NSP

Northern States Power Company

414 Nicollet Mall
Minneapolis, Minnesota 55401-1927
Telephone (612) 330-5500

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U S Nuclear Regulatory Commission
Attn: Document Control Desk
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PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket Nos. 50-282 License Nos. DPR-42
50-306 DPR-60

Reply to Questions on Design Report for the
Station Blackout/Electrical Safeguards Upgrade Project
(TAC Nos. 68588 and 68589)

References: 1) Letter from Thomas M Parker, Northern States Power Company, to U S Nuclear Regulatory Commission dated November 27, 1990 titled "Design Report for the Station Blackout/Electrical Upgrade Project"

2) Letter from Armando Masciantonio, U S Nuclear Regulatory Commission, dated June 6, 1991 titled "Request for Additional Information - Station Blackout/Electrical Safeguards Upgrade Project (TAC Nos. 68588/68589)

On November 27, 1990 we submitted for NRC Staff review the design report (Reference 1) for our project to add two additional safeguards emergency diesel generators, to upgrade the safeguards electrical distribution system, and to upgrade #121 Cooling Water Pump to become a swing safeguards pump. On June 11, 1991 the NRC Staff requested additional information (Reference 2). We are providing the answers to those questions in the attachment to this letter.

Please contact us if you have any questions related to the responses to the questions.

Thomas M Parker
Manager
Nuclear Support Services

c: Regional Administrator - Region III, NRC
Senior Resident Inspector, NRC
NRR Project Manager, NRC
J E Silberg

Attachments:
1. Response to Request for Additional Information
2. Load Sequencer Programmable Controller Processor Specifications (2 pages)
3. Safeguards Load Sequencer Verification and Validation Plan (19 pages)

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ATTACHMENT 1

NORTHERN STATES POWER COMPANY
PRAIRIE ISLAND NUCLEAR GENERATING PLANT
STATION BLACKOUT/ELECTRICAL SAFEGUARDS UPGRADE PROJECT
RESPONSE TO JUNE 6, 1991 REQUEST FOR ADDITIONAL INFORMATION
(TAC NO. 68588, 68589)

References:

1. "Design Report for the Station Blackout/Electrical Safeguards Upgrade Project", Northern States Power Company, November 27, 1990.

2. ANSI/IEEE-ANS-7-4.3.2-1982, "American National Standard, Application Criteria for Programmable Digital Computer Systems in Safety Systems of Nuclear Generating Stations".

QUESTION 1:

Provide the design information of the Unit 2 load sequencer programmable logic controller (PLC) (i.e., manufacturer, model number, etc.). Include the description of the devices used in the load sequencers, the load sequencer PLC programming language, compiler, type of microprocessors, etc.

RESPONSE TO QUESTION 1:

The load sequencer uses an Allen-Bradley 1785 PLC-5 Programmable Controller as the main processor. The programmable logic controller is provided with a battery for memory back-up, as well as, an EEPROM memory module for non-volatile storage of the application programs. Additional components of the load sequencer programmable logic controller include:

1771-P7	Power Supply
1771-OWN	32 Point Relay Output Module
1771-IAD	16 Point 125 VDC Input Module
1771-ID	8 Point 138 VDC Isolated Input Module

Applicable product specification sheets are provided as Attachment 2 to this submittal.

The Allen-Bradley programmable logic controller was programmed using:

PLC-5 A.I. Series
OFFLINE Module, Version 5.21
Catalog No. L5-140A
ICOM, Inc.

This program is a tool to program the processor with the system ladder logic. The appropriate programmable logic controller commands are entered into the system as rungs of a ladder. This ladder logic format is read by the programmable logic controller and interpreted into programmable logic controller commands.

QUESTION 2:

NRC Regulatory Guide 1.152, which endorses ANSI/IEEE-ANS-7-4.3.2-1982 (Ref. 2), is not referenced in the Northern States Power Company (NSPC) submittal (Ref. 1). Provide documentation of the acceptance criteria for the load sequencer system, and justify differences between the NSPC acceptance criteria and the Ref. 2 criteria.

