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January 6, 1984

NUCLEAR PRODUCTION DEPARTMENT

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Mr. Denton:

SUBJECT: Grand Gulf Nuclear Station
Unit 1
Docket No. 50-416
License No. NPF-13
File: 0272/L-334.0
Ref: AECM-83/0668
MAEC-83/0327
Response to NRC Questions on Agastat Relays
AECM-84/0024

Please find attached MP&L's response to the NRC's Request for Additional Information regarding Agastat Relays dated October 13, 1983. In addition, MP&L will perform the Agastat relay replacement program during the current outage, as discussed herein and in MP&L's final report to 10 CFR 21 on this matter dated October 17, 1983 (AECM-83/0668).

The attached response shows that the failure rate of Agastat relays experienced at GGNS are within design considerations and that the existing test intervals are considered sufficient to detect relay failures in order to maintain plant reliability goals. Based on these results along with the current relay replacement program, MP&L believes that the relay failure concerns have been resolved for full power licensing on GGNS Unit One.

The figures referenced in this response are considered proprietary to General Electric Company and were transmitted under separate cover by AECM-84/0023, dated January 6, 1984.

Please advise if you require additional information.

Yours truly,

For L. F. Dale
Manager of Nuclear Services

SAB/JGC:rg

Attachment

cc: See next page

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MISSISSIPPI POWER & LIGHT COMPANY

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Attachment to
AECM-84/0024

RESPONSE TO NRC REQUEST FOR
ADDITIONAL INFORMATION ON AGASTAT RELAYS

I QUESTION: Of the total population of Agastat relays in the plant's safety-related systems provide a breakdown identifying the; (1) systems involved, (2) the number of Agastat relays in each system, and (3) the frequency for testing the relays/systems.

RESPONSE: A listing of the Agastat relays by GGNS system which are safety-related or important to safety is provided in Table 1. A total of forty-four systems containing greater than 1700 Agastat relays have been identified.

The frequency of testing for specific relays is dependent on the test requirements established by the GGNS Technical Specifications which are patterned after the BWR Standard Technical Specifications. A review of each safety related Agastat relay for surveillance frequency has not been performed, however, due to the extent of technical specification surveillance testing most safety related relays are actuated on at least 18 month intervals.

The Logic System Functional Tests, which are performed approximately every 18 months, actuate virtually all relays within the logic circuits required by the GGNS Technical Specifications for system operability. The specific logic systems checked during the logic system functional tests are provided in Table 2.

In addition, System Functional Tests are performed periodically to verify system initiation of containment spray, suppression pool makeup, MSIV leakage control, standby gas treatment and RCIC. The relays required for system initiation and operation on these systems are observed for state change by simulating an initiation signal into the circuit.

Channel Functional Tests are performed monthly by similarly injecting a simulated initiation signal into a specified trip unit to verify that the trip unit relay changes state as required. Functional tests are performed on selected required trip units as specified by the GGNS Technical Specifications. A list of trip units tested by functional testing is provided in Table 3.

Of the forty four systems containing Agastat safety related relays, a sampling of eight systems underwent a review to determine the approximate number of relays that are actuated during the monthly functional tests. The relays actuated for the eight systems reviewed are contained in the following table:

System	Total No. of Relays	Approx. No. of Relays Actuated	Percent of Relays Actuated
B21	340	139	41
C71	124	58	47
E12	112	31	28
E21	32	18	56
E22	38	24	63
E51	59	42	71
M71	120	14	12
P41	74	23	31
Total	899	349	39 (ave.)

As noted above the sampling of systems reviewed represents over half the total safety related Agastat population. Even though the monthly functional tests are not intended to test the relays in a circuit, a significant number of relays are actuated by performance of these functional tests.

II QUESTION: Provide a detailed discussion, with illustrations from applicable elementary diagrams, on the at-power testing capability provided in the Grand Gulf design for those Agastat relays/systems currently tested only during plant shutdowns.

RESPONSE: A review of the NSSS elementary diagrams was conducted to determine the test capability at full power operation of the systems containing Agastat relays. The testability of a relay considered the effects upon system or plant operation to assure that the relay testing does not place the station in an unsafe condition. The following criteria were applied to the NSSS system relays to classify them as testable during plant operation:

- o Actuating the relay coil while in the circuit by proper manipulations of a pump, motor, fan, valve, switch, or system initiation was considered permissible as long as undesired actions do not occur (i.e., depressurization, over pressurization, injection into the vessel, mode change, reduction in power, and partial inhibition of the system's function).
- o Actuating the relay by tripping the trip unit in calibrate mode was considered an acceptable practice.
- o Verifying that the contacts have changed state by indication, annunciation, or by voltage/continuity checks.

