

**Table 2.1. Federal Regulations and Guidance Applicable to the Prairie Island Plant**

<b>Title</b>	<b>Agency</b>	<b>Regulation</b>
Requirements for Renewal of Operating Licenses for Nuclear Power Plants	U.S. NRC	10 CFR 54
Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.	U.S. NRC	10 CFR 51
Electronic Maintenance and Submission of Information. Federal Register Notice – Final NRC Rule.	U.S. NRC	68 FR 58792
Industry Guideline for Implementing the Requirements of 10 CFR part 54 – The License Renewal Rule, Rev 4	Nuclear Energy Institute	NEI 95-10
Standard review Plan for Review of License Renewal Applications for Nuclear Power Plants	U.S. NRC	NUREG-1800
Generic Aging Lessons Learned (GALL) Report	U.S. NRC	NUREG-1801
NRC regulations for source material, special nuclear material, and by-product material licenses	U.S. NRC	10 CFR 30, 40, 70
NRC regulations for orders, license conditions, exemptions, waste and spent fuel storage, transportation, and technical specifications including plant-specific design-basis information.	U.S. NRC	10 CFR 2, 19, 20, 21, 26, 30, 40, 50, 51, 54, 55, 70, 71, 72, 73, 100
NRC enforcement of U.S. Environmental Protection Agency (EPA) rules on nuclear power operations.	U.S. NRC, U.S. EPA	40 CFR 190 and 191
NRC regulations for the release of effluents from nuclear generating plants and dose limits.	U.S. NRC	10 CFR 20 and 50
Nuclear generating plants are required to have a formal emergency response plan and to exercise that plan periodically to ensure workability.	U.S. NRC, HSEM	10 CFR 50

**Table 3.1 Spent Fuel Assembly Inventory**

<b>Date</b>	<b>Number of Additional Spent Fuel Assemblies Discharged During Unit 1 Refueling</b>	<b>Number of Additional Spent Fuel Assemblies Discharged During Unit 2 Refueling</b>	<b>Total Number of Spent Fuel Assemblies Produced at Prairie Island</b>
<b>As 4/15/2008</b>			2109
<b>Remainder of 2008</b>		49	2158
<b>2009</b>	49		2207
<b>2010</b>		56	2263
<b>2011</b>	44		2307
<b>2012</b>	44	45	2396
<b>2013</b>		44	2440
<b>2014</b>	49		2489
<b>2015</b>	48	48	2585
<b>2016</b>		49	2634
<b>2017</b>	48		2682
<b>2018</b>	49	48	2779
<b>2019</b>		48	2827
<b>2020</b>	48		2875
<b>2021</b>	48	49	2972
<b>2022</b>		48	3020
<b>2023</b>	49		3069
<b>2024</b>	48	48	3165
<b>2025</b>		49	3214
<b>2026</b>	48		3262
<b>2027</b>	49	48	3359
<b>2028</b>		48	3407
<b>2029</b>	48		3455
<b>2030</b>	48	49	3552
<b>2031</b>		48	3600
<b>2032</b>	40		3640
<b>2033</b>	121	13	3774
<b>2034</b>		121	3895

**Table 5-1. Annual Estimated Doses to Personnel from ISFSI Cask Operations**

<b>Exposure</b>	<b>Annual Dose from TN-40 Casks (person-rem)<sup>1</sup></b>	<b>Annual Dose from TN-40HT Casks (person-rem)<sup>2</sup></b>
Cask Handling	2.3	3.1
Cask Surveillance and Maintenance	3.1	4.5

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<sup>1</sup> Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section 7.4

<sup>2</sup> Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A7.4

**Table 5-2 Cask Handling Risks – EPRI Report**

<b>Handling Phase</b>	<b>First Year Risk</b> (latent cancer deaths per cask per year)	<b>Subsequent Years Risk</b> (latent cancer deaths per cask per year)
Cask Loading	6.3 E-14	N/A
Cask Transportation	3.3 E-13	N/A
Cask Storage	1.7 E-13	1.7 E-13
Total	5.6 E-13	1.7 E-13

**Table 5-3 Skyshine Dose Estimates to the Nearest Permanent Residence and Assumptions**

<b>Assumptions</b>	<b>SAR</b>	<b>SAR Addendum A</b>	<b>CON Application</b>
Type of Cask	TN-40	TN-40HT	TN-40HT
Number of Casks	48	48	64
Fuel Loading (kg of Uranium per fuel assembly)	410	410	360 (casks 1-56) 400 (casks 57-64)
Fuel Burnup (MWD/MTU)	<b>45,000</b>	60,000	53,000 (casks 1-56) 50,000 (casks 57-54)
Cask Loading Rate	<b>2 casks every year</b>	4 casks every 2 years	2 casks every year
Estimated Annual Dose to Nearest Residence (mrem/yr.)	1.0	2.2	0.4

