DEPARTMENT OF VETERANS AFFAIRS
Medical Center
4101 Woolworth Avenue
Omaha NE 68105

October 15, 1990

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

In Reply Refer To: 636/151

Reference: Omaha Department of Veterans Affairs TRIGA Reactor
Docket N. 50-131, Facility License No. R-57

Subject: Revision of TRIGA Reactor SER and Technical Specifications

In order to upgrade the vacuum tube neutron monitoring system of the Omaha VA TRIGA Reactor we would like to replace it with the General Atomics (GA) NM-1000 neutron monitoring system. Since the new system utilizes one wide range fission detector rather than two boron-lined compensated ions chambers and a fission chamber as described in our SER and Technical Specifications it is necessary to request their revision. The General Atomics NM-1000 neutron monitoring system is designed to replace the source range, intermediate range, and power range channels with a single neutron detector assembly and amplifier/processor unit. The NM-1000 system consists of a unique neutron detector; high speed, low-noise counting circuits combined root mean square (rms) signal conditioning circuits; diagnostic/microprocessor circuits; and 4 to 20 mA isolated output buffers. The complete channel provides a wide-range logarithmic output covering the entire neutron flux range from 2×10^{-8} to 120% of full power, a multi-range linear output covering 2×10^{-8} to 120% of full power, a percent power channel covering the flux range from 1% to 120% of full power, and a wide-range period channel covering the full ten decades. Since we realize that we must have two detectors for redundancy, the existing un-compensated boron-lined chamber used for per cent power measurement together with its measuring, power supply and scram circuit will also be utilized.

The GA NM-1000 system satisfies the nuclear power industry's requirements for:

1. A neutron flux monitoring system that meets all the requirements of 10CFR50 Appendix A, Criterion 13.

2. A neutron flux monitoring system that meets all the requirements of Regulatory Guide (RG) 1.97 (3).

3. A qualified Category 1 neutron monitoring system, qualified in accordance with IEEE 323-1974 and IEEE 344-1975.

4. A qualified remote safe-shutdown monitoring channel in compliance with the requirements of 10CFR50 Appendix R.

5. A qualified neutron monitoring channel with Class 1E isolation in accordance with IEEE 384-1975.

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We also request that we be allowed to keep the original system in place until the NM 1000 is completely checked out.

We have been operating the NM-1000, with the scrams unconnected, as an additional neutron monitor in parallel to our licensed system since Nov., 1989, and it has exhibited excellent reproducibility and characteristics.

Due to the confusion with references to operation at 110% licensed power for safety set points and testing, we are also submitting a request to amend our license to operation at 20 kW. All references to 110% operation will then be changed to licensed power. Analysis of the effect of increasing the power to 20 kW shows that there are no negative or unreviewed safety implications associated with operating the Omaha Department of Veterans Affairs TRIGA Reactor (ODVATR) at 20 kW.

All proposed changes have been reviewed and approved by the ODVATR Reactor Safeguards Committee. Should there be a need for further clarification or justification or should more information be required, please let us know.

Sincerely,

R.L. Turcotte
Director

Enclosures: Amendment No. 1: SER
Technical Specifications

cc: Mr. Alexander Adams, Jr., U.S. Nuclear Regulatory Commission, PDPN, M.S. 11-B-20, Washington, D.C. 20555
Regional Administrator, USNRC, Region IV, 611 Ryan Plaza Drive, Arlington, TX 76011

After being duly sworn, the person known to me to be R.L. Turcotte, Director of the Omaha Department of Veterans Affairs Medical Center, Omaha, Nebraska, signed the above document this 15 day of October, 1990.

GENERAL NOTARY-State of Nebraska
ROBERT E. NOAH
My Comm. Exp. April 12, 1993

AMENDMENT NO. 1

to the

SAFETY EVALUATION REPORT
NUREG-0988

for the

OMAHA DEPARTMENT OF VETERANS AFFAIRS

TRIGA REACTOR

Docket Number 50-131

License Number R-57

NUCLEAR REACTOR FACILITY
MEDICAL RESEARCH
DEPARTMENT OF VETERANS AFFAIRS
MEDICAL CENTER
OMAHA, NE 68104

October 1990

Revision to Safety Evaluation Report
of the Omaha V.A. Medical Center
Research Reactor
Docket No. 50-131

I. Remove the existing Par. 4.6, page 4-4 and replace with the following:

The operation of the reactor is monitored by two separate detector channels. A wide-range fission chamber and a boron-lined uncompensated ion chamber constitute the reactor core monitoring system. These detectors monitor the neutron-flux density of the core and provide trip signals to the safety circuits. The nuclear control instrumentation and process control instrumentation are discussed in Section 7.