Additional special tests and administrative procedures would have to be developed in order to conduct testing beyond that already being conducted during the surveillance tests. Of the relays analyzed in the NSSS system, approximately 73% could be tested

under the above criteria. Testing of these relays will not prevent the required number of safety systems from operating in accordance with the FSAR, but in some cases the accommodations made for testability may place a redundant loop out of operation for a greater period of time and at more frequent intervals than already required for the present testing.

The remaining 27% of the NSSS relays were considered to only be testable during full power operation by initiating systems, relay removal and other certain normally non-desirable actions (i.e., closing/opening a valve or tripping a pump).

III QUESTION: Provide a discussion on the test intervals selected for the systems that include Agastat relays which demonstrates consideration of the following factors:

(1) system availability,
(2) manufacturers recommendations,
(3) historical experience with the use of similar equipment,
(4) failure rate data,
(5) results of preoperational testing,
(6) quality information, and
(7) regulatory requirements.

This discussion should address the single failure assumptions of the FSAR transient and accident analyses.

RESPONSE: Selected Test Intervals -- The test intervals for system testing at GGNS were established based on previous generic system design and availability considerations that evolved into the testing intervals contained in the standard BWR Technical Specifications. The test intervals contained in these Technical Specifications, as developed by the NRC, provided adequate testing frequency for all BWRs given typical system availability and component failure rates. Channel Functional Tests (monthly) and Logic System Functional Tests (every 18 months) have provided adequate assurance of system availability and failure detection to assure system function on demand.

The GGNS design is in compliance to IEEE 338-1971 which does not specifically address the review of each of these factors for test interval determination, but is based on the design of the protective systems such that periodic testing can be performed. Once test intervals have been established, verification of the test interval can later be performed using plant operational data. Section 5.2 of IEEE 338-1971 states that:

> "Information derived from operational data and test results (especially failure rates, MTTR, and test duration) shall be used to verify or correct the initial interval selections. During the life of the equipment, the test interval may be increased or decreased consistent with maintaining the reliability goals of the subsystem."

As will be further discussed in this response, the Agastat relay failures experienced at GGNS are within expected reliability goals and also the existing surveillance test intervals are considered sufficient to detect relay failures in order to maintain these goals.

Design Vs. Experienced Failure Rates -- The failure rate (λ) for the relays as stated on the GE purchase part drawings is 1×10^{-6} failures per hour, or a mean time between failures (MTBF) of one million operating hours. This failure rate is also stated in vendor literature. The GGNS specified failure rate for these relays is supported by the control relay failure rate represented in IEEE 500 (1977). The IEEE 500 high and low expected failure rates for control relays are 2.7×10^{-6} and 0.06×10^{-6} failures/hour, respectively, and the GGNS specified failure rate of 1×10^{-6} failures/hour is within the values established by this standard.

An exponential distribution model; $R(t) = e^{-\lambda t}$ (Eq. 2; IEEE 352 (1975) for calculating reliability (R) can be used to determine the probability of failure for the relays. Assuming that the failures occurred at a random failure rate within their design life and given a GGNS failure rate of 10^{-6} failures/hour, the expected failures for the GGNS Agastat relay population over various time periods are provided below:

Time (t) Yr	(hours)	Reliability (R)	Exp. Fail. Probability (1 - R)	Expected Failures/1000 Population	Expected Failures/ 1700 GGNS Pop.
.25	(2,190)	.9978124	0.0021876	2.1876	3.719
.50	(4,380)	.9956296	0.0043704	4.3704	7.430
.75	(6,570)	.9934515	0.0065485	6.5485	11.132
1.00	(8,760)	.9912783	0.0087217	8.7217	14.827
1.25	(10,930)	.9891097	0.0108903	10.8903	18.513
1.50	(13,140)	.9869460	0.0130540	13.0540	22.192

The relay failures identified during the 18 month surveillance test period were within the 22 failures expected from the reliability calculations and the test intervals presently used at GGNS were sufficient to detect relay failures within the expected failure rate.