**Table 5A-1 Summary of Estimated Doses and Cancer Incidences for the General Public and Plant Personnel with Dry Storage Cask Expansion<sup>1</sup>**

<b>General Public</b>			
<b>Exposure Pathway</b>	<b>Estimated Whole Body Dose (mrem/yr)</b>	<b>Estimated Additional Risk of Cancer Incidence<sup>2</sup></b>	<b>Estimated Additional Cancer Incidences<sup>3</sup></b>
Skyshine Radiation (64 casks)	0.4	2.8 in 100,000	0.013
<b>Plant Personnel – Cask Handling</b>			
Cask Handling and Maintenance	--- <sup>4</sup>	---	0.32
<b>Plant Personnel – General<sup>5</sup></b>			
Skyshine Radiation	14.0	98 in 100,000	0.90

mrem = millirem

<sup>1</sup> See Chapter 2, Section 5.2 for discussion of assumptions and calculations.

<sup>2</sup> For residents within 2 miles (approximately 450 persons) who receive the estimated dose annually for 70 years.

<sup>3</sup> Id.

<sup>4</sup> Cask handling and maintenance are specialized, high exposure tasks for which it is difficult to estimate individual dose rate and impacts. Because these doses are managed under the PINGP radiation protection program, the number of persons exposed, their exposure rate(s), and their time of exposure will vary.

<sup>5</sup> For plant personnel (approximately 923 persons) who receive the estimated dose annually for 70 years.

**Table 5A-2 Summary of Estimated Doses and Cancer Incidences for the General Public and Plant Personnel – Cumulative Impacts<sup>1</sup>**

<b>General Public</b>			
<b>Exposure Pathway</b>	<b>Estimated Whole Body Dose (mrem/yr)</b>	<b>Estimated Additional Risk of Cancer Incidence<sup>2</sup></b>	<b>Estimated Additional Cancer Incidences<sup>3</sup></b>
Gaseous Effluents	0.01	0.07 in 100,000	0.0003
Liquid Effluents	0.04	0.28 in 100,000	0.0012
Skyshine Radiation (64 casks)	0.4	2.8 in 100,000	0.013
Skyshine Radiation (98 casks)	5.0	35 in 100,000	0.48 <sup>4</sup>
<b>Plant Personnel – Cask Handling</b>			
Cask Handling and Maintenance <sup>5</sup>	---	---	0.32
<b>Plant Personnel – General</b>			
Plant Operations and Maintenance	132	660 in 100,000	6.1
Skyshine Radiation (64 casks)	14.0	98 in 100,000	0.90
Skyshine Radiation (98 casks)	---	---	---

mrem = millirem

<sup>1</sup> See Chapter 2, Section 5.4 for discussion and calculations. This table incorporates information from Chapter 1, Table 4-10 and Chapter 2, Table 5A-1.

<sup>2</sup> For residents within 2 miles (approximately 450 persons) who receive the estimated dose annually for 70 years.

<sup>3</sup> Id.

<sup>4</sup> Assuming exposure over approximately three 70-yr. lifetimes (3 x 70 yr. = 210 years). See Chapter 2, Section 5.4 for discussion.

<sup>5</sup> Once the 98<sup>th</sup> cask is placed on the ISFSI pad, cask handling exposures would be minimal; exposures related to maintenance would continue until the casks are moved to a federal repository. Estimated cancer incidences for maintenance are not expected to exceed those for handling plus maintenance.

<sup>6</sup> Cask handling and maintenance are specialized, high exposure tasks for which it is difficult to estimate individual dose rate and impacts. Because these doses are managed under the PINGP radiation protection program, the number of persons exposed, their exposure rate(s), and their time of exposure will vary.

<sup>7</sup> When the 98<sup>th</sup> cask is placed on the ISFSI pad, the plant will have ceased operation. Staffing levels would drop significantly at the PINGP and this exposure pathway would be eliminated.

**Table 7.1 Operating and Environmental Characteristics of a  
Pulverized Coal Power Plant<sup>1</sup>**

<b>Characteristic</b>	<b>Basis / Detail</b>
Unit size = 550 MWe	2 units @ 550 MWE = 1100 MWe
Capacity factor = 0.85	Typical for coal-fired units
Heat rate = 10,200 BTU/kWh	Typical for coal-fired units (EIA 2002)
Fuel type = sub-bituminous, pulverized coal	Coal typically used in MN
Fuel heating value = 8,914 BTU/lb.	2004 value for coal in MN (EIA 2007)
Fuel ash content by weight = 6.47%	2001 value for coal in MN (EIA 2007)
Fuel sulfur content by weight = 0.44	2001 value for coal in MN (EIA 2007)
Uncontrolled NO <sub>x</sub> emission = 7.2 lb/ton	EPA estimate
CO <sub>2</sub> emissions = 2.117 lbs/kWh	DOE estimate <sup>2</sup>
<b>Scenario Impacts</b>	
Minimum land required	350 acres (plus buffer)
Annual fuel consumption	4.7 million tons
Annual CO <sub>2</sub> emissions	8.7 millions tons
Annual SO <sub>x</sub> emissions	1,815 tons
Annual NO <sub>x</sub> emissions	848 tons
Annual water consumption	4.0 billion gallons
Annual solid waste generation	340,000 tons