Describe the plans for performing or reviewing the verification and validation (V&V) of the programmable logic controller (PLC) load sequencer logic to be implemented on Unit 2. If the V&V has been performed, provide the documentation of the V&V plan. If a V&V plan has not been developed, describe the process by which NSP will ensure the adequacy of the PLCs for 1E applications.

RESPONSE TO QUESTION 2:

The load sequencer programmable logic controller system verification & validation (V&V) plan has been implemented in accordance with ANSI/IEEE-ANS-7-4.3.2-1982. A copy of the Safeguards Load Sequencer Verification and Validation Plan is provided as Attachment 3 to this submittal. Since the load sequencer system is still under development and testing, the verification & validation program is ongoing. Software validation and software acceptance testing is in progress. When that is completed, the hardware/software integration testing will be performed by the vendor, and witnessed by NSP, to demonstrate the adequacy of the interface. A final Verification & Validation Report will be submitted to NSP which will summarize the results of the system validation testing and will show how the system is in compliance with the original system requirements.

QUESTION 3:

Describe the acceptance criteria for checking control cabinet instruments and control logic.

RESPONSE TO QUESTION 3:

The control cabinet instruments and control logic functions will be fully tested during the verification & validation testing phases. This includes module testing and integrated testing. In addition, scenario testing will be performed to demonstrate satisfactory load sequencer response to simulated plant events. The scenarios to be tested include: 1) A safety injection followed 30 seconds later by a degraded voltage; 2) A safety injection with a simultaneous loss of offsite power; and, 3) A loss of offsite power.

QUESTION 4:

Describe site acceptance/preoperational testing; specifically address loss and restoration of power to the PLCs during standby and power operation. Also describe the memory-retention capability of the PLC.

RESPONSE TO QUESTION 4:

Site acceptance testing of the load sequencers will demonstrate that the system will respond correctly during simulated emergency conditions. The programmable logic controller logic will be functionally tested during the integrated preoperational testing of the new emergency diesel generators. The load sequencer performance will be verified for tripping of load breakers, starting the emergency diesel generators, selection of a source for the emergency bus, and sequential loading of the bus after source selection.

Upon loss of power to the programmable logic controller, an EEPROM memory module installed in the programmable logic controller will contain a copy of the operating program which can be downloaded to the programmable logic controller memory on every power-up sequence. When power is restored to the programmable logic controller, the operational software will determine whether the unit is in the test mode or the operating mode, and the sequencer will resume operation at that point.

QUESTION 5:

Provide the frequency at which the PLC load sequencer algorithm will be tested, and discuss coordination of this testing with normal load sequencer operations.

RESPONSE TO QUESTION 5:

The programmable logic controller load sequencer algorithm will be verified during monthly surveillance testing. This verification will include manual scenario testing to demonstrate that the sequencer will respond correctly to simulated inputs and that the output relays respond correctly. Blocking relays are energized while all of this testing is performed so that inadvertent operation of the safeguards equipment is avoided.

While in the test mode, the load sequencer logic is designed to recognize an actual degraded voltage condition or a valid safety injection signal. When either or both of these conditions is detected, the test mode is exited and the operational software resumes. The time required to reset from a test, after a valid input is received, is dependant upon the time required to deenergize the blocking relays and to reset program timers. The time is expected to be less than or equal to 250 milliseconds. The actual time will be determined during system testing.

QUESTION 6:

Describe the methods by which a loss of load sequencer function is detected and mitigated, including the steps required to recover the load sequencer function.

RESPONSE TO QUESTION 6:

The programmable logic controller processor contains a watchdog timer which will alarm if the programmable logic controller software does not complete a cycle in a predefined time period. In addition, the programmable logic controller logic will alarm in the Main Control Room on the loss of AC or DC control power, or if the sequencer is placed in manual. The load sequencer programmable logic controller is 'reset' by cycling AC power to the programmable logic controller. This action will perform a restart of the sequencer. Manual control of the load and source breakers can be assumed by placing the load sequencer control switch on the main control board to the MANUAL position.