Review of BWR Risk Assessments -- The BWR-6 standard plant (solid state design) and Limerick Station (BWR-4 with relays) risk assessments were reviewed in combination to verify that the failure rate experienced at GGNS is within the failure rate covered by these analyses. The assumptions used in these studies have a failure rate consistent with 1×10^{-6}/hour specified for GGNS. Even though these risk assessments do not directly model GGNS, the system similarities and failure rates provide a reasonable assurance that similar risk reduction will be maintained.

The results of these studies show that the core damage frequency and public risk associated with those plants are one to two orders of magnitude less than values specified in the NRC safety guidelines. Therefore, these studies support the failures experienced at GGNS to be fully acceptable within given assumptions used for previous risk assessments.

Review of Test Intervals -- In order to confirm the existing GGNS test intervals, an analysis consistent with IEEE 352 guidelines has been performed for Grand Gulf on the Reactor Protection System (RPS). Calculations were performed using standard reliability and fault tree analysis and then confirmed using the WAM code (User Manual for Engineering Computer Programs, WAM-BM-01, NEDE-25359, November 1980). The RPS was selected for review since RPS relays are normally closed (energized) and open on demand and the RPS would be the most sensitive to relay failures.

The RPS study closely followed the format of the RPS availability calculations in the BWR-6 risk assessment. Logic design features specific to GGNS were added and failure rates applicable to GGNS components were included. For this analysis a common mode failure rate for all Agastat relays was assumed, and all test intervals were made consistent with GGNS requirements. The RPS, however, has a high degree of testing at monthly intervals, as required by the Technical Specifications, and may not represent the testing of other systems. The results, as provided in Figure 1, show how the RPS failure frequency (unavailability) is impacted by the test interval.

While the RPS unavailability is affected by the test interval, Figures 2, 3 and 4 show that the scram failure frequency, the core damage frequency and public risk are insignificantly affected by changes in the test intervals and will be consistent with longer (i.e., 18 month) test intervals.

Based on knowledge from the Limerick and BWR-6 Standard Plant PRA work completed, it is expected that the less frequent ECCS test intervals would not have a significant impact on plant safety as measured by changes in core damage frequency and public risk.

Single Failure Criteria -- It is MP&L's position that the single failure assumptions used in the GGNS design should not be directly related to the establishment of test intervals.

The single failure criterion is primarily a design requirement which requires that the plant be capable of achieving (1) emergency reactivity control, (2) emergency core and containment heat removal, and (3) containment isolation, integrity, and cleanup given an initiating event plus an independent single failure in any one of the systems required to support directly or indirectly these three nuclear safety functions (i.e., only one

single failure needs to be assumed in the plant nuclear safety-related equipment for any initiating event).

In contrast, test intervals and component failure rates are primarily considerations in the assessment of system reliability. The shorter the interval, the more likely it will be that a failure is found before a demand is placed on the component or system. The failed item can then be replaced or repaired and the component or system restored to its original condition. As shown in our previous discussion the present surveillance test intervals are adequate to recognize relay failures.

IV AGASTAT RELAY REPLACEMENT PROGRAM

MP&L committed to a replacement program of all GGNS Unit 1 safety related normally energized older design GP series relays (date code prior to August, 1977) during the spring of 1984. This replacement program is discussed in the MP&L final report for PRD-83/12, "Failure of Agastat GP Series Relays to Switch" transmitted by AECM-83/0668, dated October 17, 1983. However, due to the availability of replacement relays and the current Unit 1 outage, MP&L will replace these relays prior to starting up from this outage.

The retest program for the Agastat relays is being developed in accordance with plant procedures and programs. Each replacement relay will be bench tested prior to installation to ensure proper electromechanical operation of the relays (coil and all contacts), proper coil voltage, and correct time response (when applicable). Although the bench testing and installation controls provide a high level of confidence, additional in-place testing will be done to ensure the relay/base interface is not affected during the changeout. Continuity checks, valve strokes, and miscellaneous functional tests will verify the integrity of the affected circuits. The special tests will be reviewed by the Plant Safety Review Committee as required. The plant surveillance tests will also provide redundant verification of system operability when performed.

The remaining normally de-energized pre-August, 1977 Agastat GP Series relays for Unit 1 are not subject to the accelerated aging, but will be replaced in the future based on relay, system and plant availability due to their design characteristics.

Acceptability of Later GP Agastat Relays -- Only the pre-August, 1977 GP relays are being replaced since we have not experienced similar failures and have no evidence of an accelerated failure rate by the newer GP series relay design and considering their exhibited reliability in present use at GGNS.