<sup>1</sup> Adapted from Table 7.2-2, Coal-Fired Alternative, Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7, Environmental Report, May 16, 2008

<sup>2</sup> Carbon Dioxide Emissions from the Generation of Electric Power in the United States, U.S. Dept. of Energy, July 2000.



**Table 7.2 Operating and Environmental Characteristics of a  
Natural Gas Power Plant<sup>1</sup>**

<b>Characteristic</b>	<b>Basis / Detail</b>
Unit size = 520 MWe	2 units @ 520 MWE = 1040 MWe
Capacity factor = 0.85	Typical for gas-fired units
Heat rate = 6.040 BTU/kWh	Typical for gas-fired units
Fuel type = natural gas	
Fuel heating value = 1,008 BTU/ft <sup>3</sup>	2004 value for gas in MN (EIA 2007)
Fuel SO <sub>x</sub> content = 0.0034 lb/MMBtu	EPA estimate
Fuel NO <sub>x</sub> content = 0.0128 lb/MMBtu	EPA estimate
CO <sub>2</sub> emissions = 1.314 lbs/kWh	DOE estimate <sup>2</sup>
<b>Scenario Impacts</b>	
Minimum land required	41 acres (plus buffer)
Annual fuel consumption	48.3 billion ft <sup>3</sup>
Annual CO <sub>2</sub> emissions	5.1 million tons
Annual SO <sub>x</sub> emissions	83 tons
Annual NO <sub>x</sub> emissions	312 tons
Annual water consumption	2.4 billion gallons <sup>3</sup>
Annual solid waste generation	0

<sup>1</sup> Adapted from Table 7.2-1, Gas-Fired Alternative, Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7, Environmental Report, May 16, 2008

<sup>2</sup> Carbon Dioxide Emissions from the Generation of Electric Power in the United States, U.S. Dept. of Energy, July 2000.

<sup>3</sup> Water Consumption – Conventional Power Plants, [http://www.awea.org/faq/wwwt\\_environment.html](http://www.awea.org/faq/wwwt_environment.html).

**Table 7.3 Operating and Environmental Characteristics of a Large Wind Energy Conversion System (LWECS)**

<b>Characteristic</b>	<b>Value / Detail</b>
Typical wind turbine size	1.5 MWe <sup>1</sup>
Capacity factor	0.36 (variable with location)
Accreditation factor	0.135
SO <sub>x</sub> , NO <sub>x</sub> , and CO <sub>2</sub> emissions	0
Land requirement per MW	16 acres (wind rights, 3 x 5 RD) 100 acres (typical wind farm in MN) ≤ 0.01 acres (actual footprint)
Annual water consumption	0
Annual solid waste generation	0

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<sup>1</sup> Annual Report on U.S. Wind Power, Installation, Cost and Performance Trends: 2007, U.S. Dept. of Energy, May 2008. The average installed wind turbine size in the United States in 2007 was 1.65 MWe (Figure 9).

**Table 7.4 Environmental Impacts of an  
LWECS and Natural Gas Plant Scenario**

<b>Scenario Impacts</b>	
Minimum land required	24,000 acres
Annual fuel consumption	38.6 billion ft <sup>3</sup>
Annual CO <sub>2</sub> emissions	4.1 millions tons
Annual SO <sub>x</sub> emissions	66 tons
Annual NO <sub>x</sub> emissions	249 tons
Annual water consumption	1.9 billion gallons
Annual solid waste generation	0

**Table 7.5 Operating and Environmental Characteristics of Renewable Resource Technologies (Biomass, Anaerobic Digestion, Solar)**

<b>Characteristic</b>	<b>Value / Detail<sup>1</sup></b>
<b>Biomass</b>	
Capacity factor	0.82
Fuel SO <sub>x</sub> content	0.003 lb/MMBtu
Fuel NO <sub>x</sub> content	0.115 lb/MMBtu
CO <sub>2</sub> emissions	23.5 lbs/MMBtu
Annual fuel consumption per MW	6,800 tons dry wood
Land requirement per MW	1000 acres
Annual solid waste generation per MW	1700 tons
<b>Anaerobic Digestion</b>	
Capacity factor	0.85
SO <sub>x</sub> , NO <sub>x</sub> , and CO <sub>2</sub> emissions	Minimal
Land requirement per MW	2000 acres
Annual water consumption	Minimal
Annual solid waste generation per MW	Minimal
<b>Solar (Photovoltaic)</b>	
Land requirement per MW	11 acres <sup>2</sup>
Capacity factor	0.15 <sup>3</sup> (estimated)
Accreditation factor	0.05 (estimated)

<sup>1</sup> 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>

<sup>2</sup> Estimate based on the Optisolar Topaz Solar Farm, <http://www.optisolar.com/topaz.htm>.

