC to allow continued operation of Prairie Island Units 1 and 2 until 2033 and 2034 respectively.

The potential impacts of the continued operation of the PINGP are discussed in Chapter 1 of this EIS. It's anticipated that no new or additional impacts, beyond those discussed in Chapter 1, would occur if the PINGP continued operations through 2034. **Xcel Energy acquires and maintains permits from state agencies for operations at the Prairie Island plant. These agencies, e.g., Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, are charged with protecting the natural resources of the State of Minnesota and associated public health. Xcel Energy will be required to maintain these permits through**

[95] Minn. Rules 4410.0200, Subp. 11.

2034 should the proposed ISFSI expansion be approved by the state. Accordingly, there will be no new, additional, or otherwise unmanaged impacts beyond those discussed in Chapter 1 if the PINGP continued operations through 2034.

Use of the ISFSI to Facilitate Decommissioning

If the PINGP operates through 2034, it is foreseeable that the plant would cease operations at that time and undergo decommissioning. In the decommissioning process, spent nuclear fuel would need to be temporarily stored (e.g., in the spent nuclear fuel pool) until it could be placed in temporary, long-term storage (Prairie Island ISFSI) or in a federal geologic repository. Although there is uncertainty as to the storage alternatives that will be available in 2034, a likely scenario is temporary long-term storage of spent nuclear fuel at the Prairie Island ISFSI until the dry storage casks can be transported to a federal repository. In this scenario, approximately 34 additional casks would be needed for decommissioning, creating a total of 98 casks on the ISFSI pad upon removal of all spent nuclear fuel from the plant.

Given the uncertainty as to when a federal repository will be available to accept casks from the Prairie Island ISFSI, this document assumes, for analysis purposes only, that the casks (a total of 98) will be at the ISFSI for up to 200 years. Potential radiological impacts from the long-term storage of the casks are discussed in Chapter 2, Section 5. Potential non-radiological impacts are discussed here.

As discussed in this section, the non-radiological impacts related to the expansion of the Prairie Island IFSI are not significant. Additionally, operation of the ISFSI, an essentially passive, monitored structure, poses no significant non-radiological impacts. If an additional 34 casks will be need for decommissioning, an expansion of the pad at the Prairie Island ISFSI very similar to the currently proposed expansion (35 casks) would be required. The ISFSI site is designed such that it can be expanded to accommodate 98 casks. Thus, sometime around 2030, a second expansion of the concrete pads within the ISFSI would be likely. Once this expansion is constructed, the ISFSI would require no further structural changes to store 98 casks.

Construction of new storage pads and operation of the ISFSI most likely presents no significant non-radiological impacts for storage of 98 dry storage casks for up to 200 years. Man-made and natural phenomena could occur during this 200-year period that would introduce substantial non-radiological impacts to the region, e.g., flood, earthquake. However, the marginal impact due to the continued operation of the ISFSI within such phenomena would be insignificant.

5.0 RADIOLOGICAL IMPACTS

This section discusses the radiological impacts expected due to normal operations and to incidents and off-normal operations at the Prairie Island ISFSI. Additionally, it assesses potential radiological impacts from two related actions – the continued operation of the Prairie Island Nuclear Generating Plant (PINGP) through 2034 and the operation of the ISFSI through decommissioning.

5.1 RADIATION MONITORING – ISFSI

Radiation monitoring at the Prairie Island plant, including the ISFSI, is discussed in Chapter 1, Section 4.13.

5.2 RADIOLOGICAL IMPACTS – NORMAL ISFSI OPERATIONS

Radiological impacts from expansion of the Prairie Island ISFSI are anticipated to be within NRC regulatory limits and will not be significant during normal operations. The dry storage casks are passive systems that emit no radioactive effluents. There are no projected impacts or discharges to groundwater from ISFSI operations. Accordingly, there is a "reasonable expectation that the operation of the facility will not result in groundwater contamination."[96] Any radioactive wastes generated during loading of the storage casks in the Auxiliary Building will be treated and handled using existing waste control systems at the PINGP.

Sources of Information

Information and analysis in this section related to operation of the Prairie Island ISFSI is drawn from the Safety Analysis Report (SAR) for the ISFSI and Xcel Energy's Certificate of Need application for additional dry cask storage. The SAR is required by the NRC in order for Xcel Energy to obtain a Special Nuclear Materials (SNM) license to operate the ISFSI (SNM-2506). The Prairie Island ISFSI SAR contains essentially two analyses: (1) an initial safety analysis reflecting the placement of 48 TN-40 casks on the ISFSI pad, and (2) a subsequent safety analysis reflecting the placement of 48 TN-40HT casks on the ISFSI pad. This subsequent analysis is included as Addendum A to the SAR and reflects Xcel Energy's intent to use the TN-40HT casks at the Prairie Island ISFSI. Analysis for the TN-40HT casks was submitted as a license amendment request to the NRC on March 28, 2008.

The Prairie Island ISFSI is licensed federally for storage of up to 48 casks. The ISFSI currently has approval from the State of Minnesota for storage of up to 29 casks. Discussion and analysis in this section is focused on state benchmarks: (1) the pending request for an additional 35 casks (for a total of 64), and (2) the possible placement of a total of 98 casks on the ISFSI pad prior to transport to a federal repository.

[96] Minn. Stat. § 116C.83, Subd. 6.

The safety analysis for a Prairie Island ISFSI composed of TN-40 casks is very similar to an analysis for an ISFSI composed of TN-40HT casks or a mix of TN-40 and TN-40HT casks. However, where there is a significant difference in the characteristics of the casks or in the analyses reported in the SAR regarding the operation of the casks, it is noted and discussed.

Estimation of Doses. The dose estimates in the Prairie Island ISFSI SAR and in Xcel Energy's Certificate of Need application are obtained by computer simulation of neutron and gamma radiation transport in a three dimensional model. This modeling is computing power intensive, requiring CPU days of computation for each simulation. However, this modeling is the only way to obtain meaningful dose estimates. In the discussion that follows there are instances where dose estimates for a specific scenario are not available. These are noted and estimates or projections based on the best available data are made.

Impacts to the General Public

Radiation doses to the general public from ISFSI operations result from skyshine radiation. Skyshine radiation is gamma and neutron radiation that travels upward from the storage casks and is reflected off the atmosphere back to the ground. Shielding on the storage casks themselves reduces radiation doses, as does the earthen berm surrounding the ISFSI. The casks and berm greatly minimize direct radiation to the public, leaving skyshine radiation as the primary means of exposure.

The estimated annual dose to the nearest permanent residence (0.45 miles; 724 meters NW of the ISFSI) with 64 casks on the ISFSI pad is 0.4 mrem/yr.[97] This dose is within NRC regulatory limits for radiation exposure to the general public – 100 mrem/yr from all man-made sources (10 CFR 20) and 25 mrem/yr from ISFSI operations (10 CFR 72). The dose from skyshine radiation decreases with distance from the ISFSI. Members of the public at a distance greater than 0.45 miles would receive less than 0.4 mrem/yr. For example, the estimated annual dose at the Prairie Island Community Center and Treasure Island Casino (0.8 miles; 1285 meters NW of the ISFSI) is approximately one-tenth of the estimated dose to the nearest residence (0.04 mrem/yr).[98]

The radiation exposure contribution from ISFSI operations to a member of the general public (≤ 0.4 mrem/yr.) is indistinguishable from background radiation. Monitoring programs corroborate ISFSI exposure and dose estimates and their near-background levels. Data from themoluminescent dosimeters (TLDs) monitored by the Minnesota Department of Health (MDH) indicates exposure rates near the Prairie Island plant are at background radiation levels.[99] Monitoring by the Wisconsin Department of Health Services (WDHS) shows radiation exposure rates within background levels and comparable to other areas within Wisconsin.[100] Monitoring

[97] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 7.2.3. This estimate assumes the placement of 64 TN-40HT casks loaded with spent fuel at anticipated PINGP fuel enrichments and burnups.
[98] The change in estimated dose with distance from the ISFSI is illustrated by dose rate tables in the SAR, Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A7.5.
[99] 2006 Environmental Radiation Data Report, Minnesota Department of Health, http://www.health.state.mn.us/divs/eh/radiation/monitor/envriondatareport.html
[100] State of Wisconsin, 2007 Prairie Island Environmental Radioactivity Survey, http://dhs.wisconsin.gov/dph_beh/EnvMonitoring/PrairieIsland/piwww07.pdf

by Xcel Energy at thirty-four locations near the PINGP indicates exposure rates at background levels.[101]

Health risks to the general public result from potential long-term exposure to low-level skyshine radiation from the Prairie Island ISFSI. These risks are not anticipated to be significant. The primary health concern is cancer. If we assume that members of the local public live at the nearest residence and that they are at home, outdoors, continuously for 70 years, it is estimated that an additional 1 person in 35,700 (2.8 in 100,000) would be diagnosed with cancer and an additional 1 person in 71,000 would die from cancer.

As there are approximately 450 full-time residents within the immediate vicinity of the Prairie Island plant (2 mile radius), this translates into a hypothetical 0.013 additional cancer diagnoses and 0.006 additional cancer deaths among these residents during a 70-yr. time period. Approximately 40 percent of these residents (180 persons) would be diagnosed with cancer and 20 percent of these residents (90 persons) would be expected to die from cancer from all cancer causes during this same period.

Impacts to Plant Personnel

Radiological exposures and doses to personnel at the PINGP and Prairie Island ISFSI are monitored and controlled according to the Prairie Island radiation protection program. Per NRC regulations (10 CFR 72), exposures are kept as low as reasonably achievable (ALARA) through design and operational procedures. Radiation exposures to plant personnel from all operations at Prairie Island have decreased over time and now average approximately 111 person-rem annually.[102]

Radiation exposures to plant personnel due to operation of the Prairie Island ISFSI can be divided into three categories: (1) exposure due to handling and placing casks, (2) exposure due to surveillance and maintenance activities, and (3) exposure due to skyshine radiation. Exposures for all three categories will increase with the use of the TN-40HT casks due to higher fuel loadings and burnups. Because cask handling and maintenance are specialized, high exposure rate tasks, it is difficult to estimate individual dose rates and impacts. The SAR estimates these doses as collective doses, i.e., in person-rem (**Table 5-1**).

The SAR dose estimates are based on NRC-required assumptions and are conservative.[103] Personnel involved in these tasks will have their doses managed by the Prairie Island radiation protection program to keep them below NRC regulatory limit of 5,000 mrem/yr. for occupational exposure (10 CFR 20). Plant personnel doses are individually monitored and tracked to ensure compliance with NRC regulations. Health risks to "cask personnel" will be higher than those to

[101] 2007 Annual Radiological Environmental Monitoring Program (REMP) Report, Xcel Energy, Prairie Island Nuclear Generating Plant, May 2008, http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-specific-reports/prai1-2.html

[102] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 8.2.5.2.

[103] For example, the NRC requires the assumptions that all TN-40HT casks are loaded with spent fuel at maximum fuel loading (410 kg U per fuel assembly) and burnup (60,000 MWD/MTU). PINGP fuel has a lower fuel loading (360-400 kg U per fuel assembly) and burnup (53,000 MWD/MTU).

the general public. If we assume that cask surveillance staff performs the same job for 70 years, it is estimated that there would be 0.32 additional cancer diagnoses and 0.16 additional cancer deaths among the staff during this time period.

In contrast to direct radiation received from cask operations, skyshine radiation from the ISFSI impacts all plant personnel regardless of their duties. There is not a direct estimate (an estimate based on 64 casks on the ISFSI pad) for skyshine radiation dose to plant personnel in the SAR or in Xcel Energy's Certificate of Need application.[104] The best estimate, based on available data, for the annual average dose to plant personnel from skyshine radiation is 14 mrem/yr.[105] Individual employees will receive more or less than this average depending on their employment status and their work location. This dose is within the NRC regulatory limit of 5,000 mrem/yr. for occupational exposure (10 CFR 20).

Health risks to plant personnel result from potential long-term exposure to low-level doses from ISFSI operations. As before, the primary health concern is cancer. Assuming that all workers receive a dose of 14 mrem/yr and that they are full-time employees for 70 years, it is estimated that an additional 1 person in 1020 (98 in 100,000) would be diagnosed with cancer and an additional 1 person in 2040 would die from cancer. As there are 923 employees at the Prairie Island plant, this translates into a hypothetical 0.9 additional cancer diagnoses and 0.45 additional cancer deaths among plant personnel during a 70-yr. time period. Approximately 40 percent of plant personnel (369) would be diagnosed with cancer and 20 percent of plant personnel (185 persons) would be expected to die from cancer from all cancer causes during this same period.

Impacts to Flora and Fauna

Direct radiation doses to flora and fauna from normal ISFSI operations are typically not estimated or monitored. It is assumed that the exposure to flora and fauna is similar to that of the general public, i.e., indistinguishable from background radiation, and thus there is no significant radiological impact. However, this assumption would not hold for two cases: (1) flora that is very near the ISFSI, and (2) fauna that lives in, moves through, or otherwise utilizes the ISFSI site or nearby habitat.

The earthen berm that surrounds the ISFSI greatly minimizes radiation exposure in these cases; however, it cannot eliminate skyshine radiation, nor radiation within the ISFSI. Radiation impacts to tall nearby flora, e.g., trees, are anticipated to be minimal but unavoidable (or likely not to be mitigated as trees around the ISFSI, though receiving radiation exposure, are healthy and provide desirable ecosystem services). Radiation impacts to nearby fauna are mitigated by the fact that there is no potential habitat for fauna within the ISFSI. Birds, for example, may

[104] SAR dose estimates are based on 48 casks (TN-40 or TN-40HT) placed on the ISFSI pad.
[105] This is the estimated dose for 48 TN-40HT casks. Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A7.4 (12.9 person-rem / 923 persons = 14 mrem). The dose estimate is conservative in that it is based on maximum fuel loading, fuel burnups, and cask loading rates. Additionally, it assumes that plant personnel are outdoors, unprotected by buildings from skyshine radiation. The estimate is not conservative in that it is based on 48 casks on the ISFSI pad.

light on top of the earthen berm, but likely would not make a nest on the concrete pads. ISFSI operating procedures preclude use of the ISFSI site by nesting animals. Accordingly, radiation impacts to fauna are anticipated to be minimal.