II. Remove the existing Figure 7.1 and replace with the attached Figures 7.1, 7.2 & 7.3.

III. Remove the existing paragraph 7.4.1 and replace with the statements listed below:

7.4.1.a Nuclear Instrumentation

This instrumentation provides the operator with the necessary information for proper manipulation of the nuclear controls (Figure 7.1 & 7.2).

(1) The General Atomic NM-1000 Monitoring and Safety Channel is an industrial neutron monitoring system which is used both in research reactors and in nuclear power plants. It utilizes a fission chamber for the neutron detector, pulse processing electronics and a microcomputer to process instrument readings. Output from the microcomputer is routed to an alphanumeric display terminal with date entry and control capabilities. Log and Linear Power can be read on the display terminal and are also displayed on a chart recorder. Reactor period can be read on the display terminal and also on a hard wired bar graph. The linear power recorder is auto ranging and the range is indicated on a hard wired bar graph.

(2) The NM-1000 uses a 1.3 counts/sec-nv encased fission chamber to provide 10 decades of power indication - from shut down (source) level to full power - hence it is also referred to as a wide-range power monitor. A count rate circuit is used to monitor power for six decades up from source level; the top four decades are monitored by a Cambelling circuit. When neutron flux levels become high enough so that the detector cannot be operated in the count rate mode (power proportional to the pulses from the detector) without excessive pulse pile-up problems, the Cambelling technique is used. This technique consists of electronically deriving a signal which is proportional to the root mean square of the current fluctuations present in the fission chamber.

The amplifier/processor circuit employs designs which perform automatic on-line diagnostics and calibration verification. Detection of unacceptable circuit performance is automatically alarmed. The system is calibrated and appropriate scrams checked prior to operation during the prestart checks. The accuracy of the channels is ±3% of full scale; period and high power trip settings are repeatable within 1% of full-scale input.

(2) A minimum source-count interlock from the NM-1000 prevents rod withdrawal unless the measured source level exceeds a predetermined value.

(3) Power level and scram channel no. 2 comprises a separate uncompensated ion chamber, power supply, and power-range adjustment control and meter to indicate power level form 0 to 110% of licensed power. Scram level on this channel may be adjusted from 20 to 110% of full power.

(4) The automatic regulating channel consists of a servoamplifier that controls the regulating rod and thus keeps the reactor power level constant. The servoamplifier is activated by an error signal that is governed by the setting of the power-demand control in relation to the actual reactor power level. Because period information also is employed, the servo amplifier may be used to automatically bring the reactor up to power level, within the limits of the worth of the regulating rod, on a preset period of either 30 or 60 sec. Automatic changes in power level on these periods are possible. The servo amplifier will allow quick recovery to bring the power level back to within 1% of the original value, even when step changes in reactivity of up to several tenths of 1% of $\Delta k/k$ is made.

The two neutron-sensing chambers are hermetically sealed in aluminum or stainless steel cans and mounted on the outside of the reflector so that their positions are vertically adjustable in order to change sensitivity.

7.4.1.b Reactor Power Safety Channels. The TRIGA Mark I power safety system is designed to comply with IEEE Standard 379-1977 [1] for single failure and common mode failures. A two-channel system is provided in a one-out-of two trip logic configuration. One of the two power channels uses the output of an independent uncompensated ion chamber (Westinghouse 6937 or equivalent) and indicates percentage of power in the upper two decades of the power range. This channel is part of the original TRIGA Mark I system and is housed in its own independent enclosure with separate power supply. When a preset power level is reached on the meter a relay is activated in the control chassis causing the scram loop to open.