<sup>3</sup> Projecting the Impact of State Portfolio Standards on Renewable Energy and Solar Installations, [http://209.85.173.132/search?q=cache:fnzKw\\_UjGMEJ:www.newrules.org/de/solarestimates0105.ppt+photovoltaic+capacity+factor+minnesota&hl=en&ct=clnk&cd=3&gl=us](http://209.85.173.132/search?q=cache:fnzKw_UjGMEJ:www.newrules.org/de/solarestimates0105.ppt+photovoltaic+capacity+factor+minnesota&hl=en&ct=clnk&cd=3&gl=us)

**Table 7.6 Environmental Impacts of an  
Renewable Resources Technologies Scenario**

<b>Scenario Impacts</b>	
Minimum land required	962,000
Annual fuel consumption	4.8 million tons (dry wood)
Annual CO <sub>2</sub> emissions	900,000 tons
Annual SO <sub>x</sub> emissions	200
Annual NO <sub>x</sub> emissions	4,666
Annual water consumption	*
Annual solid waste generation	1.2 million tons

\* Too uncertain to provide a reasonable estimate

**Table 7.7 Comparison of Environmental Impacts of PINGP Alternatives**

Scenario Number / Name	0	1	2	3	4	5	6
	PINGP	Purchased Power	Generic Coal	Coal 50% <sup>1</sup>	Generic Gas	Gas plus Wind	Renewable Resources
Land Use (acres)	0	1,800	350	500	45	24,000	962,000
Annual Fuel Consumption (tons, ft <sup>3</sup> )	353 ft <sup>3</sup> (fuel assemblies)	*	4.7 E06 (tons)	4.7 E06 (tons)	48 E09 (ft <sup>3</sup> )	39 E09 (ft <sup>3</sup> )	4.8 E06 (tons)
Annual CO <sub>2</sub> emissions (tons)	0	*	8.7 E06	4.4 E06	5.1 E06	4.1 E06	0.9 E06
Annual SO <sub>x</sub> emissions (tons)	0	*	1,815	1,815	83	66	200
Annual NO <sub>x</sub> emissions (tons)	0	*	848	848	312	249	4,666
Annual water consumption (gallons)	9.2 E09 <sup>2</sup>	*	4.0 E09	4.0 E09	2.4 E09	1.9 E 09	*
Annual solid waste generation (tons)	25.4 (tons Uranium) <sup>3</sup>	*	340,000	340,000	0	0	1.2 E06

\* Too uncertain to provide a reasonable estimate

<sup>1</sup> Environmental impacts of a coal plant with 50% carbon sequestration are assumed to be identical to impacts from a generic coal plant, with the exception of CO<sub>2</sub> emissions and land use.

<sup>2</sup> Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 8.2.3.2, May 16, 2008

<sup>3</sup> Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix G, May 16, 2008

**Table 7.8 Economic Comparison of PINGP Alternatives  
under Various Scenarios**

<b>Scenarios</b>	<b>Alternatives: Cost Differentials from PINGP Re-licensing (\$ million dollars present value societal cost)<sup>1</sup></b>		
	<b>Unconstrained<sup>2</sup></b>	<b>Gas Wind</b>	<b>Coal</b>
Base Case	1,347	1,687	2,216
High Capital Costs	1,453	1,983	2,584
Low Capital Costs	1,267	1,391	1,895
High Carbon Costs	1,866	2,014	2,783
Low Carbon Costs	798	1,339	1,685
High Coal Costs	1,473	1,771	2,573
Low Coal Costs	1,293	1,645	1,900
High Gas Costs	2,107	2,240	2,359
Low Gas Costs	505	1097	2,049
High Uranium Costs	1,129	1,469	1,998
Low Uranium Costs	1,565	1,905	2,433
No Load Growth	771	1,190	1,932

<sup>1</sup> Adapted from OES Attachment SRR-8, Direct Attachments of Dr. Steve Rakow, April 22, 2009, <https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=eDocketsResult#{3213F1D9-AA7C-420D-A148-E2875275487C}>

<sup>2</sup> The “unconstrained” alternative is a least-cost combination of non-renewable energy sources; See 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}>