5.3 RADIOLOGICAL IMPACTS – POTENTIAL INCIDENTS and OFF-NORMAL ISFSI OPERATIONS

Radiological impacts from potential incidents and off-normal operations at an expanded Prairie Island ISFSI are not anticipated to be significant. The potential impacts from natural and man-made phenomena have been analyzed in the Safety Analysis Report for the ISFSI. In these scenarios, the probability of damaging the dry storage casks such that they release radioactive materials is very low. Additionally, assuming such damage might occur, the estimated radiological doses are within NRC regulatory limits (10 CFR 72).

Natural Phenomena

Incident and off-normal operation scenarios caused by natural phenomena discussed in this section include earthquakes, tornadoes, and floods. These phenomena are considered design basis accidents and are covered by cask design requirements in 10 CFR 72. All casks licensed for use by the NRC must meet these design requirements.

Earthquakes. The design basis earthquake for the Prairie Island ISFSI is the equivalent of the safe shutdown earthquake (SSE) for the PINGP. The SSE is projected to cause accelerations of 12 percent of gravity (g) horizontally and 8 percent g horizontally. This is roughly equivalent to an intensity of VI on the Mercalli scale and a magnitude of 5.4 on the Richter scale. Such an earthquake is slightly larger than the largest recorded earthquake in Minnesota.[106] Analysis of the storage casks in a safe shutdown earthquake predicts that the casks will not tip or slide. Accordingly, there is no anticipated radiological impact.

Tornadoes. The design basis tornado is a tornado with winds of 360 miles per hour (mph). Analysis of the storage casks in such a tornado predicts that the casks will not tip or slide. An additional hazard considered in this scenario is the impacting of the casks by an object which is picked up in the tornado. Such an object, impelled by the wind, would act as a missile against the casks. Analysis of two potential missiles (an automobile, a plank of wood) predicts that the missiles will not tip the casks. A cask is predicted to slide about 1 inch when hit by an automobile in a tornado. Neither missile would penetrate a cask. Thus, there is no anticipated radiological impact.

Floods. The design basis flood is the probable maximum flood that could occur at Prairie Island. This flood is a hypothetical flood that would result if all of the factors that contribute to the flood (e.g., rainfall, timing, runoff) were to reach their most critical values concurrently. The probable maximum flood at Prairie Island is calculated to be 706.7 ft. above mean sea level (MSL), with a water velocity of 6.2 ft/sec. The surface of the ISFSI concrete pads is **694.5** ft. above MSL.

[106] Minnesota Earthquake Information, http://earthquake.usgs.gov/regional/states/?region=Minnesota

Waters from a probable maximum flood would cover the ISFSI pad and extend approximately **12** ft. up the sides of the casks. The casks are approximately 16 ft. tall and flood waters would remain below cask seals. The velocity of the water in a probable maximum flood would not cause the casks to tip or slide. Accordingly, there is no anticipated radiological impact.

Burial. Thermal analysis of the dry storage casks in the Safety Analysis Report includes a scenario in which the casks cannot dissipate heat to the environment and are effectively insulated. Such a scenario might occur if the casks were buried in dry soil. Analysis of this scenario predicts that cask temperatures would reach 570º F approximately 60 hours after burial. This temperature would likely cause cask seal failure (radiological impacts from failure of a cask seal are discussed in this section). It's unclear what natural or man-made phenomena might lead to complete burial of a cask. Accordingly, there are substantial uncertainties in estimating the risk of burial and possible radiological impacts. The Prairie Island emergency response plan provides for accident conditions that could impact cask confinement. Cask burial is included as a possible accident condition and there is a plant abnormal operations procedure in the event a cask becomes buried.

Other Phenomena. Other natural phenomena, e.g., lightning, snow loading, have been modeled in the ISFSI Safety Analysis Report and are predicted to have no impact on the dry storage casks.

Man-made Phenomena

Incident and off-normal operation scenarios caused by man-made phenomena discussed in this section include fire, explosion, mishandling of the casks, terrorism, and impact by airplane. **Discussion of these phenomena assumes that emergency planning measures remain effective into the future. If emergency planning measures are not effective into the future, e.g., governmental entities with emergency responsibilities cannot adequately respond, the risk of radiological impacts increases and could be significant.**

Fire. The only source of fuel which could cause a fire at or near a cask is the fuel for the cask transporter. Analysis of this fuel combusting and engulfing a cask indicates that the cask would maintain its integrity. The cask's neutron shield would suffer damage in the fire and could lose effectiveness. Thus, the radiological impact would be limited to an increase in neutron radiation near the cask, until such time as the cask / shield could be repaired.

Accident analysis in the SAR for the TN-40HT cask assumes that all neutron shielding is lost due to the fire and that a hypothetical person remains at the site boundary 24 hours a day for 30 days. The dose to this hypothetical person is estimated to be 322 mrem, which is within NRC regulatory limits (10 CFR 72). As a fire at the ISFSI which damaged a cask would trigger emergency response measures that would preclude a local resident standing at the site boundary for 30 days, this dose estimate is very conservative. It better reflects dose levels that would be considered by plant and emergency response personnel.

Explosion. A cargo explosion on a barge in the Mississippi River would create a pressure wave that might damage the PINGP and ISFSI. Analysis of a hypothetical cargo explosion indicates that the resulting pressure wave would not damage ISFSI casks. No radiological impacts would occur.

Mishandling of Casks. The handling of dry storage casks is discussed in Chapter 2, Section 3. The primary steps include loading spent fuel assemblies into casks, preparing the casks for storage, and transporting casks to the ISFSI. Each of these steps contains sub-steps which, if performed incorrectly, could create a potential radiological impact. Consequently, there are substantial control and design measures in place at the Prairie Island plant to ensure proper cask handling.

The ISFSI Safety Analysis Report (SAR) examines possible mishandling scenarios. The casks at the PINGP are lifted in the Prairie Island Auxiliary Building by a single failure proof crane. Single failure proof means that the failure of any single component will not result in a load being dropped. The trunnions by which the casks are lifted are designed to ANSI standards for critical loads. All cask lifts are performed in accordance with the PINGP heavy load program, which requires operator and riggers that have specific training and qualifications. The casks are transported by the specialized cask transport vehicle (CTV), and are never lifted higher than 18 inches during transport.

For purposes of the SAR, these design and handling standards preclude several possible mishandling scenarios, e.g., dropping a cask in the Auxiliary Building. However, even if a cask can be handled securely in the Auxiliary Building, it is still possible that: (1) the cask was loaded with an incorrect fuel assembly, or (2) that the cask is dropped by the CTV. The SAR analysis of the administrative and record controls required by the NRC license for the ISFSI indicates that an erroneously loaded fuel assembly would be detected prior to sealing the cask. Thus, the storage casks would perform as designed and there would be no radiological impact. Analysis of an 18 inch drop of a cask onto a concrete surface (ISFSI pad, Auxiliary Building floor) indicates that the cask and its contents would remain intact. Cask confinement would not be breached; no radiological impacts would occur.

The Electric Power Research Institute (EPRI) has conducted a risk assessment of the use of the Transnuclear TN series casks at a generic nuclear generating plant.[107] The assessment evaluates possible incident-initiating events and follows these events to estimate the radiological risk to a person at the plant site boundary. The risk assessment indicates a low level of radiological risk, with no early fatality risk to the general public. The risks are expressed in latent cancer deaths per cask per year (**Table 5-2**).

The EPRI risk assessment results include the possibilities of incorrect fuel assembly loading and of crane failure (dropping a cask in the Auxiliary Building). The cask loading phase contains the least risk of the three cask handling phases, followed by cask storage and cask transportation. The relatively higher cask transportation risk is due to the possibility of a generic transporter fire which is of sufficient duration to cause cask seal failure.

[107] Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Updated Qualification and Analysis Report, EPRI, Palo Alto, CA; 2004, www.epri.com.

Considering the SAR and EPRI risk assessments together, the SAR indicates that specific cask storage risks (e.g., flood, tornado) and specific cask transportation risks (fire) present little or no radiological risk. Specific cask loading risks (incorrect fuel loading, crane failure) are not considered credible. The EPRI risk assessment supports the SAR in concluding that loading risks represent the smallest share of cask handling risks. The EPRI risk assessment highlights that a transporter fire represents a relatively higher radiological risk, one that should be evaluated for a specific site-transporter-cask combination. The SAR performs this evaluation (discussed above). Thus, the SAR and EPRI risk assessments suggest that radiological impacts due to mishandling of casks are not likely.

Terrorism. The radiological risks resulting from a terrorist attack on the Prairie Island ISFSI are covered to a great degree by the risk analyses for natural and man-made phenomena referenced in this section. That is, there are few forces that could be brought to bear on the storage casks by terrorists greater than those already examined, e.g., tornado, flood, fire, explosion. It is possible that armaments could be used to attack the casks, creating damage or a fire that causes a cask seal failure. An airplane could be commandeered to attack the casks (discussed below). These risks are difficult to assess and include substantial uncertainties. However, the risks and potential radiological impacts are likely no greater than risks from natural and man-made phenomena discussed in this section.

Following the events of September 11, 2001, the NRC developed and required security enhancements for all spent fuel storage installations. The NRC also initiated a classified review of the capability of nuclear facilities to survive a terrorist attack, including commercial aircraft attacks, vehicle bomb assaults, and ground assaults. This review indicated that the likelihood of a radioactive release with significant radiological impacts was very low. Nonetheless, the NRC is providing revised guidance to all licensees regarding security requirements against terrorism.[108] Xcel Energy has implemented security enhancements at the Prairie Island in accordance with NRC guidance and regulations.

Impact by Airplane. The radiological risks associated with the impact of an airplane on a dry storage cask were discussed in the 1991 final environmental impact statement (FEIS) for the Prairie Island ISFSI and are discussed in the 2004 EPRI risk assessment. The FEIS notes that an airplane crash is an unlikely event, and is not analyzed in the ISFSI SAR.[109] The impact of a small propeller aircraft or jet would be similar to a tornado impelled missile, and would likely not create a radiological risk. Impact from a commercial airplane would likely cause a cask to tip over but would not breach the cask confinement. The FEIS suggests that the worst case scenario for a commercial airplane would be the direct impact of jet turbine rotor with a cask, which would damage the outer shell and shielding, but likely leave the cask confinement intact.

[108] Backgrounder – Nuclear Security, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/security-enhancements.html

[109] Final Environmental Impact Statement, Prairie Island Independent Spent Fuel Storage Installation, Minnesota Environmental Quality Board, 1991.

The EPRI risk assessment analyzes the impact of an airplane as a "loss of integrity due to high temperature and heavy missiles."[110] The EPRI risk assessment indicates that impact from a small airplane could cause a fire, but would not tip a cask or penetrate the cask. Depending on the fire characteristics, cask shielding would be damaged and cask confinement may or may not be maintained. The assessment indicates that impact from a commercial airliner could cause a cask to tip, depending on which part of the airplane hits the cask. The impact would likely cause a fire which would damage cask shielding and could compromise cask confinement.

Taken together, the FEIS and EPRI risk assessment indicate that radiological risks due to airplane impact are low, but that there are substantial uncertainties, particularly concerning impact by a commercial airliner, in estimating the risks. Significant radiological impacts to the general public are not anticipated.

Hypothetical Cask Confinement Failure

The scenarios and analyses discussed in this section indicate that loss of cask confinement is a very low risk event. None of the specific risks evaluated in the SAR compromise cask confinement. Nonetheless, recognizing the fallibility of all human endeavors, the SAR evaluates the possibility of breach of the cask seal by some hypothetical unspecified means and the resulting radiological impacts. The confinement failure analyses in the SAR for the TN-40 and TN-40HT casks are slightly different and are discussed separately here.

In the confinement failure analysis for the TN-40 cask, it is assumed that the cask seal is breached and that the fuel pellets and cladding for all fuel assemblies in the cask fail.[111] This failure releases radioactive Krypton gas (Kr-85), the only nuclide in the fuel assemblies in a gaseous state. It is assumed that all of the Kr-85 gas is release instantaneously, is not mitigated in any way, and exposes a person at the Prairie Island site boundary to a dose of radiation. The distance from the ISFSI to the nearest site boundary is approximately 0.07 miles (110 meters). The estimated dose to this person is 338 mrem. This dose is within the NRC limit of 5 rem (5,000 mrem) for a design basis accident at an ISFSI (10 CFR 72). The estimated dose to the nearest permanent residence (0.45 miles away; 720 meters) is approximately 12 mrem. If we assume all local residents (450 persons) receive this dose, this translates into a hypothetical 0.005 additional cancer diagnoses and 0.003 additional cancer deaths among these residents during their lifetimes.

In the confinement failure analysis for the TN-40HT cask, it is assumed that all fuel rods fail and fire conditions exist.[112] However, unlike the TN-40 analysis, the release rate of radionuclides is limited to the seal leak rate (1 E-05 cm^3/sec) and occurs over a 30 day period. As before, Krypton gas is projected to provide the greatest amount of activity and exposure. The estimated dose to a person at the nearest site boundary (110 meters) is 24 mrem. This dose is within the NRC regulatory limits for a design basis accident at an ISFSI (10 CFR 72). The estimated dose

[110] Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Updated Qualification and Analysis Report, Section B.4.3.7, EPRI, Palo Alto, CA; 2004, www.epri.com.
[111] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section 8.2.9.
[112] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A8.2.9.

to the nearest permanent residence (0.45 miles away; 720 meters) is approximately 1 mrem. If we assume all local residents (450 persons) receive this dose, this translates into a hypothetical 0.0005 additional cancer diagnoses and 0.0002 additional cancer deaths among these residents during their lifetimes.

The SAR analyses indicate that doses to local residents under cask confinement failure conditions will be limited and will not cause significant impacts. Persons at the plant, either working at the plant or for some reason within the plant boundary, would likely receive higher doses and would experience relatively greater health impacts. These persons could receive approximately one year's worth of background radiation in one accident event. Emergency responders could receive even higher doses. **If emergency response measures are not effective, doses to local residents and plant personnel would increase and could cause significant health impacts.**

It is conceivable that an incident at the ISFSI (e.g., impact by commercial airliner) could cause more than one cask to suffer a confinement failure. If in constructing a worst-case scenario we assume: (1) the ISFSI pad is loaded with 98 casks (the projected decommissioning total), half of which experience confinement failure due to airliner impact, (2) the failure is one of immediate release (such as the TN-40 cask analysis), and (3) the estimated dose per cask to local residents is that of the TN-40 analysis (12 mrem), then the estimated dose to residents is approximately 588 mrem/person (49 x 12 mrem). If we assume all local residents (450 persons) receive this dose, this translates into a hypothetical 0.26 additional cancer diagnoses and 0.13 additional cancer deaths among these residents during their lifetimes.