QUESTION 7:

Provide the PLC Surge Withstand Capability (SWC) specifications, and justify the margin between the SWC and expected surges. Include the PLC power sources.

RESPONSE TO QUESTION 7:

The programmable logic controllers' logic power supply requires a 120VAC external source of power. This external 120VAC will be supplied from 120VAC uninterruptable power supplies which will provide a regulated and filtered source of power to the units.

According to Allen-Bradley product literature, the PLC-5 family of programmable logic controllers has been tested for noise immunity in accordance with NEMA Publication ICS-2 Section ICS-2-230. In addition, the PLC-5 family's surge withstand capability was tested in accordance with ANSI Standard C37.90a-1974 (IEEE Standard 472-1974). Both of the above mentioned industry standards deal with solid state equipment installed in industrial and utility environments similar to that present at Prairie Island.

QUESTION 8:

Provide the PLC Electromagnetic Compatibility (EMC) specifications, and justify the margin between the EMC specifications and the electromagnetic interference.

RESPONSE TO QUESTION 8:

There are no strong sources of radio frequency interference (RFI) in the vicinity of Prairie Island which are not under plant control (such as commercial radio or television transmitters). A radio frequency interference survey of the control rod drive rooms conducted in 1985 confirmed this when levels less than 100 mV/meter were measured. Therefore, the source of objectionable radio frequency interference is primarily from the use of hand held walkie-talkies near susceptible solid state equipment.

To ensure that the programmable logic controllers within the load sequencer are sufficiently immune to the expected electromagnetic interference at the Prairie Island site, the equipment will be tested for radiated and conducted susceptibility in accordance with SAMA Standard PMC 33.1-1978, and MIL Standard 461 and MIL Standard 462. MIL Standard Test Methods CS01, CS02 and CS06 will be the basis for the conducted susceptibility test. The Prairie Island site falls into Class 2 for radiated susceptibility as defined by SAMA Standard PMC 33.1-1978, since hand held transmitters are the primary source of objectionable electromagnetic interference. The equipment will therefore be tested for a 10 Volt/meter radiated field strength. An electromagnetic interference survey of the D5/D6 Building will be conducted to confirm this Class 2 field strength designation.

QUESTION 9:

> Provide a detailed description of the device(s) used to accomplish electrical isolation between 1E and non-1E systems and describe the specific testing performed to demonstrate that the devices are acceptable for this application. This description should include elementary diagrams to indicate the test configuration and how the maximum credible faults were applied to the device(s).

RESPONSE TO QUESTION 9:

ASEA Type RXMH2 auxiliary relays are used for 1E vs. non-1E isolation purposes. These relays have heavy duty contacts which are rated to carry 10 amperes of 125VDC current continuously and 135 amperes for 200 milliseconds for an already closed contact (fault duty).

The non-safety related circuits which are connected to the contacts of these isolation relays fall into three categories; 1) plant computer inputs which are wired to a remote multiplexor unit (RMU), 2) inputs to the plant's annunciator system, and 3) contacts that control main control board indicating lights which have been classified as non-1E. The same quality class of cable is used for this non-safety related wiring as is used for the safety-related wiring in the plant. This wiring is also routed in control raceways which do not contain any power (480VAC or 4160VAC) circuits. The power supplies associated with 1) and 2) above are power limited, and cannot deliver currents in excess of 2 to 3 amperes even with a bolted fault across the power supply output.

The non-1E main control board indicating lights (Category 3 above) are supplied from non-1E 125VDC. The most likely seismic induced failure mode of the indicating light is an open circuit of the lamp filament. In the unlikely event that a light module shorts out, the combined cable resistance of the DC feeder from the battery to the load sequencer and control circuit from the load sequencer to the main control board will limit the fault current to less than 100 amperes. Five ampere fuses located in the load sequencer cabinet will interrupt this fault current in less than the 200 millisecond short time duty of the contacts.

