UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

ENCLOSURE 1

COMPLIANCE WITH GDC 17

NORTHEAST UTILITIES

MILLSTONE UNIT 2

DOCKET NO. 50-336

1. INTRODUCTION

During a safety system functional inspection (SSFI) conducted by the licensee approximately two years ago, a concern was identified which was subsequently classified as an allegation by the staff. The concern involved the compliance of Millstone Unit 2 with GDC 17; specifically, a scenario wherein a single fault on a Class 1E bus could cause the simultaneous disruption of power from the reserve station service transformer 2 (RSST-2) to both redundant 4 kV Class 1E buses. By a memorandum from Charles W. Hehl, Director, Division of Reactor Projects Region I to Jose Calvo, Assistant Director for Region I Reactors, DRP I/II, dated May 20, 1991, the staff was requested to assess two safety issues: one involving a licensing question regarding the compliance of Millstone 2 with GDC 17; and the other a protective relaying question of breaker coordination.

2.0 BACKGROUND:

The offsite power system is the preferred source of power for Millstone, Unit 2. The electrical grid is the source of energy for the offsite power system. The safety function of the offsite power system (assuming that the onsite power systems are not available) is to provide the capacity and capability to ensure that the specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded and to ensure that core cooling, containment integrity, and other vital functions are maintained in the event of accidents.

The normal station service transformer (NSST) which is powered by the main generator, provides normal power to two onsite 4 KV non-Class 1E buses, 24A and

24B. Non-Class 1E buses 24A and 24B supply power to 4 KV Class 1E buses 24C and 24D, respectively. In the event of a unit trip, Class 1E buses ?C and 24D are automatically transferred to Unit 2 reserve station service transformer (RSST-2) by a fast transfer scheme. In the event that neither the NSST nor the RSST-2 is available to provide power, Unit 1 RSST (RSST-1) can be connected manually to buses 24C or 24D. Breakers from RSST-1 are interlocked with a locally operated Kirk key switch to restrict power from RSST-1 to only one Class 1E bus. On complete loss of offsite power, Class 1E buses 24C and 24D are connected automatically to their respective EDGs.

3.0 EVALUATION

One issue raised by Region I was regarding the compliance of Millstone Unit 2 with GDC 17; specifically, a scenario, involving a LOCA wherein a single failure on an onsite Class 1E bus and eventual loss of the RSST-2 could cause the simultaneous disruption of offsite power to both Unit 2 redundant 4kV Class 1E buses. The single failure is a bus fault on either 4kV bus "24C" or 4kV bus "24D" which follows a large break loss of coolant accident (LOCA). The LOCA will result in a reactor and turbine trip and an automatic transfer of both onsite buses to offsite power circuit RSST-2. If the single failure, such as a bus fault, occurs on onsite bus "A" following the LOCA, excessive current will flow on the faulted bus "A." Low voltage will occur on buses "A" and "B" as they are both fed from the same transformer winding and will both experience the same voltage drop. As a result buses "A" and "B" trip on undervoltage before the supply breaker to bus "A" can trip on overcurrent and thereby, isolate the fault. Undervoltage relays at Unit 2 are set to trip faster (set at 70% with a time delay of 0.5 second) than the overcurrent relays (overcurrent trip time for a 3-phase bolted bus fault at 4KV is 0.78 second). Thus, instead of the fault being isolated by an overcurrent trip of appropriate division "A" breaker, the fault affects both the divisions.

Once Division "A" and Division "B" buses have isolated themselves from their offsite power circuit (RSST-2), no automatic transfer can occur to RSST-1 because this transfer requires manual operation. Both Unit 2 EDGs will start and connect to their respective buses (24C and 24D). The division "A" EDG should then trip on overcurrent as a result of the fault remaining on the division "A" bus. The division "B" EDG unaffected by the fault on division "A" bus will connect to bus "B" and will provide the necessary capacity and capability to cool the core and safely shutdown the plant should this scenario occur. However, a concern is raised that considering a fault on bus "A," bus "B" does not stay connected to RSST-2 for as long as possible before switching over to the EDG. This concern is further discussed in the evaluation of the coordination of the protective devices.

The staff's evaluation of the compliance of Millstone Unit 2 with GDC 17 is as follows:

a. An offsite power system and an onsite power system shall be provided, each independent of the other and capable of providing power for all safety functions. The offsite and onsite power systems considered together must meet the single failure criterion on a system basis without loss of capability to provide power for all safety functions.

The power system at Millstone 2 is divided into two electrically independent, physically separated groups, each with access to two offsite power sources via RSST-2 and RSST-1 and one onsite standby diesel generator. RSST-2 is an immediate access source and RSST-1 is a delayed access sources. The offsite and onsite power systems considered together meet the single failure criterion on a system basis without loss of capability to provide power for all safety functions. The only requirement in GDC 17 for explicitly meeting the single failure criterion is with regard to the onsite power systems. There is no requirement in GDC 17 with regard to the offsite power system to assume a single failure coincident with an accident and loss of onsite power supplies. This would be, in effect, requiring multiple single failures in addition to the accident in question which is inconsistent with the stated requirement of GDC 17. Therefore, Millstone 2 meets the requirement of this portion of GDC 17.

b. The complete onsite electric power system (Class 1E) must be capable of sustaining a single failure without loss of capability to provide power for the minimum required safety functions.