There are substantial uncertainties in estimating such a worst-case dose, e.g., damage to casks, release conditions, release rates. There are also uncertainties related to the risk of such a dose, e.g., probability of airliner impact causing 49 casks to fail, release conditions caused by such an impact, and the effectiveness of emergency response measures. Nonetheless, projecting from confinement failure analyses in the SAR, it appears that multiple cask confinement failures would not cause a significant human health impact to local residents. Plant personnel and emergency responders would experience relatively greater health impacts. **If emergency response measures are not effective, doses to local residents and plant personnel would increase and could cause significant health impacts.** Because of the substantial uncertainties involved in making a worst-case scenario projection there are likely differences of opinion regarding potential health impacts.

5.4 CUMULATIVE IMPACTS

Cumulative impacts are impacts on the environment that result from the incremental effects of a project in addition to past, present, and reasonably foreseeable future projects regardless of who undertakes these projects.[113] Two reasonably foreseeable future projects are considered here: (1) continued operation of the PINGP until 2034, and (2) use of the ISFSI to facilitate

[113] Minn. Rules 4410.0200, Subp. 11.

decommissioning of the PINGP after cessation of operations. **Additionally, this section discusses possible scenarios for storage of spent nuclear fuel should the currently proposed federal repository, Yucca Mountain, be unavailable.**

Operation of the PINGP Through 2034

If Xcel Energy is granted a certificate of need to expand the storage capacity of the Prairie Island ISFSI by 35 dry storage casks, it is foreseeable that the PINGP will continue operating an additional 20 years past its original license term. Xcel Energy has submitted an operating license renewal application to the NRC to allow continued operation of Prairie Island Units 1 and 2 until 2033 and 2034 respectively.

Normal Operations. The potential radiological impacts of continued normal operation of the PINGP are discussed in Chapter 1 of this EIS (Section 4.13). It's anticipated that no new or additional impacts, beyond those discussed in Chapter 1, would occur if the PINGP continued operations through 2034. Potential radiological impacts are projected to be within NRC regulatory limits and would not be significant during normal operations.

Incidents and Off-normal Operations. Assuming that regular maintenance continues as currently performed at the PINGP, radiological impacts from incidents and off-normal operations at the PINGP which might occur during an additional 20 years of operation (through 2034) are projected to be within NRC regulatory limits and are not anticipated to be significant. Potential incidents at the PINGP and their consequences are discussed and analyzed in the environmental report which Xcel Energy submitted to the NRC for license renewal of the PINGP.[114] Applicable sections of the report are discussed here.

Potential incidents at the PINGP are analyzed using probabilistic risk assessment (PRA). PRA develops and examines fault trees for incidents that could lead to the release of radionuclides. Because the components of Unit 1 and Unit 2 at the PINGP have different fault characteristics, e.g., the steam generator for Unit 1 was replaced 2004, while the Unit 2 replacement is scheduled for 2013, the risk of incidents is expressed for each unit. The risk of an incident that results in reactor core damage is estimated at 9.79 E-06/yr for Unit 1 and 1.21 E-05/yr for Unit 2.[115] This frequency is approximately once every 82,644 reactor-years. Thus, an incident resulting in core damage is highly unlikely.

If an incident resulting in core damage does occur, the potential release of radionuclides could follow any of several pathways depending on the type of incident and the potential responses. Modeling in the environmental report, which assumes effective emergency response measures, estimates the collective dose to the general public from a core damage

[114] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, Section 4.17, Attachment F, May 16, 2008.

[115] Id. Attachment F, Table F.3-7. The risk for Unit 2 is higher than for Unit 1 due to the age of the steam generator, i.e., an older steam generator is more vulnerable to a steam generator tube rupture which could be an initiating event for a core damage incident.

incident to be 2.94 person-rem for Unit 1 and 8.43 person-rem for Unit 2.[116] Using the higher estimate from Unit 2, this dose corresponds to an estimated 0.008 additional cancer diagnoses and 0.004 additional cancer deaths among the general public due to an incident.

The NRC has evaluated potential incidents (accidents) at commercial reactor sites in its Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS).[117] The GEIS uses regression analysis to estimate the environmental impacts of incidents at 72 commercial reactor sites throughout the Unites States. Analysis in the GEIS estimates the collective dose to the general public from a severe accident at the Prairie Island plant to be 237 person-rem.[118] This dose corresponds to an estimated 0.24 additional cancer diagnoses and 0.12 additional cancer deaths among the general public due to an incident. The GEIS dose estimate is a conservative estimate, and due to the methodology and assumptions used, is higher than the estimate in the environmental report.

The most serious accident to occur at a U.S. commercial nuclear plant is the accident at the Three Mile Island plant near Middletown, Pennsylvania, in 1979.[119] Due to a loss of coolant, the reactor core at the plant suffered a meltdown, a most severe core incident. The estimated collective dose to the general public from the incident was approximately 2000 person-rem.[120] This dose corresponds to an estimated 2.0 additional cancer diagnoses and 1.0 additional cancer deaths among the general public due to the incident.

Considering the environmental report, the GEIS, and the health impacts of the Three Mile Island (TMI) accident, potential radiological impacts to the general public from continued operation of the PINGP are not anticipated to be significant. Projected dose levels are within NRC regulations (100 mrem/yr., 10 CFR 20). To be sure, the potential health impacts of the TMI accident are not to be taken lightly. Substantial improvements, both in the regulation and operation of commercial nuclear plants in the United States, have occurred as a result of the TMI accident. The risk of a core damage incident is very low, and the consequences of such an incident, calculated (environmental report, GEIS) and experienced (TMI), are not significant.

The above discussion of potential radiological impacts assumes that emergency response measures are effective. Such measures are necessary to reduce potential exposures and health impacts to the general public. If emergency response measures are not effective into the future, e.g., governmental entities with emergency responsibilities cannot adequately respond, the risk of radiological impacts from potential PINGP incidents increases and could be significant.

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[116] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, Attachment F, Table F.3-7, May 16, 2008.
[117] Generic Environmental Impact Statement for License Renewal of Nuclear Plant, NUREG-1437, Section 5, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/v1/part05.html#_1_129.
[118] Id. Table 5.6.
[119] NRC Fact Sheet on the Three Mile Island Accident, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html.
[120] Id. Approximately 2 million persons in the area received an average dose of 1 mrem.

Use of the ISFSI to Facilitate Decommissioning

If the PINGP operates through 2034, it is foreseeable that the plant would cease operations at that time and undergo decommissioning. In the decommissioning process, spent nuclear fuel would need to be temporarily stored (e.g., in the spent nuclear fuel pool) until it could be placed in temporary, long-term storage (Prairie Island ISFSI) or in a federal geologic repository. Although there is uncertainty as to the storage alternatives that will be available in 2034, **the most** likely scenario, **the only scenario in accordance with current Minnesota and federal law governing storage of spent nuclear fuel,** is temporary long-term storage of spent nuclear fuel at the Prairie Island ISFSI until the dry storage casks can be transported to a federal repository. In this scenario, approximately 34 additional casks would be needed for decommissioning, creating a total of 98 casks on the ISFSI pad upon removal of all spent nuclear fuel from the plant.

Given the uncertainty as to when a federal repository will be available to accept casks from the Prairie Island ISFSI, this document assumes, for analysis purposes only, that the casks (a total of 98) will be at the ISFSI for up to 200 years. Potential non-radiological impacts from the long-term storage of the casks are discussed in Chapter 2, Section 4. Potential radiological impacts are discussed here.

Normal Operations. Assuming that regular monitoring and maintenance continue as currently performed at the ISFSI, radiological impacts from continued operation of the Prairie Island ISFSI for up to 200 years would be within NRC regulatory limits and would not be significant during normal operations. The dry storage casks are passive systems that emit no radioactive effluents. Radiation exposure would occur solely through cask monitoring and skyshine radiation (discussed above, Section 5.2).

It is assumed that the 34 additional casks needed for decommissioning would be TN-40HT casks. Thus, the composition of casks on the ISFSI pad at decommissioning would be: 29 TN-40 casks and 69 TN-40HT casks, for a total of 98 casks. The additional 34 casks would increase radiation exposure to the general public by increasing skyshine radiation. The maximum exposure and dose rate would occur when the 98th cask is placed on the pad. Once it is placed, exposure rates would decrease due to radioactive decay of the contents of the casks.

There is not a direct estimate (an estimate based on 98 casks on the ISFSI pad) for skyshine radiation dose to the general public in the SAR or in Xcel Energy's Certificate of Need (CON) application (**Table 5-3**).

However, dose estimates in the SAR and the CON application can be used to project, with some confidence, a bounding dose rate for the general public. The annual dose to the nearest residence (0.45 miles; 724 meters NW of the ISFSI) with 98 casks on the ISFSI pad is projected to be no greater that 5 mrem/yr.[121] This dose would be within NRC regulatory limits for radiation

[121] Doubling the estimated dose in SAR Addendum A (2.2 x 2 =4.4 mrem/yr.) would be a conservative estimate of 96 casks on the ISFSI pad.

exposure to the general public (25 mrem/yr., 10 CFR 72). Members of the public at a distance greater than 0.45 miles would receive less than 5 mrem/yr.

Health risks from this exposure and dose are not expected to be significant. The primary health concern is cancer. If we assume that members of the local public live at the nearest residence and that they are at home, outdoors, continuously for 70 years, it is estimated that an additional 1 person in 2,850 (35 in 100,000) would be diagnosed with cancer and an additional 1 person in 5,700 would die from cancer. As there are approximately 450 full-time residents within the immediate vicinity of the Prairie Island plant (2 mile radius), this translates into a hypothetical 0.16 additional cancer diagnoses and 0.08 additional cancer deaths among these residents during a 70-yr. time period. **Over a 200-year timeframe (approximately 3 lifetimes), this translates into a hypothetical 0.48 additional cancer diagnoses and 0.24 additional cancer deaths among residents near the Prairie Island plant.**[122]

If the population of full-time residents within a 2-mile radius (particularly within a 1-mile radius from the ISFSI) increases over a 200-year timeframe, the potential health risks would also increase. Though population growth can be expected in the general area, particularly in and around the city of Red Wing, it is not expected that there would be a large population increase near the PINGP and Prairie Island ISFSI. The projected population within a 2-mile radius of the PINGP in 2034 is 2,210 persons.[123] **Assuming these are all full-time residents, this translates into a hypothetical 0.78 additional cancer diagnoses and 0.39 additional cancer deaths among these residents during a 70-year time period. Over a 200-year timeframe (approximately 3 lifetimes), this translates into a hypothetical 2.3 additional cancer diagnoses and 1.2 additional cancer deaths among residents near the Prairie Island plant.**

The collective dose (person-mrem/yr) and associated health risks will vary over a 200-year timeframe based on the number of full-time residents and the exposure they receive, which will decrease with distance from the ISFSI and time, i.e. radioactive decay of the spent fuel in the storage casks. Estimates presented here are conservative in that (1) they rely on a projected exposure rate from the SAR, not a direct estimate, (2) the exposure rate does not take into account radioactive decay over a 200-year timeframe, (3) the exposure rate is for persons assumed at home, outdoors, continuously for 70 years, and (4) the exposure rate for all persons within 2 miles is assumed to be equal to the nearest resident (0.45 miles). It is not possible to provide more accurate estimates without a direct estimate of skyshine radiation that takes into account radioactive decay (see Section 5.2 of this chapter discussing estimation of doses).

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[122] This estimate assumes that exposure levels from ISFSI skyshine radiation will remain constant over 200 years. This is a conservative assumption. Exposure levels would drop over the 200-year timeframe due to radioactive decay of the spent nuclear fuel.

[123] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, Attachment F, Table F.9, May 16, 2008.

Radiological impacts to plant personnel during decommissioning are expected to be minimal. Casks would no longer need to be loaded and placed on the ISFSI pad. Thus, this component of plant personnel exposure would be eliminated. Casks would still need to be monitored and maintained until moved to a federal repository, thus this exposure component would remain.

It is assumed that plant staffing levels would drop with decommissioning. Thus, impacts due to skyshine radiation would be greatly reduced. There would still be radiation due to the storage casks, but few persons to receive the exposure.

Assumptions. The analysis of dry cask storage for up to 200 years at the Prairie Island ISFSI assumes that regular monitoring and maintenance continue as currently performed at the ISFSI. This monitoring and maintenance would ensure that the ISFSI and its components function as designed to protect public health. In order for this to occur, the social and political infrastructure that supports the Prairie Island plant and ISFSI must continue to function. This continuation of social, political, and economic functioning is commonly known as institutional control. Whether or not, in a country just over 230 years old, institutional control can be maintained for 200 years such that the dry cask storage at Prairie Island performs as designed is a relevant question and one that is challenging to answer. Such a question has been examined in the environmental impact statement for the proposed federal repository at Yucca Mountain.[124] Analysis from the Yucca Mountain EIS that addresses this question is discussed here.

The Yucca Mountain EIS, in its evaluation of a "no-action alternative" assumes that Yucca Mountain does not enter operation, and that commercial spent nuclear fuel is stored in ISFSIs at existing plant locations for 10,000 years.[125] The EIS examines two scenarios – one in which institutional control exists for all 10,000 years (Scenario 1), and one in which institutional control ends after 100 years (Scenario 2). Because the EIS attempts to consider all ISFSI types over a very long time period, it necessarily makes some basic assumptions. Among these are that the ISFSIs use horizontal canister systems (discussed in Section 6 of this chapter), that they undergo a major repair or revision when they are 50 years old, and that they are replaced every 100 years.

In Scenario 1, because institutional control exists for 10,000 years, ISFSIs function as designed and estimated doses to the general public are relatively low (≤ 1 mrem/yr) and within NRC regulations (25 mrem/yr., 10 CFR 72).[126] As is the case with estimated doses at

[124] Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada; http://www.ocrwm.doe.gov/eis/index.shtml [hereafter "Yucca Mountain EIS"].

[125] Id. The 10,000 year timeframe is for comparison purposes only, i.e., to compare the proposed action (operation of Yucca Mountain) with the no-action alternative (storage at existing commercial reactor sites). It is not intended to reflect the time that spent nuclear fuel needs to be isolated from the environment to ensure public health. This time period is measured in millions of years. In September 2008, the Environmental Protection Agency issued radiation protection standards for Yucca Mountain for up to 1 million years; http://www.epa.gov/rpdweb00/yucca/index.html.

