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

Title	Agency	Regulation
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

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

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

Exposure	Annual Dose from TN-40 Casks (person-rem)[1]	Annual Dose from TN-40HT Casks (person-rem)[2]
Cask Handling	2.3	3.1
Cask Surveillance and Maintenance	3.1	4.5

[1] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section 7.4
[2] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A7.4

Table 5-2 Cask Handling Risks – EPRI Report

Handling Phase	**First Year Risk** (latent cancer deaths per cask per year)	**Subsequent Years Risk** (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

Assumptions	**SAR**	**SAR Addendum A**	**CON Application**
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)	**45,000**	60,000	53,000 (casks 1-56) 50,000 (casks 57-54)
Cask Loading Rate	**2 casks every year**	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[1]

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

mrem = millirem

[1] See Chapter 2, Section 5.2 for discussion of assumptions and calculations.
[2] For residents within 2 miles (approximately 450 persons) who receive the estimated dose annually for 70 years.
[3] Id.
[4] 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.
[5] 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[1]

General Public			
Exposure Pathway	**Estimated Whole Body Dose (mrem/yr)**	**Estimated Additional Risk of Cancer Incidence[2]**	**Estimated Additional Cancer Incidences[3]**
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[4]
Plant Personnel – Cask Handling			
Cask Handling and Maintenance[5]	---[6]	---	0.32
Plant Personnel – General			
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)	---[7]	---	---

mrem = millirem

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[1] 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.
[2] For residents within 2 miles (approximately 450 persons) who receive the estimated dose annually for 70 years.
[3] Id.
[4] Assuming exposure over approximately three 70-yr. lifetimes (3 x 70 yr. = 210 years). See Chapter 2, Section 5.4 for discussion.
[5] Once the 98th cask in 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.
[6] 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.
[7] When the 98th cask in 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[1]

Characteristic	Basis / Detail
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_x emission = 7.2 lb/ton	EPA estimate
CO_2 emissions = 2.117 lbs/kWh	DOE estimate[2]
Scenario Impacts	
Minimum land required	350 acres (plus buffer)
Annual fuel consumption	4.7 million tons
Annual CO_2 emissions	8.7 millions tons
Annual SO_x emissions	1,815 tons
Annual NO_x emissions	848 tons
Annual water consumption	4.0 billion gallons
Annual solid waste generation	340,000 tons

[1] 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

[2] 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[1]

Characteristic	Basis / Detail
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^3	2004 value for gas in MN (EIA 2007)
Fuel SO_x content = 0.0034 lb/MMBtu	EPA estimate
Fuel NO_x content = 0.0128 lb/MMBtu	EPA estimate
CO_2 emissions = 1.314 lbs/kWh	DOE estimate[2]
Scenario Impacts	
Minimum land required	41 acres (plus buffer)
Annual fuel consumption	48.3 billion ft^3
Annual CO_2 emissions	5.1 million tons
Annual SO_x emissions	83 tons
Annual NO_x emissions	312 tons
Annual water consumption	2.4 billion gallons[3]
Annual solid waste generation	0

[1] 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

[2] Carbon Dioxide Emissions from the Generation of Electric Power in the United States, U.S. Dept. of Energy, July 2000.

[3] Water Consumption – Conventional Power Plants, http://www.awea.org/faq/wwt_environment.html.

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

Characteristic	**Value / Detail**
Typical wind turbine size	1.5 MWe[1]
Capacity factor	0.36 (variable with location)
Accreditation factor	0.135
SO_x, NO_x, and CO_2 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

[1] 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

Scenario Impacts	
Minimum land required	24,000 acres
Annual fuel consumption	38.6 billion ft^3
Annual CO_2 emissions	4.1 millions tons
Annual SO_x emissions	66 tons
Annual NO_x 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)

Characteristic	Value / Detail[1]
Biomass	
Capacity factor	0.82
Fuel SO_x content	0.003 lb/MMBtu
Fuel NO_x content	0.115 lb/MMBtu
CO_2 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
Anaerobic Digestion	
Capacity factor	0.85
SO_x, NO_x, and CO_2 emissions	Minimal
Land requirement per MW	2000 acres
Annual water consumption	Minimal
Annual solid waste generation per MW	Minimal
Solar (Photovoltaic)	
Land requirement per MW	11 acres[2]
Capacity factor	0.15[3] (estimated)
Accreditation factor	0.05 (estimated)

[1] 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

[2] Estimate based on the Optisolar Topaz Solar Farm, http://www.optisolar.com/topaz.htm.

[3] 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

Table 7.6 Environmental Impacts of an Renewable Resources Technologies Scenario

Scenario Impacts	
Minimum land required	962,000
Annual fuel consumption	4.8 million tons (dry wood)
Annual CO_2 emissions	900,000 tons
Annual SO_x emissions	200
Annual NO_x 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%[1]	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^3)	353 ft^3 (fuel assemblies)	*	4.7 E06 (tons)	4.7 E06 (tons)	48 E09 (ft^3)	39 E09 (ft^3)	4.8 E06 (tons)
Annual CO_2 emissions (tons)	0	*	8.7 E06	4.4 E06	5.1 E06	4.1 E06	0.9 E06
Annual SO_x emissions (tons)	0	*	1,815	1,815	83	66	200
Annual NO_x emissions (tons)	0	*	848	848	312	249	4,666
Annual water consumption (gallons)	9.2 E09[2]	*	4.0 E09	4.0 E09	2.4 E09	1.9 E 09	*
Annual solid waste generation (tons)	25.4 (tons Uranium)[3]	*	340,000	340,000	0	0	1.2 E06

* Too uncertain to provide a reasonable estimate

[1] 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_2 emissions and land use.
[2] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 8.2.3.2, May 16, 2008
[3] 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

Scenarios	Alternatives: Cost Differentials from PINGP Re-licensing ($ million dollars present value societal cost)[1]		
	Unconstrained[2]	Gas Wind	Coal
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

[1] 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}

[2] 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}