The second power safety channel is provided by the digital wide range power monitor (NM1000). This channel has been designed to satisfy all requirements necessary to operate as a Class 1E system as a nuclear safety channel for the nuclear power industry [1-4]. The NM1000 neutron monitor design utilizes high speed counting circuits, shielded signal and data communications cables, high speed digital (microprocessor) processing of the signal, and optically isolated output buffers for processing of power data from the fission chamber. As such, its use as a power safety channel meets the criteria of equipment <u>diversity</u> required for redundancy by ANSI/ANS 15.15 [5]. To test its response to rapid power changes, the response time of the NM1000 to a sudden change in power (step changes in reactivity) has been measured and compared to the existing analog safety channels on the Mark I Torry Pines reactor by General Atomic [6]. These timing tests showed that the response time of the digital channel fully satisfies the requirements for a scram channel for the TRIGA. Similar to the analog channel of the Per Cent Power channel, the NM1000 trip output is also hardwired into the scram loop; Thus any overpower condition in the NM1000 will also interrupt magnet current. The NM1000, therefore, also provides complete redundancy for operation as a license required safety channel with the analog per cent power channel.

The digital power monitor and safety channel (NM1000) uses the standard, well established technique of wide range power monitoring by the use of count rate and Cambelling techniques to monitor power from source range to full power [7]. However, the processing of the data from the amplifiers is performed digitally using state-of-the-art, high-speed data processors. The response time of the digitally processed signal for performance of the required safety function has been shown through direct parallel testing by General Atomic to be equivalent, as regards TRIGA safety, to that from the older analog safety system.

A schematic representation of conditions leading to a scram on the TRIGA Mark I reactor is shown in Figure 7.3

7.4.1.c. Internal Diagnostics

Internal diagnostics and self-tests within the NM 1000 are performed to ensure NM-1000 operation integrity. RAM, ROM and battery backed-up RAM (BBRAM) are continually monitored and tested. The NM-1000 hardware is also equipped with a watchdog timer that will reset the NM-1000 software if it is not reset periodically. Its purpose is to prevent the NM-1000 software from failing and not performing its power monitoring function while giving false results. It is reset every 16.7 msec while the NM-1000 communication is in sync with the counter/transmitter and the task level software is executing. Any failure will be indicated on the microterminal and a failure of the watchdog timer will initiate a scram.

IV. Remove the existing Table 7.1. page 7-6 and replace with the attached Table 7.1.

V. Reference is made to 18 kW on the following pages. It is concluded that since the increase in power from 18 kW to 20 kW reflects only an 11% increase, the safety margin in the original assessment was large enough that the increase would not effect the original evaluation. Consequently, it is requested that 18 kW be changed to 20 kW in the pages listed below:

A. Par. 1. page 1-1, line 28.
B. Par. 4.1, page 4-1, line 6.
C. Par. 4.3, page 4-3, line 23.
D. Par. 14.3, page 14-3, line 49.
E. Par. 14-7, page 14-6, line 27.
F. Par. 14-3, page 14-4, line 6.
G. Par. 14-7.1, page 14-7, line 2.
H. Par 17-1, page 17-1, line 27.

VI. The values in Table 14-1, and Table 14.2, page 14-9, were based on calculations for a cladding failure after an extended reactor operation at 18 kW. An increase of power to 20 kW would change the values in the tables by +11% but they still would be far below the guidelines and limits of 10 CFR 20.

VII. The references to ^{41}Ar concentration in Par. 11.1.1, page 11-1 and Par. 12.3.1, page 12-2 would also only be increased by 11% and consequently the levels would still be far below the guidelines and limits of 10 CFR 20.

VIII. We are not certain if it is necessary to change Par. 1-2, page 1-2, line 11 and page 1-3, line 2 since these refer to previous licensing.

REFERENCES

1. Application of the Single Failure Criterion to Nuclear Power Generating Class 1E Systems, Institute of Electrical and Electronic Engineers Standard IEEE ?79-1977.

2. Criteria for Protection Systems for Nuclear Power Generating Stations, Institute of Electrical and Electronic Engineers Standard IEEE 279-1971.

3. Digital Neutron Monitor NM-1000, GA Technologies Inc. Document INS-25, GA Proprietary Information (1983).

4. Qualification Test Report: NM-1000 Digital Neutron Monitoring System, GA Document E-269-1239, GA Technologies Proprietary Information (May, 1984).

5. Criteria for the Reactor Safety Systems of Research Reactors, American National Standard Institute Guide ANSI/ANS 15.15-1978.

6. Results of Timing T ts on NM-1000 High Power Scrams, J. Razvi to W.K. Hyde, General Atomics Internal Correspondence (May, 1988).