[126] Id. See Chapter 7, Environmental Impacts of the No-Action Alternative, Table 7-6, Table 7-11.

the Prairie Island ISFSI, estimated doses to workers at the associated facilities are higher than those to the general public (e.g., 23 mrem/yr for general employees).

In Scenario 2, institutional control ends after 100 years and this cessation leads to degradation of the ISFSI storage systems, their failure, and the eventual release of radionuclides into the environment. For facilities located in the Upper Midwest, the EIS estimates that precipitation will infiltrate the ISFSIs' concrete storage structures 70 years after the end of institutional control, leading to degradation of the metal storage canisters (by corrosion) and an initial release of radionuclides 1000 years after the end of institutional control.[127] Radionuclides would be released to the air, soil, and surface waters causing chronic exposures and adverse health impacts. The EIS projects approximately 3,700 additional cancer fatalities over the 10,000 year period, and projects that fatalities would peak about 3,400 years after the end of institutional control due to releases to the Mississippi River and its tributaries.[128] Individuals living near degraded ISFSIs are projected to suffer severe health impacts due to direct radiation and/or internal doses due to ingestion.

As is clear from this brief discussion of the Yucca Mountain EIS, assumptions about institutional control directly influence how well ISFSIs will perform their designed functions and how well public health will be protected. The Yucca Mountain EIS illustrates that lack of institutional control leads to a degradation of ISFSI function and chronic health impacts.

<u>Costs.</u> Institutional control that ensures ISFSIs perform as designed requires resources, i.e., energies and monies to monitor, maintain, service, and repair ISFSIs. The Yucca Mountain EIS estimates life-cycle costs for the no-action alternative scenarios discussed above. The EIS estimates costs of $436 – 492 million dollars/year for the first 100 years of storage at 72 commercial ISFSI sites.[129] It estimates costs of $407 – 460 million dollars/year for the next 9,900 years. Thus, using the more conservative 100-year estimates, a rough average annual cost for on-going operation of an ISFSI would be $6.4 million dollars.[130]

With respect to the assumptions in the Yucca Mountain EIS, costs for operation of the Prairie Island ISFSI would likely be at the low end of the estimated range(s). First, it's unclear that the Prairie Island ISFSI would require major repair after 50 years. Due to the passive operational nature of the concrete pad and the casks, it's unclear what major repair would be required (or is anticipated by the Yucca Mountain EIS). Second, the dry storage casks at Prairie Island use a non-canister system, i.e., they do not rely on a concrete storage module to house (and protect) the casks. Thus, discussion in the Yucca Mountain

[127] Id. See Chapter 7, Environmental Impacts of the No-Action Alternative, Figure 7-8; Appendix K, Long-Term Radiological Impact Analysis for the No-Action Alternative.
[128] Id.
[129] Id. See Chapter 2, Proposed Action and No-Action Alternative, Table 2-6. The range of costs is based on the assumption that the spent fuel would be placed in dry storage casks that (1) would not need to be replaced over the 10,000 year period (low cost) or (2) would have to be replaced every 100 years (high cost).
[130] Average 100-year costs ((436+492)/2) divided over 72 commercial sites.

EIS about concrete cracking and fatigue such that concrete housing needs to be replaced every 100 years is not directly applicable. There is a concrete pad at the Prairie Island ISFSI, and its integrity is necessary to proper operation of the ISFSI. However, it is an embedded flat concrete surface, not a three-dimensional, surface-mounted structure. Accordingly, it is likely to suffer cracking at a slower rate, with greater opportunity to inspect and repair incipient cracks to prevent further damage.[131] The Prairie Island ISFSI concrete pad, should storage exist there for hundreds of years, would need to be replaced, but the timeline for this replacement is likely more than the 100-year assumption in the Yucca Mountain EIS.

Estimates of annual ISFSI operation costs by the Minnesota Department of Commerce, Office of Energy Security are consistent with estimates from the Yucca Mountain EIS. In a proceeding for an ISFSI at the Monticello Nuclear Plant, a plant operated by Xcel Energy and located near Monticello, Minnesota, the estimated annual operation costs for an ISFSI of 30 casks (horizontal canisters) was $4.4 million dollars.[132]

The payment of costs associated with on-going operation of the Prairie Island ISFSI is discussed in Section 3.4 of this chapter. ISFSI operation costs are included in the nuclear decommissioning trust fund established for the PINGP and Prairie Island ISFSI. Additionally, eventual storage of spent nuclear fuel in a federal repository is a federal obligation. Federal courts have held that the Department of Energy is liable for damages attributable to delays in accepting spent nuclear fuel for placement in a federal repository. Thus, the Department of Energy will pay costs attributable to the on-going operation of the Prairie Island ISFSI.[133]

What is not reflected in these discussions of cost and payment are those costs of institutional control that are indirectly tied to on-going operations of the Prairie Island ISFSI. That is, institutional control assumes not only a solvent and effective entity (e.g., Xcel Energy) responsible for maintaining proper functioning of the ISFSI, but also solvent and effective socio-political institutions that provide a stable societal framework for the ISFSI. For there to be institutional control of the Prairie Island ISFSI, the city of Red Wing, Goodhue County, the State of Minnesota, and the United States of America all have to exist as functioning political entities. There are myriad demands on these entities. In

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[131] Yucca Mountain EIS. See Appendix K Long-Term Radiological Impact Analysis for the No-Action Alternative, Section K.2.1.1.

[132] Rebuttal Testimony and Attachments of Dr. Steve Rakow, May 12, 2009, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={2DD285A6-F035-47A3-92E9-B1E86ABB0C7A}&documentTitle=20095-37422-01

[133] See http://www.leg.state.mn.us/LRL/Issues/prairieIsland.asp. In 1998, after the U.S. Department of Energy failed to meet its deadline to accept waste from the country's nuclear power plants, Xcel Energy/NSP filed a lawsuit in the U.S. Court of Federal Claims against the department seeking reimbursement for the costs of storing the waste at its Minnesota facilities. The suit was settled in September 2007, with Xcel Energy/NSP being awarded $116 million for costs accrued through 2004. In August 2007, Xcel Energy filed another lawsuit against the U.S. Department of Energy seeking money to cover waste storage costs from 2005 through June 2007.

this respect, the Prairie Island ISFSI is just one more demand on the list. However, the ISFSI is unique in that its demands will last much longer than typical socio-political demands and the consequences for failing to meet these demands are predictable and severe.

Incidents and Off-normal Operations. Assuming that regular monitoring and maintenance continue as currently performed at the ISFSI, radiological impacts from incidents and off-normal operations at the Prairie Island ISFSI which might occur within 200 years, would be within NRC regulatory limits and would likely not be significant. The addition of 34 casks for decommissioning and the storage of the casks for up to 200 years does not introduce any new phenomena, natural or man-made, that could compromise cask confinement.

The risk that is introduced by storing the casks for 200 years is time itself. For many of the risks discussed in this section, the passage of time does not increase the probability that a radiological impact will occur. The casks are designed to withstand design basis accidents that are essentially independent of a 200 year timeframe, e.g., earthquake, maximum probable flood, tornado. For example, if the casks can withstand a tornado in 2010, they can withstand a tornado in 2040. There may be many tornadoes over time, but the passage of time does not change the risk of a radiological impact.

Time is a consideration for risks related to the mishandling of casks. The more times you operate a particular mechanical system, the more opportunities there are for the system to fail in some regard. For the Prairie Island ISFSI, once the casks are loaded, transported, and placed on the ISFSI pad, they are no longer handled. Barring the need to repair a cask seal or other possible damage, the casks are not handled or transported within the PINGP site. Thus, handling of the casks effectively ends within the first 50 years of the 200 year time frame. The 2004 EPRI risk assessment estimates the risks associated with loading and transporting casks is on the order of 3 E-13 latent cancer deaths per cask per year. Multiplying this risk by an additional 34 casks and 50 years does not make this risk significant.

The only additional handling that would occur is the loading of the casks for transport to a federal geologic repository. The federal Department of Transportation (DOT) and NRC share responsibility for establishing standards for the safe transport of the casks. Casks must be licensed for transport by the NRC (10 CFR 71). It is anticipated that the risks associated with cask handling for removal to a geologic repository, under DOT and NRC regulation, are of a similar magnitude as the risks associated with cask handling operations at the ISFSI. As discussed above, these risks are not expected to be significant.

Time is also a consideration for risks posed by man-made phenomena that, unlike cask handling, will exist for the full 200 years and may change over time, e.g., risk of explosion, terrorism, airplane impact. Current analyses indicate that the risk of radiological impacts from these events is small. If emergency planning measures remain effective into the future and if we assume that these man-made risks remain relatively constant over time, then multiplying these risks over an additional 200 years will likely not make them significant. Compared with natural phenomena and well-regulated cask handling systems, risks posed by these man-made phenomena are likely the more uncertain. **If emergency planning measures are not effective into the future, e.g., governmental entities with emergency responsibilities cannot adequately respond, the risk of radiological impacts from man-made phenomena increases and is likely significant.**

<u>Assumptions</u>. **The analysis of radiological impacts from potential incidents at the Prairie Island ISFSI assumes that regular monitoring and maintenance continue and that emergency planning measures remain effective into the future. In the language of the Yucca Mountain EIS, the analysis assumes institutional control. The Yucca Mountain EIS concludes that, with institutional control, spent nuclear fuel can be safely stored in dry casks at commercial ISFSI sites (Scenario 1) for up to 10,000 years.[134] The EIS examined possible incidents at the ISFSI sites and found no events which could lead to the release of radionuclides to the environment.[135] In the analysis, the two events which provided the greatest challenge to the integrity of the storage modules were impact by an aircraft and a severe seismic event. These events are discussed for the Prairie Island ISFSI in section 5.3 of this chapter.**

If institutional control is not maintained, incident risks become greater. If the dry casks are not monitored and maintained they will likely deteriorate with time and their barriers to release will degrade. Under such circumstances, natural and man-made phenomena, previously resisted by the storage casks, could cause release of radionuclides. Of the possible initiating phenomena examined in the Yucca Mountain EIS, impact by aircraft on degraded storage modules created the greatest radiological consequences, with an estimated 13 additional cancer fatalities in the general public due to radioactive release after aircraft impact.[136] Risks due to sabotage or terrorism would also increase if institutional control is not maintained. The increase would be due to increased ease of access to the casks such that armaments might be successfully employed and the increased vulnerability of degraded casks.

Possible Scenarios – Yucca Mountain Unavailable

The cumulative impacts scenario analyzed in this section – the temporary long-term storage of spent nuclear fuel at the Prairie Island ISFSI until the dry storage casks can be transported to a federal repository – is the only scenario in accordance with current Minnesota and federal law. Minnesota law requires that dry cask storage be temporary and managed such that spent nuclear fuel can be shipped to a repository as soon as feasible.[137] The Nuclear Waste Policy Act (NWPA), as amended, makes the placement of

[134] Yucca Mountain EIS. See Chapter 7, Environmental Impacts of the No-Action Alternative, Section 7.2.1.
[135] Id. See Section 7.2.1.8.
[136] Yucca Mountain EIS. See Appendix K, Long-Term Radiological Impact Analysis for the No-Action Alternative, Section K.3.2.1.
[137] See Minn. Stat. 116C.71, Subd. 7, distinguishing ISFSIs from radioactive waste management facilities where radioactive waste is disposed of or permanently stored; Minn. Stat. 116C.83, Subd. 4, requiring that waste be managed for shipment to a repository as soon as feasible.

commercial spent nuclear fuel in a federal repository a federal obligation. Additionally, it identifies Yucca Mountain as the only site for development of an initial repository.[138]

There is uncertainty as to when the Yucca Mountain repository will open, its capacity, and the consequences of its opening being delayed (see Section 6.1 of this chapter). In 1984, U.S. Department of Energy (DOE) anticipated that a first repository would begin operation in 1998, and a second in 2004.[139] In 1990, DOE anticipated that a repository would begin operation in 2010, and there would be no "back-up" repository site. On June 3, 2008, DOE submitted a license application for the Yucca Mountain repository to the NRC, with a best achievable date for opening the repository of 2020.[140] Prospects for opening Yucca Mountain on this timetable have likely weakened with the new federal administration.[141]

Xcel Energy anticipates that Yucca Mountain will not be available before 2017.[142] DOE has stated that the best achievable date is 2020. The Nuclear Regulatory Commission (NRC) has expressed confidence that radioactive wastes produced by nuclear power plants can be safely stored at ISFSIs until such time as a federal repository is available. The NRC has recently proposed that the length of time such storage can be safely affected is 60 years beyond the licensed life of the reactor which produces the spent fuel.[143] Thus, the NRC is proposing that the dry casks at the Prairie Island ISFSI could be safely stored until at least 2094. The Yucca Mountain EIS suggests that, with institutional control, dry casks at the Prairie Island ISFSI could be stored for 10,000 years with minimal radiological impacts.

The analysis in this section of temporary long-term storage of spent nuclear fuel at the Prairie Island ISFSI adopts a timeframe of 200 years in an attempt to bound the uncertainty related to the opening of the Yucca Mountain repository. Given that the timeline for opening a federal repository has already slipped from 1998 to 2020, a total of 22 years, it appears prudent to factor in additional delay in evaluating the temporary long-term storage scenario. The 200-year timeframe is roughly 10 times the length of the delay to date and is anticipated to bound the uncertainty related to the opening of a federal repository.

It is possible that the Yucca Mountain repository will not be available in the long term, i.e., that it will not be constructed or operate. The Yucca Mountain EIS briefly discusses scenarios should activities at Yucca Mountain be terminated.[144] They include: (1) continued storage of spent nuclear fuel at one or more centralized locations, (2) selection of

[138] The Report to the President and the Congress by the Secretary of Energy on the Need for a Second Repository, December 2008, DOE/RW-0595, http://www.ocrwm.doe.gov/uploads/1/Second_Repository_Rpt_120908.pdf
[139] Nuclear Regulatory Commission, Waste Confidence Decision Update, 73 FR 197, October 9, 2008.
[140] Id.
[141] See, "Future Dim for Nuclear Waste Repository," New York Times, 3/5/09, http://www.nytimes.com/2009/03/06/science/earth/06yucca.html; Q & A: Steven Chu, Technology Review, 5/14/09, http://www.technologyreview.com/business/22651/.
[142] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 5.2.4.4.
[143] Nuclear Regulatory Commission, Waste Confidence Decision Update, 73 FR 197, October 9, 2008.
[144] Yucca Mountain EIS, Chapter 2, Proposed Action and No-Action Alternatives, Section 2.2

another location for a geologic repository, (3) the development of new technologies, and (4) reconsideration of alternatives to geologic disposal. All of these scenarios would require new federal legislative authority. The granting of such authority, the alternatives to Yucca Mountain that would be developed, and the timeline for their development are uncertain.