As has been reported and discussed previously with the NRC, the failures experienced during GGNS 18 month surveillance test period were in the older date code GP series relays. These relays have exhibited failures due to the movable contact arm interfering with a rib on the melamine phenol relay base. The

newer GP series relays have been modified to prevent the movable arm and the phenol base interference. Even though not all of the GGNS relay failures exhibited this failure mode, at least two did and another six failed in a similar manner but could not be specifically attributed to this type of failure when later observed.

During subsequent GE testing, 14 pre-August, 1977 relays and 2 post-August, 1977 relays were subjected to ambient temperatures of 130°F for six days. Four failures occurred during testing or in the post test analysis, which all were in the pre-August, 1977 relays. These relays exhibited the same failure mode which was the contact arm interfering with the relay base rib.

GE analysis of the pre-August, 1977 GP relays has determined that service aging of the normally energized relays in a mild environment in combination with the mechanical configuration and tolerances of their internal parts were the primary cause of failure. The service life of the continuously energized Agastat GP series relays has been initially and conservatively calculated to be approximately 4.5 years. It is MP&L's understanding that this 4.5 year service life is based on the nylon relay coil bobbin. The Amerace Corporation, manufacturer of Agastat relays, is reported to be in the process of evaluating later series relays to substantiate an extended service life in the continuously energized state. The August, 1977 and later GP series Agastats which are presently being used at GGNS have shown to be very reliable and are not subject to the type of failure experienced at GGNS.

V CONCLUSION

The recent Agastat failure rate experienced at GGNS has been shown to be acceptable based on the expected failure rates provided in IEEE 500 and that specified by the NSSS supplier. Generic BWR risk assessments have also been shown to support the acceptability of the GGNS experienced failures. Initial reviews of the surveillance test intervals have generally shown that even though system unavailability increases with increased failure rates, the scram failure rates, core damage frequency, and public risk are relatively unaffected and the existing surveillance test intervals are acceptable. Even though the experienced failure rate can be considered as random failures, specific failures can be accredited to the pre-August, 1977 GP series relay design.

New post-August, 1977 Agastat relays are being installed to replace the normally energized Agastat GP series relays that have a date code of pre-August, 1977 with completion scheduled for prior to startup from the current outage. The newer Agastat GP relays, which have been modified to remove the relay base/contact arm interference material from the barrier strip have experienced a high reliability and are not believed by MP&L to warrant replacement at this time.

MP&L concluded that the Agastat relay failure rate experienced at GGNS is within the specified requirements and that the surveillance test intervals are adequate to recognize relay failures. MP&L believes that the proposed relay replacement program will resolve the concerns with the reliability of the Agastat relays.

TABLE 1

GGNS SYSTEMS AND QUANTITY OF
SAFETY RELATED AGASTAT RELAYS

GGNS SYSTEM	QUANTITY	GGNS SYSTEM	QUANTITY
B21	340	P41	74
B33	14	P42	15
C11	14	P44	23
C41	5	P45	18
C71	124	P52	10
C88	2	P53	8
E12	112	P60	8
E21	32	P64	12
E22	38	P66	4
E30	34	P71	22
E31	52	P75	24
E32	25	P81	10
E38	6	R20	116
E51	59	R21	37
E61	64	T41	2
G33	4	T42	6
G36	4	T48	88
G41	10	X77	3
G46	2	Y47	3
M41	18	Z51	67
M71	120	Z77	16
P11	20	Non System Specific (local panels)	64
P21	4		

TOTAL 1733

TABLE 2

SYSTEMS TESTED DURING LOGIC SYSTEM
FUNCTIONAL TESTING

1. Reactor Protection System - Tested from sensor to verification of control rod insertion.

2. Containment Drywell and Auxiliary Building Isolation System including the primary containment, secondary containment, main steam line (MSIV's), reactor water cleanup, reactor core isolation cooling, and the residual heat removal.

   - Tested from sensor to verification of automatic closure of isolation valves.

3. ECCS Actuation System - Tested from sensor to starting of ECCS pumps and standby diesel generators, opening of valves and opening of ADS SRV's.