7. Radiation Detection and Measurement, Chapter 14, John Wiley & Sons (1979).

Table 7.1 Minimum reactor safety channels

Safety channel	Function	Set Point
Percent power	Scram	Licensed power
Linear power level	Scram	Licensed power
Log N and period period	Scram	Minimum of 7 seconds
Startup	Prevents withdrawal of all control rods	Minimum of 10 counts per second
Console scram button	Scram	Manual
Ion chamber power supply	Scram	Failure of power supply
Magnet current key switch	Scram	Manual
Simultaneous manual with-drawal of two rods*	Prevents withdrawal	....
Withdrawal of shim or regulating rod with safety rod not all the way out or seated*	Prevents withdrawal	....
Withdrawal of safety rod with shim or regulating rod not seated*	Prevents withdrawal	....
Pool level	. . . .	Alarm when water level is less than [illegible] ft above top of core
Pool water temperature	Meter indication	35°C

*May be defeated for control rod calibration.

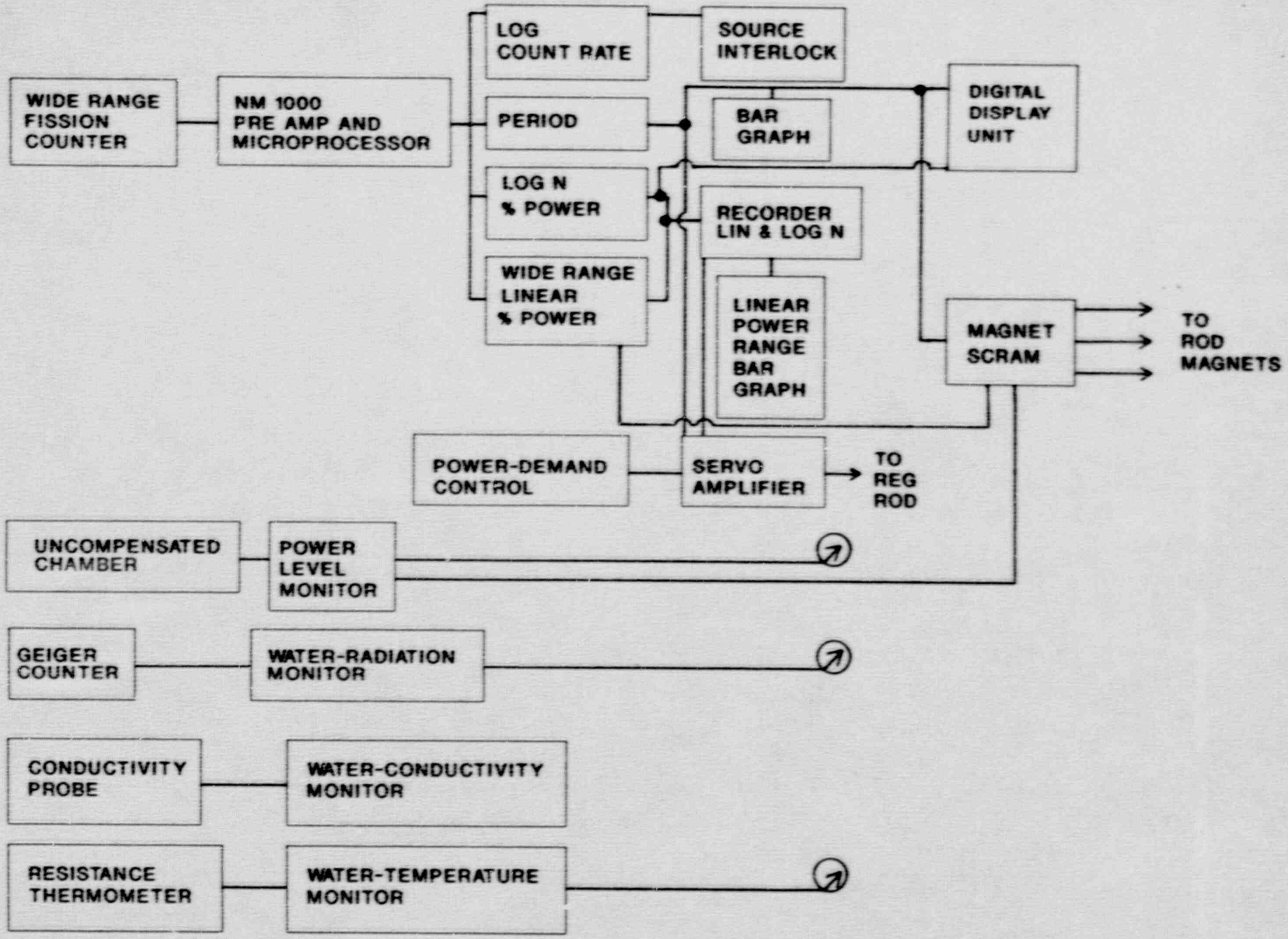

FIG. 7.1 BLOCK DIAGRAM OF INSTRUMENTATION

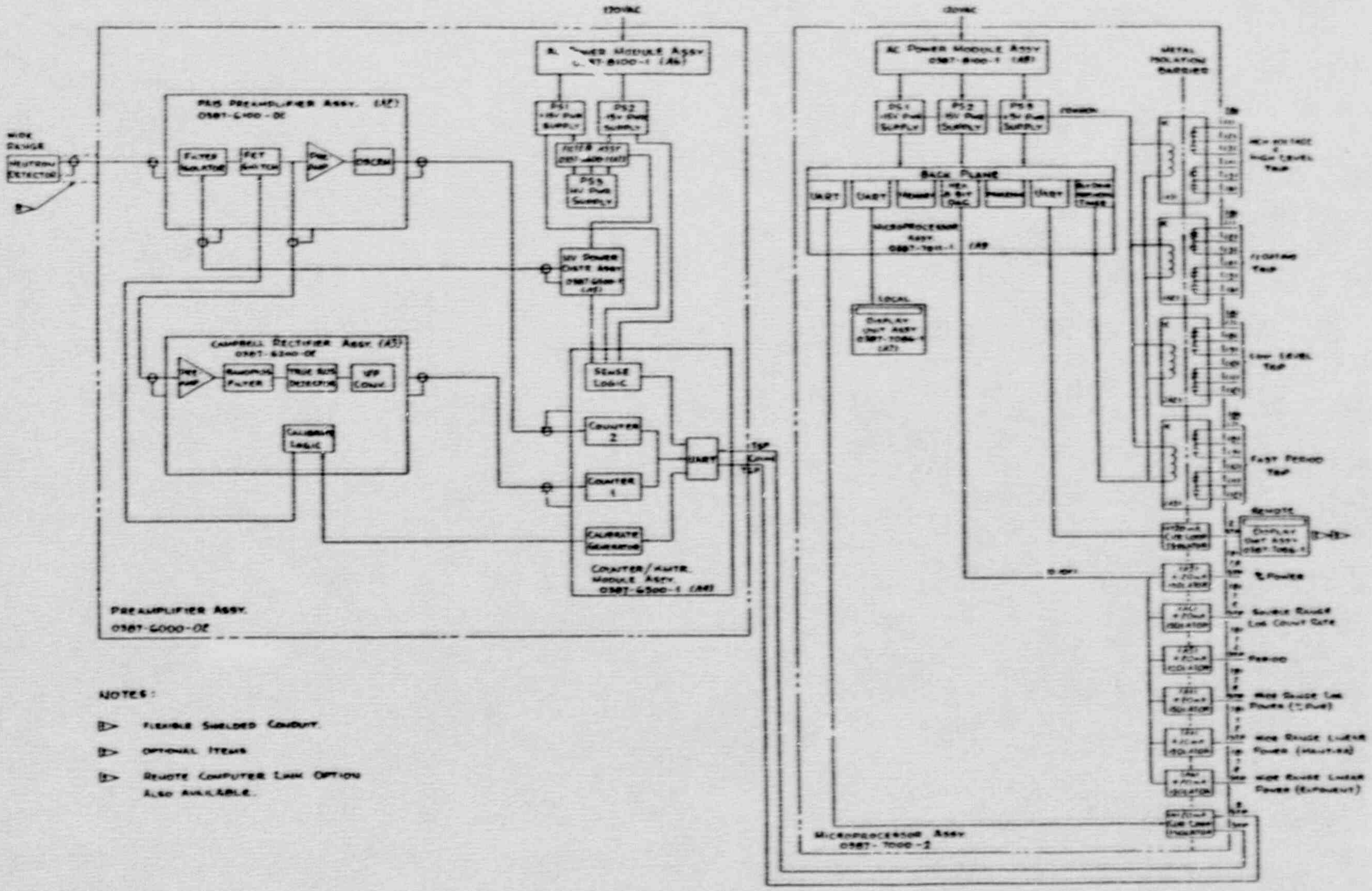

FIG. 7.2 FUNCTIONAL DIAGRAM NM-1000

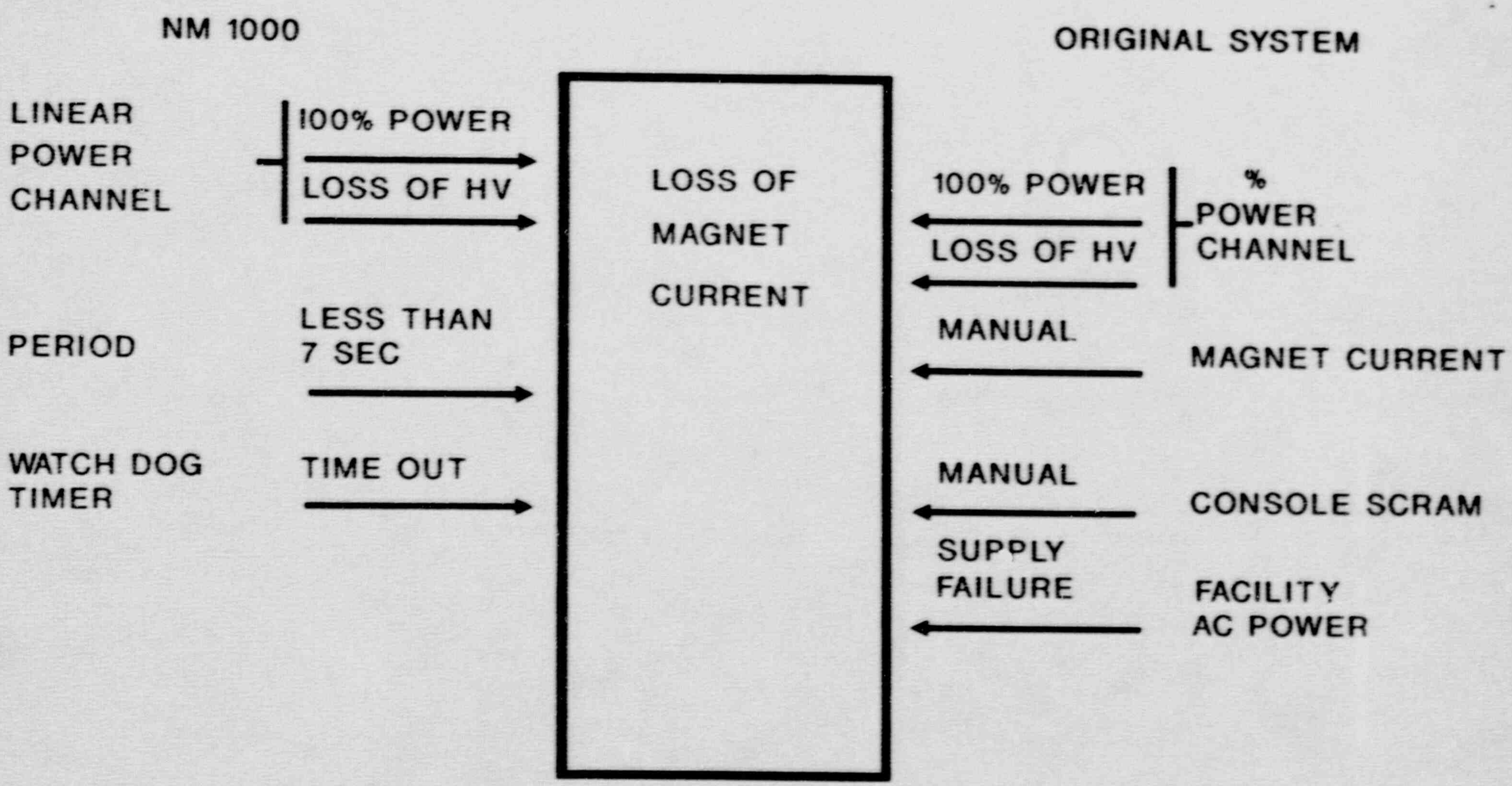

FIG. 7.3 SCHEMATIC REPRESENTATION OF CONDITIONS LEADING TO A SCRAM ON THE TRIGA MARK I REACTOR