Environmental Justice

Environmental justice is a principle which informs state and federal agency processes such that all persons, regardless of race, color, national origin, or income, are provided fair treatment and meaningful involvement in the development and implementation of environmental policies.[145] The goal of this principle is to ensure that no persons bear a disproportionate share of the negative environmental consequences of a proposed project.[146]

For the cumulative impacts discussed in this section, the Prairie Island Indian Community (PIIC) is a community of persons for whom there are environmental justice concerns. These concerns can be roughly divided into two parts: (1) concerns with radiological impacts from normal operations at Prairie Island, and (2) concerns of uncertainty and risk should there be an incident at the PINGP or Prairie Island ISFSI.[147] Of these two, the latter is likely the greater concern.

Radiological impacts to the general public related to normal operations of the PINGP and Prairie Island ISFSI are projected to be within federal regulatory guidelines and are not anticipated to be significant. Thus, radiological impacts will be within federal guidelines and not significant for the PIIC. This said, the PIIC is the closest community to the Prairie Island site. Additionally, this EIS assumes a linear no-threshold model for radiological impacts due to low-level radiation exposures. Thus, PIIC members will receive slightly higher exposure levels and doses than communities at a greater distance. These doses will create a small incremental risk that the PIIC will bear differentially from other communities.

The likely larger uncertainty and incremental risk borne by the PIIC is the uncertainty related to an incident at the PINGP or Prairie Island ISFSI. As discussed in this section, the probabilities associated with such incidents are projected to be very low; consequently their impacts are not anticipated to be significant. Nonetheless, there is uncertainty. This uncertainty is borne by all communities surrounding Prairie Island, but likely most directly felt by those communities which could be impacted should an incident occur, e.g., PIIC, City of Red Wing. As discussed in Chapter 1, Section 4.5, this uncertainty may be associated with socio-psychological impacts.

[145] Minnesota Pollution Control Agency (MPCA) and Environmental Justice, http://www.pca.state.mn.us/assistance/ej.html

[146] Id.

[147] Concerns discussed here reflect analysis of this EIS with respect to cumulative impacts of this section. They are not intended as a limit on concerns that the PIIC may have, or as an expression of the community's concerns.

The cumulative impacts described in this section are proposed to occur at an existing power plant facility, Prairie Island. As there are limitations in current Minnesota law as to alternative locations for nuclear power plants and ISFSIs, the only apparent means to mitigate environmental justice concerns related to the PIIC would be to discontinue operations at the PINGP and replace its energy generation with an alternative source (see Chapter 2, Section 7). This course of action would not eliminate risks related to continuing operation of the ISFSI until such time as the storage casks are removed to a federal repository.

6.0 SPENT FUEL STORAGE ALTERNATIVES

This section analyzes the feasibility of alternatives for storing the spent nuclear fuel generated by PINGP operations for the term of its proposed license renewal (2014 – 2034). The alternatives to storing spent fuel at the Prairie Island ISFSI discussed in this section include: (1) Storing the spent fuel off site, (2) Storing the spent fuel on site, but not in the ISFSI, (3) Storing the fuel at the ISFSI but with different cask technology, and (4) Reducing the need for spent fuel storage by ceasing PINGP operations in 2014.

None of the off-site storage options offers a feasible alternative to expansion of the Prairie Island ISFSI. None of the on-site options appear to be a more reasonable alternative than the proposed ISFSI expansion. The potential human and environmental impacts of ceasing PINGP operations in 2014 and decommissioning the plant are discussed in Section 7 of this chapter.

6.1 OFF-SITE STORAGE ALTERNATIVES

Minnesota law requires that spent nuclear fuel stored in Minnesota be stored on the site at which the fuel is used.[148] Thus, off-site storage of spent nuclear from the Prairie Island plant must also be out-of-state. The four alternatives discussed here are all out-of-state.

Reprocessing

Reprocessing is a method of recovering unused uranium and plutonium from used nuclear fuel and recycling it for use in new reactor fuel. Reprocessing does not result in elimination of all nuclear wastes and radioactivity. However, the volume of high-level waste to be stored is reduced. When electric power companies first considered using nuclear energy to generate electricity, it was assumed that when the nuclear fuel was used up or "spent," it would be recycled so that useful fuel could be extracted and used again. Approximately 96 percent of the spent fuel is uranium that could be reprocessed into usable fuel to generate electricity. It is this assumption that led to sizing spent fuel pools to provide the limited space necessary to cool spent fuel for a few years before transporting for reprocessing.

In 1977, President Carter, concerned about the possibility of nuclear proliferation, banned commercial reprocessing for private companies. As a result, the two private reprocessing facilities, then under construction, were never made operational. In 1981, President Reagan lifted the ban, but because of the economics of reprocessing compared to fabrication of new fuel and the political uncertainty surrounding reprocessing, no private companies invested in the construction or operation of reprocessing facilities in United States. In 1993, the Clinton administration reinstated policy opposing reprocessing in the United States.

In 2006, as part of President Bush's Advanced Energy Initiative, the Department of Energy (DOE) launched a new initiative, the Global Nuclear Energy Partnership (GNEP).[149] One of the

[148] Minn. Stat. § 116C.83, Subd. 4b.
[149] 71 FR 55, March 22, 2006.

goals of this partnership is to "recycle nuclear fuel using new proliferation-resistant technologies to recover more energy and reduce the volume of waste."[150] In October, 2008, the GNEP released a draft programmatic environmental impact statement for its proposed programs.[151] The DOE states that it "envisions changing the U.S. nuclear energy fuel cycle from an open (or once through) fuel cycle …to a closed fuel cycle in which SFN [spent nuclear fuel] would be recycled to recover energy-bearing components for use in new nuclear fuel." Given the political and institutional history of reprocessing in the U.S., there are substantial uncertainties that preclude reprocessing as a feasible off-site storage alternative.

Existing Off-Site Storage Facilities
The only facility currently storing spent fuel on a contract basis from commercial nuclear power reactors is the General Electric Morris facility in Morris, Illinois. However, it is no longer accepting spent fuel from commercial nuclear power plants. Thus, this facility is not a feasible off-site storage alternative.

Private Fuel Storage Initiative
Xcel Energy is pursuing temporary, off-site storage of spent nuclear fuel in Utah as a member of Private Fuel Storage, LLC ("PFS").[152] PFS is a consortium of eight utilities, including Xcel Energy, which is working to build a spent fuel storage facility on the west central Utah reservation of the Skull Valley Band of Goshute Indians. PFS and the Skull Valley Band of Goshute Indians entered into an agreement in December 1996 that allows for temporary storage of spent fuel from commercial nuclear power plants.

The license application for PFS was submitted to the NRC in June 1997. The NRC staff issued their final Safety Evaluation Report in December 2001. The NRC issued their Final Environmental Impact Statement in January 2002. Both reports declared that the project design and supporting analyses met the federal regulatory requirements for Independent Spent Fuel Storage Installations. The Nuclear Regulatory Commission approved the license for PFS on September 9, 2005.

In September 2006 the U.S. Department of the Interior ("DOI") disapproved the PFS-Goshute lease and the use of public lands for an Intermodal Transfer Facility, which was to be used for a rail spur from the mainline to the storage facility. On July 17, 2007, PFS and the Skull Valley Band of Goshute Indians filed a complaint in U.S. District Court challenging the September 2006 decision.

Even if PFS and the Skull Valley Band are successful in their judicial challenge to reverse the DOI decision, the project faces further obstacles. The State of Utah remains opposed to the project. Ultimately the feasibility of PFS will depend not only on the outcome of the licensing process, legislative activity, and litigation, but also on the interest and commitment to use the

[150] 71 FR 55, March 22, 2006.
[151] GNEP, Programmatic Environmental Impact Statement, http://www.gnep.energy.gov/peis.html
[152] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 5.2.3, May 16, 2008.

facility by utilities with spent fuel. Due to the considerable uncertainty surrounding the project, PFS is not a feasible alternative to additional spent fuel storage at Prairie Island.

If PFS were to become available, it may represent an opportunity to reduce the overall number of storage casks used to keep Prairie Island operating beyond 2014 or the length of time that a dry cask storage facility will be needed on-site.

Federal Geologic Repository
In 1982, Congress, through the Nuclear Waste Policy Act (NWPA), directed the Department of Energy (DOE) to characterize and recommend two geologic repository sites for the disposal of the nation's spent nuclear fuel (SNF) and high-level radioactive waste. In 1987, Congress amended the NWPA to: (1) select Yucca Mountain in Nye County, Nevada as the only site for further study, and (2) terminate the program for a second repository. In 2002, after numerous technical studies, legal challenges, and an environmental impact statement, the U.S. Senate passed and the president signed into law legislation designating Yucca Mountain as the site for the nation's first repository.[153]

Responsibility for operations at Yucca Mountain is divided among three federal agencies. The DOE is responsible for design, construction, and operation of the repository. The DOE must obtain a license for the repository from the NRC. The NRC is responsible for reviewing the license application and ensuring compliance with safety and radiological standards. The Environmental Protection Agency (EPA) is charged with setting radiological standards that will protect public health and the environment from the risks of radioactive material in the repository for up to 1 million years after the facility closes.

The DOE submitted a license application to construct the Yucca Mountain repository in June 2008. The EPA promulgated amended standards for the protection of public health and the environment in September 2008. If, after review, the NRC approves the license application, the DOE will construct the repository, and the DOE will then apply to the NRC for a license to receive SNF and HLW. The DOE's best-achievable repository schedule projects that receipt of SNF will being in March 2017.[154]

There are several significant uncertainties with respect to the ability of Yucca Mountain to serve as an off-site storage alterative for SNF from the Prairie Island plant. These uncertainties preclude Yucca Mountain as a feasible off-site storage alternative.

Timing. The PINGP currently has authorization from the State of Minnesota for enough dry casks (29) to store spent fuel generated until the end of the plant's current NRC license in 2013 and 2014. The DOE's best-achievable availability for storage at Yucca Mountain is 2017. Thus, storage at Yucca Mountain will be available at least three years too late. Given the history of the

[153] Yucca Mountain Repository: History of the Nuclear Waste Program, http://www.ocrwm.doe.gov/ym_repository/about_project/history.shtml
[154] Yucca Mountain Repository: About the Project, http://www.ocrwm.doe.gov/ym_repository/about_project/index.shtml

Yucca Mountain repository, it is uncertain that the repository will open in 2017. In 1984, DOE anticipated that the first repository would begin operation in 1998 and the second in 2004. Xcel Energy estimates that the Yucca Mountain repository will not begin receiving SNF until 2020.[155] In 2008, the U.S. House Appropriations Committee requested DOE to plan for taking custody of SNF stored at decommissioned reactor sites and placing it an interim storage facility to demonstrate that "DOE can move forward in the near-term with at least some element of nuclear waste policy."[156] In response, DOE noted that it does not have authority under the NWPA to construct or operate an interim storage facility prior to the opening of the Yucca Mountain repository. Thus, there is no possibility, absent new federal legislation, of interim storage for SNF prior to final disposal at Yucca Mountain.

Capacity. The SNF storage capacity of Yucca Mountain is a statutory limit.[157] The limit, set by the NWPA, is 70,000 metric tons heavy metal (MTHM). Under NWPA this limit will remain in place until a second repository is in operation. Of the 70,000 MTHM limit, 63,000 MTHM is reserved for SNF from commercial reactors. The current inventory of commercial SNF in the U.S. is approximately 58,000 MHTM and is increasing by about 2,000 MTHM annually. At this rate, that portion of Yucca Mountain capacity reserved for commercial SNF will be exceeded by 2010.

The queue for accepting SNF at Yucca Mountain is managed according to the principle of "old fuel first" (OFF). The oldest SNF, as measure by date of discharge from the reactor, is given the highest priority in the acceptance queue. The additional SNF generated by continued operation of the PINGP for an additional 20-yr. license term (2014-2034) would not enter the Yucca Mountain queue until several years after 2014. Thus, there is currently no room at Yucca Mountain for the SNF proposed to be generated by the PINGP during its license renewal term. To place the additional Prairie Island SNF in a federal geologic repository will require raising the statutory limit on Yucca Mountain's capacity or developing a second geologic repository.

In December 2008, U.S. Secretary of Energy, Samuel Bodman, recommended to the President and Congress that the statutory limit of 70,000 MTHM for Yucca Mountain be removed.[158] DOE studies indicate that the Yucca Mountain repository could be expanded to safely hold at least three times its current statutory limit. DOE suggests that lifting the statutory limit on Yucca Mountain is preferable to the alternative of beginning work on a second repository given the uncertainty about the future growth of nuclear power and the possibility of fuel reprocessing. If the Yucca Mountain limit is removed, then Yucca Mountain could have capacity for additional SNF from the PINGP. It's uncertain when the additional capacity at Yucca Mountain would be available.

[155] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 3A.1, May 16, 2008.
[156] Report to Congress on the Demonstration of the Interim Storage of Spent Nuclear Fuel from Decommissioned Nuclear Power Reactor Sites, December 2008, DOE/RW-0596.
[157] The Report to the President and Congress by the Secretary of Energy on the Need for a Second Repository, December 2008, DOE/RW-0595.
[158] *Id.*

Funding. The development of Yucca Mountain is paid for by customers of utilities who own and generate electricity from nuclear power plants. A fee of 1 mil (0.1 cents) for each kilowatt-hour generated by a nuclear power plant is collected and paid to the federal government. These fees are placed into the federal government's general fund and Congress must act each year to appropriate the collected funds to the Yucca Mountain project. Through December 2006, Xcel Energy's customers have paid approximately $620 million into the federal Nuclear Waste Fund to finance nuclear waste management. Nationally, customers have contributed $25.9 billion into the federal Nuclear Waste Fund. Through December 2006, the DOE has received $6.1 billion in disbursements from the Nuclear Waste Fund. For fiscal year 2008, the DOE requested $495 million and was appropriated $387 million.[159] Under-funding of the Yucca Mountain repository adds uncertainty to the timeline for completion of the repository and the possibility of expanding its capacity.