Based on the above, we have concluded that the ASEA RXMH2 relay is a suitable isolation device, and no additional testing is required.

QUESTION 10:

Provide data to verify that the maximum credible faults applied during the test(s) discussed in Question 9 were the maximum voltage/current to which the device could be exposed, and define how the maximum voltage/current was determined.

RESPONSE TO QUESTION 10:

A discussion of the maximum credible fault on the non-1E side of the isolation device is contained in our response to Question 9 above.

QUESTION 11:

Provide data to verify that the maximum credible fault was applied to the output of the device in the transverse mode (between signal and return) and to verify that other faults were considered (i.e., open and short circuits).

RESPONSE TO QUESTION 11:

Electromechanical relays are used to isolate the 1E and non-1E circuits through coil to contact or contact to contact separation. There is no common return path between the 1E and non-1E side of the isolation relay circuits. Therefore, there is no transverse mode fault mechanism.

Short circuits are discussed in our response to Question 9. Because relays are used as isolation devices, open circuits on the non-1E wiring connected to the isolation relay contacts have no effect on the 1E side of the device.

QUESTION 12:

Define the pass/fail acceptance criteria for each type of isolation device.

RESPONSE TO QUESTION 12:

As stated in our response to Question 9 above, ASEA Type RXMH2 relays provide the isolation between the 1E circuits and non-1E monitoring and indication signals. This relay was selected because of its rugged design and high momentary current capability of its contacts.

QUESTION 13:

Discuss the process by which NSPC will verify that the electromagnetic environment at the plant site is enveloped by the PLC manufacturer's EMC test parameters.

RESPONSE TO QUESTION 13:

As stated in our response to Question 8, an electromagnetic interference site survey will be conducted, and the results of this survey will be compared to the electromagnetic interference test intensities to ensure that the test envelopes the measured values.

QUESTION 14:

Describe the configuration control plan for the Unit 2 load sequencer.

RESPONSE TO QUESTION 14:

During the software development and verification & validation testing phases, the configuration control of the programmable logic controller ladder logic and data files is administered by load sequencer vendor in accordance with their QA Manual and the Software Configuration Management document. This document delineates the responsible individual for control of the software in each phase of development. The Software Configuration Management document also addresses control of documentation and testing data.

After the load sequencer is delivered to NSP, responsibility for configuration control is transferred to the Electrical Systems Engineering group at the plant site. Control of the system will be accomplished in three areas and in accordance with the Prairie Island Quality Assurance Manual. First, all functional testing will be done in accordance with the Surveillance Procedure program. Second, any troubleshooting, without changing ladder logic or data files, will be done in accordance with the Work Control program. Finally, any changes to the hardware or software will be done in accordance with the Uniform Modification Process, including 10 CFR Part 50 Section 50.59 reviews.

QUESTION 15:

Provide the Mean-Time-To-Failure (MTTF) and the Mean-Time-To-Repair (MTTR) information for the PLCs.

RESPONSE TO QUESTION 15:

The Mean-Time-To-Failure (MTTF) is derived from Allen-Bradley field performance data only, and uses the product installed base and product repair information. The Mean-Time-To-Repair (MTTR) is the time required to replace the faulty module and return the load sequencer to service, but does not include personnel mobilization time.

EQUIPMENT		MTTF	MTTR
1785-LT	(Processor)	377,614 Hrs.	1 Hr.
1771-IAD	(Input Mod)	4,004,797 Hrs.	1 Hr.
1771-ID	(Input Mod)	5,778,240 Hrs.	1 Hr.
1771-OWN	(Output Mod)	NO DATA	
1771-OW	(Output Mod similar to 1771-OWN)	1,638,031 Hrs.	1 Hr.
1771-P7	(Power Sply)	907,435 Hrs.	1 Hr.