4. Anticipated Transient Without Scram (ATWS-RPT) - Tested from sensor to opening of recirculation pump breakers.

5. End-of-Cycle Recirc Pump Trip (EOC-RPT) - Tested from sensor to opening of recirculation pump breakers.

6. RCIC Initiation - Tested from sensor to starting of RCIC turbine and repositioning of valves.

7. RHR Containment Spray - Tested from sensor to RHR pump start and valve realignment.

8. Main Turbine/RFPT LL8 Trip - Tested from sensor to the tripping of the main turbine and feed pump turbines.

9. SRV Relief & Low-Low Set Logic - Tested from sensor to opening SRV's.

Note: A detailed list of the specific circuits tested within each of the above logic systems has not been included due to the extent of the list.

TABLE 3

GGNS SYSTEM TRIP UNITS VERIFIED BY MONTHLY
FUNCTIONAL TESTING

1. Reactor Protection System for: IRM, APRM, Reactor High Pressure, Reactor Low Level, Reactor High Level, MSIV Closure, MSL High Radiation, Drywell Pressure High, Scram Discharge Volume High Level, Turbine Stop Valve Closure, Turbine Control Valve Fast Closure, Manual Scram.

2. Isolation Actuation Instrumentation for:

   a) Primary Containment Isolation

      Reactor Low, Low Level, High Drywell Pressure, Containment and Drywell Ventilation Exhaust High Radiation

   b) Main Steam Line Isolation

      Reactor Low, Low, Low Level, Main Steam Line High Radiation, Main Steam Line High Flow, Condenser Vacuum Low, Main Steam Line Tunnel High Temperature, Main Steam Line Tunnel High dT

   c) Secondary Containment Isolation

      Reactor Low, Low Level, Drywell Pressure High, Fuel Handling Area Ventilation Exhaust High Radiation, Fuel Handling Area Pool Sweep Exhaust High Radiation.

   d) Reactor Water Cleanup Isolation

      High Differential Flow, Differential Flow Timer, Equipment Area High Temperature, Equipment Area High dT, Reactor Low, Low Level, MSL Tunnel High Ambient Temperature, MSL Tunnel High dT.

   f) RCIC Isolation

      RCIC Steam Line High Flow, RCIC Steam Supply Low Pressure, RCIC Turbine Exhaust Diaphram High Pressure, RCIC Equipment Room High Temperature, RCIC Equipment Room High dT, MSL Tunnel High Temperature, MSL Tunnel High dT, MSL Tunnel Temperature Timer, RHR Equipment Room High Temperature, RHR Equipment Room High dT, RHR/RCIC High Steam Line Flow.

   g) RHR System Isolation

      RHR Equipment Room High Temp, RHR Equipment Room High dT, Reactor Low Level, Reactor High Pressure, Drywell High Pressure

3. ECCS

   a) LPCS, RHR A, B and C (LPCI Mode)

      Reactor Low, Low, Low Level, Drywell High Pressure, LPCI Pump A/B Start Time Delay Relay

   b) ADS A and B

      Reactor Low, Low, Low Level, Drywell High Pressure, ADS Timer, Reactor Low Level, LPCS/LPCI A, B, C Discharge High Pressure

   c) HPCS

      Reactor Low, Low Level, Drywell High Pressure, Reactor High Level, CST Low Level, Suppression Pool High Water Level

4. ATWS - Recirc Pump Trips

   Reactor Low, Low Level, Reactor High Pressure

5. End-of-Cycle-Recirc Pump Trips

   Turbine Stop Valve Closure, Turbine Control Valve Fast Closure

6. RCIC System System Actuation Instrumentation for Reactor Low, Low Level, Reactor High Level, CST Low Level, Suppression Pool High Water Level

7. Containment Spray for Drywell High Pressure, Containment High Pressure, Reactor Low, Low, Low Level, Containment Spray Timers

8. Feedwater/Main Turbine Trip for Reactor High Level

9. Lo Lo Set/Pressure Relief Valves for Reactor High Pressure

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FIGURE 1

RPS (ELECTRICAL) FAILURE FREQUENCY AS A
FUNCTION OF SURVEILLANCE TEST INTERVAL

Transmitted by AECM-84/0023
dated January 6, 1984.

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FIGURE 2

SCRAM FAILURE FREQUENCY AS A FUNCTION OF
SURVEILLANCE TEST INTERVAL

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FIGURE 3

CORE DAMAGE FREQUENCY AS A FUNCTION OF
SURVEILLANCE TEST INTERVAL

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FIGURE 4

PUBLIC RISK AS A FUNCTION
OF SURVEILLANCE TEST INTERVAL

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