6.2 ON-SITE STORAGE ALTERNATIVES

There are three on-site alternatives to increase the present capacity at the PINGP to store spent fuel assemblies without expanding the Prairie Island ISFSI: consolidation, re-racking, and a new spent fuel storage pool.[160] Two of the three are not feasible alternatives to expansion of the ISFSI. The third alternative, a new spent fuel storage pool, is feasible, but not a more reasonable alternative than expansion of the ISFSI.

Consolidation

Fuel rod consolidation is a process that reduces the volume of spent fuel assemblies by disassembling and repackaging the fuel rods and assembly hardware. Fuel rod consolidation and hardware processing can be performed in the existing spent fuel pool. During this process, fuel rods are removed from the fuel assembly. The rods are then grouped in a closer-packed array and placed in a container with similar dimensions as a fuel assembly. The assembly hardware is compacted and then packed into separate containers in the pool or in a dry storage configuration.

Fuel rod consolidation has not been widely used and U.S. nuclear industry experience with consolidation is not extensive beyond demonstration projects. Consequently, the technology is not optimized or as commercially mature as other alternatives. Rod consolidation would require a complex and site-specific solution, if implemented.

Northern States Power (NSP, Xcel Energy) conducted a fuel rod consolidation demonstration project at the PINGP in 1986. Although some volume reductions for spent fuel were realized, the predicted compaction ratios for assembly hardware were not achievable. Additionally, the occupational dose was significantly higher than predicted because workers were subject to increased exposure from the time consuming and labor intensive fuel-handling activities.

[159] Civilian Radioactive Waste Management, Budget and Funding, http://www.ocrwm.doe.gov/about/budget/index.shtml

[160] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 5.3, May 16, 2008.

Since 1986, there have been no industry initiatives or design advances that would render rod consolidation to be a more feasible alternative. No U.S. nuclear plant owner that is considering rod consolidation as a long-term solution to spent fuel storage. Therefore, consolidation is not a feasible alternative to expanded storage at the Prairie Island ISFSI.

Re-Racking to Increase Pool Storage

Re-racking is a process by which current storage racks are replaced with storage racks designed to provide a more compact array for storing the spent fuel assemblies. Re-racking has already been performed twice at Prairie Island, once in 1977 and again in 1981. The current licensed storage capacity of the spent fuel pool is 1,386 fuel assemblies. In 1995, a feasibility study was performed to assess the potential increase in wet storage capacity via the use of state-of-the-art storage racks. The study concluded that it might be possible to gain up to 790 storage cells within Prairie Island’s spent fuel storage pools. An increase in wet storage of 790 spent fuel assemblies is not sufficient additional storage to support 20 additional years of PINGP operations. Thus, re-racking to increase pool storage is not a feasible alternative to expanded storage at the Prairie Island ISFSI.

Constructing a New Spent Fuel Storage Pool

Storage of additional spent nuclear fuel in a new storage pool would require constructing a new building on the PINGP site containing a new spent fuel storage pool and associated components. The new building and pool structure would be designed and constructed to the same or higher standards as the existing spent fuel storage pool and would be licensed and regulated by the NRC. A transfer cask would be required to transfer spent fuel assemblies from the existing pool to the new pool. Under this alternative, the number of times the spent fuel assemblies are handled would most likely increase. This handling would in turn increase radiation doses received by plant personnel.

A new storage pool would require the same components as the existing pool and would rely on active cooling rather than passive cooling systems. These components would include storage racks, pool cooling and filtration systems, pool bridge crane and fuel assembly handling tools, building ventilation systems, radiation monitoring equipment, and a cask decontamination area. It would take approximately three years to design a new pool building and to complete state and federal reviews and approvals. Construction would last approximately two years; the total design and construction period would be approximately five years. The new storage pool would likely be located at close as possible to the existing spent fuel storage area.

This alternative was evaluated in the 1991 Prairie Island Certificate of Need Application. The estimates of the project costs in 1991 were on the order of $31 million to build, $0.5 million per year to operate, and $50 million to decommission the pool. This estimate did not include costs associated with purchasing hardware or plant personnel to load and transport the spent fuel to Yucca Mountain when it becomes available. In 2008 dollars, costs for a new spent fuel storage pool would be approximately $140 million. This cost, coupled with an increase in radiation exposure to plant personnel due to extra handling of fuel assemblies, makes this alternative less attractive than expansion of the ISFSI. The financial risk and safety risks associated with a new spent fuel storage pool make the ISFSI expansion a more reasonable approach.

6.3 ALTERNATIVE STORAGE SYSTEMS

The NRC approves spent fuel dry storage systems by evaluating each design for resistance to accident conditions such as floods, earthquakes, tornado missiles, and temperature extremes, and authorizes a nuclear power plant licensee to store spent fuel in NRC-approved systems at a site that is licensed to operate a power reactor. All spent fuel storage systems must meet NRC licensing requirements established in 10 CFR 72. As a result, all alternative storage technologies provide the same level of safety and resistance to accident conditions.

Currently there are four types of NRC-approved storage systems available for dry storage of spent nuclear fuel. Xcel Energy evaluated and compared these technologies before deciding on the Transnuclear TN-40HT casks.[161] All four systems rely on passive cooling to remove decay heat from the spent fuel. They vary in the manner in which they store the spent fuel, how they accommodate the transfer of spent fuel from the power plant, and how they are transported. All of the alternative storage systems are feasible alternatives. Based on costs, projected radiological doses to personnel, ease of use, and past experience, none of the alternative storage systems appears more reasonable than the TN-40HT casks.

Non-Canister Storage Systems

The non-canister storage system is the proposed system for the Prairie Island ISFSI expansion. It is the system currently used at the Prairie Island ISFSI (see Project Description, Chapter 2, Section 3). The storage system is a metal cask with a bolted lid, O-rings, and a pressure monitoring system. The casks are designed to store up to 40 spent fuel assemblies in an internal basket or in storage cells dispersed throughout the cask. The Transnuclear TN-40 cask currently in use at Prairie Island is licensed for storage under 10 CFR 72. The Transnuclear TN-40HT cask will be licensed prior to use in the Prairie Island ISFSI.

The proposed Transnuclear non-canister system is the system that has been used at the Prairie Island ISFSI for the past 10 years. Thus, the PINGP has in place the equipment, procedures, and infrastructure needed to load and transport a cask to the ISFSI. The system is simpler than available alternatives, e.g., no welding or transfers of loaded canisters. **This simplicity facilitates the eventual removal of the casks to a federal repository. Of the storage systems discussed in this section, the non-canister system is the easiest to handle and transport.** Additionally, the relatively higher number of fuel assemblies that may be stored within a cask, i.e., 40 vs. 24, reduces the number of casks/containers that must be loaded, transferred, and stored in the ISFSI. This reduced handling results in reduced radiological doses to plant personnel.

[161] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 5.4, May 16, 2008.

Horizontal Canister Systems

The horizontal canister storage system consists of: (1) a welded sealed metal canister to contain spent fuel assemblies and provide the primary confinement boundary, (2) concrete storage modules that house the canisters, (3) a transfer cask to handle the canisters, (4) and a transportation cask to ship the canisters offsite. The storage module, transfer cask and transportation cask provide radiation shielding and physical protection during canister transportation, transfer, or storage. A typical canister will hold 24 or 32 spent fuel assemblies. Currently, the only horizontal system available is the TN NUHOMS (Nuclear Horizontal Modular System), which is designed, licensed and manufactured by Transnuclear, Inc. The system is used at several nuclear power plants throughout the United States including Xcel Energy's Monticello nuclear generating plant.

Transitioning from the current non-canister system to a canister system would require construction at the ISFSI site to occur approximately 10 years earlier. It would also require the purchase of new major equipment (e.g., a transfer cask, trailer, automatic welding machines, and a building to store new equipment). The loading process is more complicated for the canister storage system, e.g., welding and transfer of a canister, which would require new and specialized training for personnel. Currently, NRC licensed horizontal canister systems can store 24 fuel assemblies of the high burnup fuel utilized at Prairie Island. Thus, this system would require 66 percent more canisters be purchased, loaded, transferred, and stored than casks in the proposed system. Handling more canisters would increase the radiological dose received by plant personnel and would increase the cost per fuel assembly stored.

Vertical Canister Systems

Vertical canister storage systems are similar to horizontal systems except that the canisters and concrete modules are stored vertically on a pad as opposed to horizontally. For the reasons discussed above, these systems are not preferable to the proposed Transnuclear non-canister system.

Modular Vault Dry Storage Systems

The modular vault dry storage (MVDS) system is a large concrete storage vault designed to store multiple storage containers of spent nuclear fuel. MVDS differs from other systems in that, rather than storing individual casks on a concrete storage pad outdoors, the spent fuel is stored in tube like containers within an indoor concrete vault. One fuel assembly is loaded into each container. The MVDS system consists of: (1) the storage vault, (2) fuel storage containers to hold the spent fuel assemblies, (3) a container handling machine to transfer the containers, (4) a structure that supports the fuel containers, and (5) an overhead crane to lift the container handling machine. Several vaults can be constructed end-to-end to provide a larger vault. Each vault is designed to hold up to 83 fuel assemblies, each within its own storage container.

The MVDS System is expected to have relatively greater upfront costs for design, licensing, and installation compared to the proposed non-canister system. The vault system is used by one utility and its primary purpose was to support decommissioning of the Fort St. Vrain plant in Colorado. Transferring fuel to the MVDS system would be relatively more time consuming and complicated since only a single fuel assembly is placed in each storage container and transfer of the container involves additional handling compared to the proposed system.

6.4 ALTERNATIVE ISFSI SIZE – NO ISFSI EXPANSION, CEASING PINGP OPERATIONS in 2014

Xcel Energy's proposed 35-cask expansion of the Prairie Island ISFSI is intended to support storage of spent nuclear fuel for the 20 year term of its proposed license renewal (2014 – 2034). The availability of off-site storage alternatives is uncertain. Accordingly, to ensure that the Prairie Island plant is reliably available and to facilitate long-term planning, it is reasonable to consider the proposed Prairie Island ISFSI expansion appropriately sized. No larger or smaller expansion is proposed by Xcel Energy. No other expansion size is considered in this document, except consideration of a no expansion alternative, which is discussed here.

If a Certificate of Need is not granted by the Minnesota Public Utilities Commission for the proposed ISFSI expansion, the PINGP could not operate beyond 2014 and would be forced to shut down. The PINGP would be decommissioned. To complete the decommissioning process, spent fuel assemblies would be removed from the reactor and pool, and eventually stored at the Prairie Island ISFSI. Thus, denial of a Certificate of Need does not eliminate the need for additional ISFSI storage, but rather changes the purpose of dry cask storage expansion from support for continued operations to support for decommissioning. Xcel Energy would be required to apply to the Commission for an ISFSI expansion to accommodate decommissioning.

It's anticipated that 39 additional dry storage casks will be required to decommission the PINGP. Thus the potential human and environmental impacts of a decommissioning expansion would be very similar to the continuing operation impacts discussed in this chapter (35 casks).[162]

There would be some additional impacts due to decommissioning. Decommissioning activities must be completed within 60 years after operations cease and are subject to environmental review under the National Environmental Policy Act. The NRC Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (NUREG-0586) provides a summary of decommissioning activities, generic environmental impacts of the decommissioning process, and an evaluation of potential changes in impact that could result from deferring decommissioning.[163] Decommissioning of the Prairie Island plant is more specifically discussed in Appendix J of Xcel Energy's Certificates of Need Application.[164]

Finally, there would be additional human and environmental impacts from activities undertaken to replace the electrical power currently produced by the PINGP. These potential impacts are discussed in Section 7 of this chapter.

[162] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 4.6.3, May 16, 2008.
[163] NRC (U.S. Nuclear Regulatory Commission). 1988. *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*. NUREG-0586. Office of Nuclear Regulatory Research. Washington, D.C.
[164] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7.1, May 16, 2008.

7.0 PRAIRIE ISLAND PLANT ALTERNATIVES

The "No ISFSI Expansion" alternative, described in Section 6.4 of this chapter, would lead to the shutdown and decommissioning of the PINGP and subsequent loss of 1,100 megawatts (MW) of generating capacity. This section discusses alternatives for replacing this electrical power and examines the potential human and environmental impacts of these alternatives.

7.1 ELECTRICAL ENERGY SOURCES

In 2005, Minnesota's electrical generators had a total generating capacity of 12,105 megawatts electrical (MWe).[165] This capacity is primarily coal (45%), natural gas (26%), and nuclear (13%), with smaller contributions from renewables (8%), petroleum (6%), and others sources.

The PINGP currently has a net generating capacity of 1,100 megawatts electrical (MWe). The plant provides approximately 10 percent of the electricity used by Xcel Energy customers. In 2007, the plant generated approximately 8,913,000 megawatt-hours (MWh) of electricity.[166] The plant is a reliable energy producer with an average capacity factor over the past five years of 90.2 percent.

7.2 ALTERNATIVES to CONTINUED OPERATION of the PINGP

This section discusses the potential human and environmental impacts of reasonable alternatives for replacing the electrical power currently generated by the PINGP.[167] The PINGP is highly reliable plant that produces a substantial portion of Xcel Energy's generation portfolio. Reasonable alternatives would be energy sources, or combinations of sources, that could effectively replace the electrical generating characteristics of the PINGP.

Xcel Energy's Environmental Report for its operating license renewal considered three reasonable alternatives to the PINGP: (1) purchased power, (2) gas-fired generation, and (3) coal-fired generation.[168] Xcel Energy's Certificates of Need application considered two feasible alternatives to the PINGP: (1) coal-fired generation with carbon sequestration and (2) gas-fired generation.[169] Other possible energy sources (e.g., wind, DSM) were not considered reasonable alternatives to the PINGP. Factors that made these options unreasonable included reliability, economics, and difficulty in implementation.[170]

[165] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, May 16, 2008.
[166] Energy Information Administration (EIA), http://www.eia.doe.gov/cneaf/nuclear/page/nuc_generation/usreact07.xls
[167] Minn. Rules 4410.2300, Part G.
[168] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, May 16, 2008.
[169] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 4, May 16, 2008.
[170] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7.2.3, Environmental Report, May 16, 2008

Considerations of reliability, economics (in particular, valuing externalities), and difficulty of implementation are, for the greater part, beyond the scope of this document. These factors will be discussed by parties to the Certificates of Need proceedings, including by the Office of Energy Security, Energy Regulation and Planning unit. General economic impacts of PINGP alternatives are discussed in Section 7.3 of this chapter. For purposes of analysis here, reasonable alternatives include energy sources which by themselves, or in combination with other resources, could effectively replace the electrical generating characteristics of the PINGP.