Processor Specifications

Processor Specifications

System Configuration (typical)

- 1 local chassis – PLC-5/10 and PLC-5/12
- 1 local chassis and up to 12 remote I/O chassis (3 logical rack numbers) – PLC-5/15
- 1 local chassis and up to 16 remote I/O chassis (7 logical rack numbers) – PLC-5/25

- 6K (PLC-5/10, -5/12 and -5/15)
- 13K (PLC-5/25)

I/O Capacity

- Bulletin 1771 I/O including 8, 16, and 32 point I/O and intelligent modules
- PLC-5/10
  256 I/O with 16-pt modules
  512 I/O with 32-pt modules
- PLC-5/12
  256 I/O with 16-pt modules
  512 I/O with 32-pt modules
- PLC-5/15
  512 I/O, any mix
  512 inputs and 512 outputs using 16 or 32-pt modules
- PLC-5/25
  1024 I/O, any mix
  1024 inputs and 1024 outputs using 16 or 32-pt modules

I/O Hardware Addressing

- 2-slot
  any mix of 8-pt modules, 16-pt modules must be I/O pairs, no 32-pt modules
- 1-slot
  any mix of 8 and 16-pt modules, 32-pt modules must be I/O pairs
- 1/2-slot
  any mix of 8, 16 and 32-pt modules

Communication

- Local – standalone (PLC-5/10)
- Adapter
  slave to a supervisor (PLC-5/12, -5/15, -5/25)
- Scanner
  local and remote I/O (PLC-5/15 and -5/25); 10,000 cable-ft max for remote I/O
- Data Highway Plus
  10,000 cable-ft max
- Data Highway via 1785-KA

Memory Configuration

- up to 1000 program files
- up to 1000 data files
- user configurable

Memory Modules (optional)

- 4K RAM expansion, 1785-MR (PLC-5/15 and -5/25)
- 8K RAM expansion, 1785-MS (PLC-5/15 and -5/25)
- 8K EEPROM backup, 1785-MJ (all PLC-5 processors)
- 16K EEPROM backup, 1785-MK (PLC-5/25 only)

Program Scan

- 2 ms/K words (bit logic)
- 8 ms/K words (typical)

Processor Specifications

Discrete I/O Scan (typical)

- 1 ms/local I/O rack
- 10 ms/remote I/O rack number

Backplane Current

[illegible]A

Backup Battery

- self-contained lithium battery (1770-XY)
- 1-year memory life without ac

Time-of-Day Clock and Calendar

- maximum variation at 60° C: ± 3 minutes per month
- typical variation at 20° C: ± 20 seconds per month
- timing accuracy: one program scan

Environmental Conditions

- operating temperature: 0 to 60° C (32 to 140° F)
- storage temperature: -40 to 85° C (-40 to 185° F)
- relative humidity 5 to 95% (without condensation)

Certification (UL and CSA)

- Class 1, Division 2 Groups A, B, C, D

Compatible Supervisory Processors

- PLC-2/30
- PLC-3, -3/10
- PLC-5/15, -5/25
- PLC-5/250

Compatible I/O Adapters

- Remote I/O Adapter Module (1771-ASB)
- Single-Point I/O Adapter Assembly (1771-JAB)
- PLC®-5/10, -5/12 processor in adapter mode
- PLC®-5/250 Remote Scanner (5150-RS2)
- Direct Communication Module (1771-DCM)
- PLC Interface Module (3500–NA1) for digital AC and DC drives
- Remote I/O Adapter for Bulletin 1336 drives (1336-MOD-G2)
- Serial Port Connector (MOD-S1)
- RediPANEL™ Pushbutton and Keypad Modules (bulletin2705)
- Option Module (1784-F30D) for the T30 Plant-Floor Terminal
- 8600 CNC with remote I/O adapter option (8600-2058K)
- CVIM™ set for adapter mode (5370-CVIM)