Six reasonable alternative scenarios to continued operation of the PINGP are discussed in this section:

1) Purchased power
2) Pulverized coal power plant
3) Pulverized coal power plant with partial carbon sequestration
4) Natural gas combined cycle plant
5) Large wind energy conversion system (LWECS) and natural gas plant combination
6) Renewable resource technologies

Potential human and environmental impacts of each of these scenarios could be reduced through demand side management (DSM). Thus, the impacts discussed for each of the scenarios are bounding, i.e., they are worst-case impacts which could be mitigated by DSM. For example, if DSM could reduce the need for generating capacity by 10 percent, then environmental impacts would be reduced by 10 percent.

Human and environmental impacts of the alternative scenarios, because they are hypothetical scenarios, are of a generic nature. General characteristics of the energy sources in these scenarios are discussed in Chapter 1, Section 3. Land use, fuel consumption, emissions, and other environmental characteristics are estimated for each scenario. Additional facilities such as new natural gas supply pipelines, new rail for delivery of coal, and new transmission lines to connect to the grid would be required for some scenarios.

Purchased Power
A purchased power scenario would include a long-term power purchase agreement between Xcel Energy and a power provider (e.g., utility, group of utilities, merchant plant). Impacts from purchased power are difficult to estimate due to two uncertainties: (1) uncertainty as to the how the purchased power will be generated and (2) uncertainty related to transmission of the power itself.

If there is not sufficient power in Mid-Continent Area Power Pool (MAPP) for purchase, then a power purchase scenario would likely require construction of an energy source somewhere in the region. The need to construct a replacement energy source as well as many of the potential impacts from the source would be shifted to this region. Technologies that would be used to generate the purchased power are a matter of conjecture; however, based on Minnesota capacity and utilization data and national and regional projections, Xcel Energy believes that the most likely candidates would be coal-fired and nuclear sources during off-peak periods and gas-fired sources during on-peak periods, probably supplemented by power from renewable sources, particularly wind turbines.[171]

In view of constraints in the existing transmission infrastructure, Xcel Energy projects that substantial additions to either the 500 kV or 345 kV transmission systems in the Upper Midwest would be required to import power into Minnesota in amounts that would replace generation from the PINGP.[172] The construction and operation of new transmission lines would impact land uses, ecosystems, and aesthetics. Assuming for purposes of analysis that 100 miles of new 345-kV transmission line with a 150-foot wide right-of-way is required, approximately 1,800 acres would be affected.

Pulverized Coal Power Plant

A pulverized coal power plant scenario would replace the PINGP with a supercritical, pulverized coal-fired steam plant with advanced, clean-coal technology and air emission controls. Such technology is commercially available in large-capacity unit sizes that could effectively replace the generating capacity of the PINGP.

The plant would consist of two 550 MWe units (for a total of 1,100 MWe). Projected operating and environmental characteristics of the plant are shown in **Table 7-1**.

The plant would be designed to meet applicable Minnesota Pollution Control Agency (MPCA) emissions standards and Minnesota Department of Natural Resources (DNR) water appropriation permit standards. As noted in Chapter 1, Section 3, the primary environmental impacts of a pulverized coal power plant include air emissions, solid waste (ash), discharge of waste heat to the environment, land use, and rail or barge traffic.

Pulverized Coal Power Plant with Partial Carbon Sequestration

A pulverized coal power plant with partial carbon sequestration scenario would replace the PINGP with a supercritical, pulverized coal power plant with some type of carbon sequestration technology. Carbon sequestration technology is not currently commercially available; it is confined to demonstration projects. U.S. Department of Energy analysis identifies the price of the technology as a limiting factor in its deployment:

> Existing [carbon] capture technologies…are not cost-effective when considered in the context of sequestering CO_2 from power plants. Most power plants and other large point sources use air-fired combustors, a process that exhausts CO_2 diluted with nitrogen. Flue gas from coal-fired power plants contains 10-12 percent CO_2 by volume, while flue gas from natural gas combined cycle plants contains only 3-6 percent CO_2. For effective carbon sequestration, the CO_2 in these exhaust gases must be separated and concentrated.

[171] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7, Environmental Report, May 16, 2008
[172] *Id.*

> CO_2 is currently recovered from combustion exhaust by using amine absorbers and cryogenic coolers. The cost of CO_2 capture using current technology, however, is on the order of $150 per ton of carbon - much too high for carbon emissions reduction applications. Analysis performed by SFA Pacific, Inc., indicates that adding existing technologies for CO_2 capture to an electricity generation process could increase the cost of electricity by 2.5 cents to 4 cents/kWh depending on the type of process. Furthermore, carbon dioxide capture is generally estimated to represent three-fourths of the total cost of a carbon capture, storage, transport, and sequestration system.[173]

Operating and environmental characteristics of this plant would be similar to the pulverized coal power plant, with an anticipated 50 percent reduction in CO_2 emissions. There would likely be a greater land requirement for this plant in order to place carbon sequestration facilities.

Natural Gas Combined Cycle Plant

A natural gas combined cycle plant scenario would replace the PINGP with a combined cycle natural gas plant. For purposes of analysis, the plant would consist of two 520 MWe units (for a total of 1040 MWe). Though this generating capacity is slightly less than that of the PINGP, it facilitates comparisons with recently constructed plants and is reasonably comparable. Each unit is assumed to consist of two steam combustion turbines (CTs), each with an associated heat recovery steam generator (HRSG) that together supply steam to a single steam turbine generator.

Projected operating and environmental characteristics of the plant are shown in **Table 7-2**.

The NGCC plant would be designed to meet applicable MPCA emissions standards. **Offsite infrastructure needed for this scenario could include a natural gas supply pipeline and new transmission facilities to connect the plant to the grid. However, if NGCC plant was sited at Prairie Island, no new transmission facilities would be required. The feasibility of converting (repowering) the PINGP to an NGCC plant has been studied.[174]**

LWECS and Natural Gas Plant

In the LWECS and natural gas plant scenario, the PINGP is replaced by 990 MW of natural gas generation and 440 MW of wind power generation. The relative generation contributions of each power source are based on the LWECS and gas plant scenario proposed in the Monticello Nuclear Generating Plant ISFSI EIS.[175] Wind power is an intermittent source of electric generation; power output varies depending on the speed of the wind and ability of the transmission system to carry the power when it is generated. Wind power's discontinuous availability means it is not, by itself, well suited to replace the generating characteristics of the

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[173] Carbon Capture Research, http://fossil.energy.gov/sequestration/capture/index.html
[174] Feasibility Study for Conversion of Prairie Island to Natural Gas Fired Generation, November 2002, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={CCE97585-7A52-4194-8EE0-959DC9BAB69F}&documentTitle=20096-38560-03
[175] Monticello Spent Fuel Storage Installation Final Environmental Impact Statement, March 2006, http://energyfacilities.puc.state.mn.us/documents/9901/Final-EIS-CN-05-123.pdf

PINGP. In order to provide an equivalent reliability and generating capacity, wind power must be combined with some other energy source or storage capability.[176] In this scenario, wind power is paired with natural gas power generation.

The operating and environmental characteristics of a combined cycle natural gas plant are shown in Table 7.2. This scenario assumes the same operating characteristics, but with impacts modified to reflect the addition of wind power generation. The operating and environmental characteristics of a typical LWECS (wind farm) are shown in **Table 7-3**. Projected environmental impacts of an LWECS and natural gas plant scenario are shown in **Table 7-4**.

The environmental impacts an LWECS – natural gas plant scenario are dependent on a number of site-specific factors such as the availability of a large gas pipeline, adequate wind resources, sufficient transmission capacity, and proximity to power demand. Thus, there are uncertainties in estimating these impacts.

Renewable Resources Technologies

In the renewable resources technologies scenario, the PINGP is replaced by a combination of renewable resource technologies – wind, biomass, anaerobic digestion, and solar. Renewable energy sources have the potential to be sustainable energy sources with relatively fewer environmental impacts. Renewable energy sources are typically diffuse and geographically dispersed. These characteristics have potential benefits and drawbacks. Benefits include fewer environmental impacts (though impacts vary with the technology) and the potential to integrate energy sources more directly into communities which they might serve. Drawbacks include the need to connect dispersed energy sources to the electrical grid. These connections may require the construction of additional transmission lines. Because they rely on relatively diffuse energy sources, renewables also have relatively lower capacity factors, i.e., their power generation tracks the sporadic nature of their energy source (e.g., wind, sunlight).

The scenario discussed here is adapted from the distributed generation scenario proposed in the Monticello Nuclear Generating Plant ISFSI EIS.[177] This is one scenario of many possible renewable technology scenarios; nonetheless, it is representative and provides a reasonable basis for comparing potential impacts.

The operating and environmental characteristics of an LWECS are shown in Table 7-3. This scenario assumes the same operating characteristics, but with impacts modified to reflect the addition of other energy sources. The operating and environmental characteristics of typical biomass power generation, anaerobic digestion, and solar (photovoltaic) power generation are shown in **Table 7-5**.

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[176] As noted in Chapter 1, Section 3, the growth of interconnected and geographically dispersed wind power generation in the Upper Midwest has increased the system-wide capacity and reliability of this generation alternative.

[177] Monticello Spent Fuel Storage Installation Final Environmental Impact Statement, March 2006, http://energyfacilities.puc.state.mn.us/documents/9901/Final-EIS-CN-05-123.pdf

For purposes of analysis, this scenario assumes that each renewable resource technology provides a percentage of the total replacement generating capacity for the PINGP. In this scenario the PINGP is replaced by 1600 MW of wind generation, 700 MW of biomass generation, 50 MW of anaerobic digestion generation, and 200 MW of solar generation. This combination provides an approximate accredited generation capacity of 976 MW.

Wind power. This scenario relies heavily on generation by large energy wind conversion systems (LWECS). As noted above, this technology has a relatively lower capacity factor and performs best when combined with another energy source.

Biomass. This scenario also relies heavily on generation powered by biomass – including woody biomass, crop residues, and biodiesel. Biomass technologies are commercially available and there is strong state and federal support for their development. As an example, in September, 2008, Xcel Energy announced its intention to convert a coal-fired unit at its Bay Front Power Plant in Ashland, WI, to biomass gasification technology.[178] Challenges to implementing biomass technology include long-term biomass availability, transportation, and competition for biomass with other uses, e.g., food, fiber.

Biodiesel is included in this scenario as a biomass generation source. Biodiesel can be used in commercially available diesel fueled turbines and associated generators. Biodiesel is readily available in Minnesota; the state has capacity to produce approximately 63 million gallons of biodiesel per year.[179] Ethanol is not included in this scenario as a biomass generation source. Reasons for not including ethanol include: (1) a lack of suitable ethanol fueled generating equipment, (2) the quantity of ethanol that would be required, and (3) the lack of mature markets for ethanol as an electrical generation resource.

Anaerobic Digestion. Anaerobic digesters of animal manure, food processing waste, and municipal waste water solids provide a limited amount of power generation in this scenario. The capacity factor for anaerobic digesters is based on experience in Minnesota with anaerobic digestion of dairy cow manure.[180]

Solar. Solar power (photovoltaic) provides a limited amount of power generation in this scenario. Solar power is a renewable resource with few operational environmental impacts. Photovoltaic technology is just beginning to reach commercial viability and utility scale application.[181] Due to it reliance on direct sunlight, it has a very limited capacity factor.

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[178] Xcel Energy Announces Largest Biomass Plant in Midwest, September 30, 2008, http://www.xcelenergy.com/Company/Newsroom/Pages/XcelEnergyAnnouncesLargestBiomassPlantintheMidwest.aspx

[179] Prospects for Expansion of the Soy-Based Biodiesel Industry in Minnesota, November 2006, http://www.auri.org/research/diesel/pdfs/Executive%20Summary%20Bio-Diesel%20Study%20December%2006.pdf

[180] Final Report: Haubenschild Farms Anaerobic Digester, August 2002, http://www.mnproject.org/pdf/Haubyrptupdated.pdf

[181] PG&E Signs Historic 800 Mw Photovoltaic Solar Power Agreements With Optisolar and Sunpower, http://www.pge.com/about/news/mediarelations/newsreleases/q3_2008/080814.shtml

The potential environmental impacts of a renewable resources technologies scenario are shown in **Table 7-6**. These impacts are highly dependent on the relative proportion of each technology in the scenario.

7.3 COMPARISON of IMPACTS of the ALTERNATIVES

This section compares the potential human and environmental impacts associated with continued operation of the PINGP with those of the six alternatives scenarios. Human impacts include economic, employment, and sociological impacts.[182] **Detailed economic analysis was conducted by the Office of Energy Security, Energy Regulation and Planning (OES-ERP) unit in the Certificates of Need proceedings for this project. See the testimony of Ham, Rakow, and Davis.**

Environmental Impacts

The potential environmental impacts associated with alternatives to the PINGP are summarized in **Table 7-7**. Potential impacts from operation of the PINGP and Prairie Island ISFSI are discussed in this document. As appropriate, these impacts have been included in Table 7-7 for comparison purposes.

PINGP and Prairie Island ISFSI. The relative environmental advantages of continued operation of the PINGP include no new land use, no CO_2, SO_x, or NO_x emissions, and a compact fuel cycle with relatively small fuel throughput and solid waste generation. Additionally, continued operation of the PINGP requires no new transmission line construction. The environmental impacts include water consumption, discharge of heat to the environment, and controlled emissions of radioactivity (see Chapter 1, Section 4 and Chapter 2, Sections 4 and 5).

Fossil Fuel Technologies. The relative environmental advantages of fossil fuel technologies are limited. Fossil fuel technologies require high fuel throughput which creates substantial CO_2, SO_x, and NO_x emissions as well as solid wastes (ash). If operated without evaporative cooling towers, these technologies can consume relatively less water than the PINGP. Carbon dioxide (CO_2) is now understood to be the most important greenhouse gas (GHG) – responsible for global warming and associated environmental impacts including significant changes to world weather systems and ecosystems.[183] Sulfur oxides (SO_x) can cause acid rain and human respiratory illness.[184] Nitrous oxides (NO_x) are greenhouse gases that also cause ozone and related respiratory illnesses.[185] As an example of the debilitating effect of nitrous oxides, a recent EPA rulemaking to strengthen NO_x standards projected that the rulemaking change would avoid 200 – 2000 premature deaths annually by 2020.[186] Potential local impacts from SO_x and

[182] Minn. Rules 4410.2300, Subd. H.
[183] Climate Change 2007: Synthesis Report, Summary for Policymakers, An Assessment of the Intergovernmental Panel on Climate Change (IPCC), http://www.ipcc.ch/
[184] Health and Environmental Impacts of SO_2, http://www.epa.gov/oar/urbanair/so2/hlth1.html
[185] Health and Environmental Impacts of NO_x, http://www.epa.gov/air/urbanair/nox/hlth.html
[186] Strengthened National Standards for Ground Level Ozone, http://www.epa.gov/air/ozonepollution/actions.html#mar07s

NO_x emissions can be mitigated by dispersion of these emissions by prevailing winds to other regions of the country. Dispersion is not a mitigating strategy for CO_2 emissions.

Impacts related to fossil fuel technologies can be mitigated by sequestering carbon before it can become a greenhouse gas (scenario #3), or by using natural gas, which has a relatively lower potential for CO_2 generation (scenario #4). A natural gas plant, compared to other fossil fuel technologies, has relatively lower SO_x and NO_x emissions, consumes less water for operations, and generates no solid wastes. Of the fossil fuel technologies, a natural gas plant has the fewest potential environmental impacts. All of the fossil fuel technologies, if sited other than at the current Prairie Island plant, would likely require the development of new transmission lines.

Renewable Resource Technologies. The relative environmental advantages of renewable resource technologies vary with the technology. In general these technologies use or capture a more diffuse energy resource. Thus, they typically have a relatively greater land use impact and lower waste impacts. Of the renewable resource technologies that are commercially available, wind power has the fewest potential environmental impacts. Wind turbines do not consume fuel or water, or create emissions or wastes. They do have a relatively higher land use impact. However, these impacts are limited because wind turbine operations allow for concurrent land uses, e.g., agriculture. Direct land use impacts – impacts associated with the physical footprint of the wind turbine – are minor. Of the technologies considered in this section, including the PINGP, wind power has the fewest potential environmental impacts.

Renewable resource technologies that utilize carbon energy sources have drawbacks associated with fossil fuel technologies, e.g., emissions, solid wastes. However, these technologies (biomass, biodiesel, anaerobic digestion) have a greater potential to operate as carbon neutral technologies. Because they depend on current, annually renewable carbon stocks (plants, trees, manures), they cannot as easily draw down their fuel stocks. Or, rather, the effect of doing so is more readily apparent as compared to fossil fuel technologies.

Renewable resource technologies may or may not require the development of new transmission lines to distribute their power generation. If transmission lines are needed, these lines would have negative environmental impacts associated with them. A study commissioned by the Minnesota Legislature concluded that there is potential for locating 600 megawatts (MW) of dispersed renewable generation within Minnesota's existing transmission infrastructure.[187] Thus, approximately half of the PINGP's generating capacity could be met with renewable resource technologies that do not require additional transmission. Depending on the transmission needs for the remainder of the renewable resource capacity required, environmental impacts from transmission lines for renewable

[187] Dispersed Renewable Generation Transmission Study, June 2008, http://www.state.mn.us/portal/mn/jsp/content.do?subchannel=-536881736&programid=536916477&sc3=null&sc2=-536887792&id=-536881351&agency=Commerce

resource technologies could be less than those for fossil fuel technologies.[188] If renewable resource technologies were combined with a natural gas repowering of the PINGP, there could be no additional transmission required, i.e., the renewable resources could be dispersed across existing transmission infrastructure and the Prairie Island site has existing transmission infrastructure regardless of the energy source.

Risks and Uncertainties. The alternative scenarios to the PINGP all involve impacts, risks, and uncertainties. In the near term, renewable resource technologies will likely need to be supplemented by fossil fuel technologies in order to replace the generating characteristics of the PINGP. Fossil fuel technologies create significant risks and uncertainties related to global warming. Though research has illuminated the linkages between human activities, greenhouse gas (GHG) emissions, and global warming, there is uncertainty as to the projected effects of these linkages, how to mitigate them, and how to value them in public decision-making processes.[189,190]

The PINGP and Prairie Island ISFSI avoid the uncertainties of GHG emissions, but do so by trading them for uncertainties related to the safe handling, storage, and eventual placement in a federal repository of spent nuclear fuel (SNF) generated at the PINGP. The potential human and environmental impacts of handling and storing SNF have been discussed in this document in the context of the Prairie Island ISFSI. They are not anticipated to be significant. Nonetheless, uncertainties remain, e.g., the uncertainty of a terrorist attack on the ISFSI, the uncertainties related to the availability of a federal repository.

All this is to say that potential human and environmental impacts associated with the PINGP and alternatives to the PINGP – in particular, those related to safe handling of SNF and to GHG emissions – are subject to social-political-institutional forces and value judgments. Accordingly, there may be differences of opinion as to potential risks and impacts.

Economic and Employment Impacts

Xcel Energy analyzed the economics of alternatives to the PINGP in its Certificates of Need application.[191] Its analysis indicated that continued operation of the PINGP was more cost effective than coal-fired or gas-fired generation. In addition, sensitivity analysis indicated that the cost effectiveness of the PINGP was relatively robust, i.e., not sensitive to changes in assumptions about costs and externalities. **Under all scenarios examined, continued operation**

[188] Id. Phase II of the study will examine the potential for locating an additional 600 MW of generation on the existing transmission infrastructure, for a total of 1200 MW. This total would exceed the generating capacity of the PINGP.
[189] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 11.4, May 16, 2008
[190] Climate Change 2007: Synthesis Report, Summary for Policymakers, An Assessment of the Intergovernmental Panel on Climate Change (IPCC), http://www.ipcc.ch/
[191] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 4, May 16, 2008 and Supplemental Filing, March 20, 2009, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=eDocketsResult#{3FD82E10-A1D4-4968-B1C6-1238FED9F025}

of the PINGP was less expensive than alternatives by between $0.44 billion and $2.78 billion dollars.[192]

The Minnesota Department of Commerce, Office of Energy Security, analyzed alternatives to the PINGP, including renewables (wind), coal-fired generation, gas-fired generation, and combinations of renewables with least-cost non-renewables. Its analysis indicated that continued operation of the PINGP, under a variety of cost and externality scenarios, was between $0.51 billion and $2.78 billion dollars less expensive than the alternatives**[193] **(see Table 7.8). The analysis incorporated externalities (societal costs), e.g., greenhouse gas emissions (CO_2), radiological exposure. Among the scenarios examined was the possibility of no increase in demand for electricity through 2034, a scenario under which continued operation of the PINGP was between $0.77 billion and $1.93 billion dollars less expensive than the alternatives ("no load growth" scenario). Inclusion of costs for dry cask storage for up to 200 years at the Prairie Island ISFSI did not significantly affect the analysis – continued operation of the PINGP remained the least-cost alternative.[194]

Economic impacts to Minnesota communities and citizens were analyzed in Xcel Energy's Environmental Report accompanying its NRC license renewal application.[195] This analysis projects socioeconomic impacts of PINGP alternatives to be "moderate" to "large," based on loss of tax revenue for the City of Red Wing. This impact is more properly framed as economic impact to citizens of Red Wing, not citizens of Minnesota. Alternatives to the PINGP, located in other cities within Minnesota, would generate similar tax revenues for these cities. Thus, the economic impact within Minnesota would be minimal. Loss of the PINGP would disrupt tax revenues and negatively impact citizens of Red Wing; however, these revenues would likely be generated elsewhere in the state by a PINPG alternative and positively impact citizens in these regions.

The Environmental Report estimates that economic impacts due to changes in employment would be small. However, the report does project changes in long-term employment under alternative scenarios to the PINGP. The report estimates that it takes approximately 520 permanent employees to operate the PINGP; whereas, it would take only 120 employees to operate a coal plant, and 35 employees to operate a gas plant.[196] Thus, alternatives to the PINGP could have an adverse economic impact related to long-term employment. As the Environmental

[192] Id. Revised Table 4-4 PVRR Sensitivities
[193] Direct Testimony of Dr. Steve Rakow, April 22, 2009, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=eDocketsResult#{73C3F5D1-548D-46C0-BDB5-CF9640957F18}; Direct Attachment of Dr. Steve, Rakow, April 22, 2009, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=eDocketsResult#{3213F1D9-AA7C-420D-A148-E2875275487C}.
[194] Rebuttal Testimony and Attachments of Dr. Steve Rakow, May 22, 2009, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={2DD285A6-F035-47A3-92E9-B1E86ABB0C7A}&documentTitle=20095-37422-01
[195] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, May 16, 2008.
[196] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, Table 8-2, May 16, 2008.

Report did not analyze potential employment impacts related to wind power generation or other renewable resource technologies, it's uncertain how these alternatives would impact employment. Because these technologies harness relatively more diffuse energy sources, it's likely that they would employ more persons than a coal or gas plant. [197] Thus, renewable resource technologies could have a neutral or positive long-term employment impact compared to continued operation of the PINGP.

All alternatives to the PINGP would likely have a positive economic impact on short-term construction employment.

Sociological Impacts

Potential sociological impacts related to the PINGP and PINGP alternatives are difficult to assess. Sociological impacts include but are not equivalent to socioeconomic impacts. The relative economic impacts of the PINGP alternative scenarios are discussed in this section. The economic dislocation that would occur to citizens of Red Wing should the PINGP be shut down and an alternative constructed, is likely better described as a sociological impact than an economic impact to the State of Minnesota. All of the alternative scenarios would disrupt the Red Wing community. They would also likely foster growth in other Minnesota communities.

Aesthetics is likely a factor in assessing sociological impacts. How citizens feel about their community depends to some degree on the perceived beauty that they interact with on a daily basis. Thus, generally, alternatives that require new land use (e.g., new power plant, new transmission lines, new pipeline) would likely have a negative aesthetic and sociological impact. Continuing operation of the PINGP (no new land use) would likely have a neutral aesthetic and sociological impact. There will be differences of opinion as to the extent of new land use impacts. For example, some persons find wind turbines graceful and peaceful; others find them to be a blight on the landscape.

Additionally, new land use could interfere with cultural and social activities, e.g., hunting, gathering, recreation, worship. When such activities are associated with a particular geography, impacts to this geography create negative sociological impacts.

Finally, psychology likely plays a factor in sociological impacts. The psyche of a community could be influenced independent of aesthetics. For example, a person might be positively impacted by the thought of using renewable resource technologies, yet not like the sight of wind turbines out their back window. The potential psychological impacts of the PINGP are discussed in Chapter 1, Section 4.5. **The potential psychological impacts borne by the Prairie Island Indian Community (PIIC), and other communities near the PINGP, are discussed in Chapter 2, Section 5.4.**

Whether the psychological impacts of PINGP alternatives would be relatively less or more than continued operation of the PINGP is uncertain; **however, alternatives that use relatively more**

[197] Putting Renewables to Work: How Many Jobs can the Clean Energy Industry Generate?, RAEL Report, University of California, Berkeley, 2006, http://rael.berkeley.edu/old-site/renewables.jobs.2006.pdf

diffuse energy sources would have less potential for impacts that can be projected through distance or time. All of the alternatives would be subject to incidents, i.e., they are all human endeavors. Alternatives that use diffuse energy sources (e.g., wind, solar) are less capable of turning an incident into a far-reaching impact.

A negative psychological impact could occur due to fear or distrust of a PINGP alternative that is located close to a citizen's home. For example, research on the effect of transmission lines on property values indicates that part of the potential negative impact on property values is due to safety concerns of homeowners.[198] Research also indicates that the passage of time can ameliorate psychological impacts, i.e., known risks that have been lived with are less likely to have a negative psychological impact than the introduction of new risks. **Thus, the type of PINGP alternative, its location(s), and a community's sense of whether a new risk is being introduced are all factors in determining psychological and sociological impacts.**

[198] Power Lines and Property Values Revisited, Appraisal Journal, Fall 2007, http://www.entrepreneur.com/tradejournals/article/171851335.html

8.0 UNAVOIDABLE IMPACTS AND MITIGATION

The primary impact of the proposed expansion of dry cask storage at the Prairie Island ISFSI is an increase in the annual radiological doses received by plant personnel and the general public. The increase in radiological exposure to plant personnel results from cask handling and skyshine radiation. The increase in radiological exposure to the general public is due to skyshine radiation. The increases in radiological doses are not anticipated to be significant and all doses are projected to remain below federal regulatory limits (See Chapter 2, Section 5). Accordingly, mitigating measures, beyond policies and procedures already in place at the PINGP, do not appear necessary.

Indirect or cumulative impacts of the proposed dry cask storage expansion include: (1) those associated with continued operation of the PINGP until 2034, and (2) use of the Prairie Island ISFSI to facilitate decommissioning of the PINGP. Unavoidable impacts related to continued operation of the PINGP are discussed in Chapter 1 of this document. In addition, continued operation introduces an incremental risk related to the possibility of an incident at the PINGP which could result in radiological exposures to plant personnel, emergency responders, and the general public. These exposures are projected to be below federal regulatory limits. This risk is not anticipated to be significant (See Chapter 2, Section 5).

Use of the Prairie Island ISFSI to facilitate decommissioning of the PINGP introduces impacts related to the placing of additional casks on the ISFSI pad and the storage of these casks until placement in a federal repository. Handling and storing the casks will increase radiological exposures to plant personnel. Skyshine radiation from the casks will increase radiological exposure to the general public. The increases will be within federal regulatory limits. Storage of the dry storage casks until placement in a federal repository introduces an incremental risk related to the possibly of an incident at the Prairie Island ISFSI that could result in radiological exposures. From a technical standpoint, this risk is not anticipated to be significant. However, there are uncertainties in the socio-political components of the risk that, left unmanaged, would make the risk significant, i.e., a lack of institutional control during the time period for which the casks are stored at the Prairie Island ISFSI would lead to significant radiological exposures and health impacts (See Chapter 2, Section 5).

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TABLES

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FIGURES

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