GDC 17 requires that the onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure. The redundant divisions are electrically independent and physically separate to assure the availability of the power supply to the safety related equipment assuming a single random failure. Given a single failure, i.e., the fault on a 4 KV bus, both divisions trip from their offsite power supply on undervoltage, the EDGs start and load the Class 1E buses, one EDG will fail to energize the faulted division, and the un-faulted division remains powered from its EDG. This meets the single failure criterion.

c. The offsite system shall be comprised of two physically independent circuits connecting the transmission network (grid) to the onsite distribution system (safety buses). Separate transmission line towers are required but common switchyard structures are acceptable.

Two physically independent circuits are provided by RSST-2 and RSST-1 connecting the grid to the onsite distribution system. In the event that power is not available from RSST-2, the operator can manually connect one of the emergency buses to RSST-1. There is no requirement for meeting single failure, and in the absolute sense, single failure cannot be met because there are events for which the offsite system is not designed which could feasibly cause loss of both sources. Therefore, the design meets the cited criteria.

d. One of these circuits shall be designed to be available within a few seconds following a loss of coolant accident.

The staff has designated this circuit as the "immediate access or immediate available circuit." To meet this requirement, the offsite source must be normally connected to or it must have an automatic transfer to energize the bus from offsite power following a LOCA. Since only one such circuit is required, the offsite power system need not meet the single failure criterion with respect to its immediate access function.

At Millstone 2, the requirement to provide offsite power from at least one of the two offsite circuits to be available immediately following a LOCA is provided by an automatic transfer of divisions "A" and "B" to RSST-2. To be designed to be available immediately, a GDC offsite power source must either be normally connected to the Class 1E bus or it must have an automatic transfer to energize the bus from the offsite power source following a LOCA. The staff has accepted both these approaches for offsite power to be available immediately. Therefore, Millstone 2 meets the requirement of this portion of GDC 17.

e. Each of the two required offsite power circuits shall be designed to be available in sufficient time to effect safe shutdown in the event of loss of all onsite power and the loss of the other circuit.

The first source has been designated by the staff as the "immediate access or immediate available circuit," and this offsite power circuit is provided by the automatic fast transfer of divisions A and B to RSST-2.

The second circuit has been designated by the staff as the "delayed access circuit," and this offsite power circuit is provided from RSST-1 to the Class 1E buses 24C or 24D by the operator after locally aligning the key interlocks and shall be available in sufficient time following loss of the other offsite source "to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded." Breakers from RSST-1 are inter-locked with a locally operated kirk key switch to restrict power from RSST-1 to only one Class 1E bus. Therefore, Millstone 2 meets the requirement of this portion of GDC 17.

f. Provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies in the event of loss of the nuclear unit generator, the most critical transmission line, or the loss of power from the onsite electric power supplies.

The licensee had earlier performed the analyses and verified that the grid remained stable in the event of loss of the nuclear unit generator, the largest other unit on the grid or the most critical transmission line or the loss of power from the onsite electric power supplies.

Based on the above, it is clear that in the evaluation of the offsite power circuit design, GDC 17 does not assume a single failure coincident with an accident and a loss of onsite power supplies. If such a single failure were assumed for the offsite power systems (like loss of the offsite power grid), the electric power system could not provide its safety function because the onsite power would also not be available. Therefore, the ability of Unit 2 to cope with a simultaneous loss of onsite ac power and offsite ac power should not be considered in the context of evaluating Millstone 2 for compliance with GDC 17. However, any <u>single</u> failure may be assumed in the evaluation of the design for conformance to GDC-17. For an event such as an emergency diesel generator (EDG) bus fault, the review should show that no more than one Class 1E division is disabled and that offsite power (delayed access) can be manually restored to at least one division of the Class 1E system. For the offsite system, this evaluation of course excludes such events as seismic, tornadoes, etc. for which the offsite system is not designed. Since the assumed bus fault does not prevent the connection of the delayed access source to the unfaulted remaining Class 1E bus nor does it prevent the use of the EDG on the unfaulted bus, the minimum requirements of GDC-17 on the electric power system for Millstone, Unit 2, for this postulated event are satisfied.

The second issue raised by Region I was that a bus fault on 4kV bus "A" can result in an undervoltage trip of both 4kV Class 1E buses "A" and "B" from their NSST rather than in an overcurrent trip of division "A." Thus, the protective devices do not isolate only that portion of the electrical system where the abnormality occurs.

The offsite power system is the preferred and most reliable source of power for plant safety systems. The plant should remain connected to the preferred source for as long as possible before switching to the EDGs. Therefore, the relaying coordination is an important issue because if a fault should occur on either of the 4kV buses, the overcurrent device should trip the faulted bus breaker prior to allowing the undervoltage relaying scheme to trip both buses. At Millstone 2, the time-overcurrent relay trip time (from the curve GEK-34054) at 20,000 ampere fault current is 0.9 second and the over current trip time for a 3-phase bolted bus fault is 0.78 second. The loss of voltage protection scheme is set at 70% and 0.5 second and acts faster than the overcurrent protection. Therefore, the source of power to both divisions is removed rather than isolating the fault. A good engineering practice regarding protective devices is that in which the protective devices isolate only that portion of the system where the abnormality occurs.

Unit 2 operators have limited means to identify the location of a fault on the 4kV bus, given the scenario of a bus fault on one division causing both Class 1E buses to trip on undervoltage. Following the trip, the fault location is provided by two indications: an undervoltage condition on both Class 1E buses and an overcurrent trip of the EDG that attempted to energize the faulted bus. The staff has found that connecting an EDG on a faulted bus is not good engineering practice.

In response to the above, the licensee is evaluating various options including the bus differential scheme, increasing the undervoltage relay time delay, or the installation of newer, fast acting overcurrent relays.

The first option is to install the bus differential relays. A differential relay trips the feeder breaker if the current supplied to the bus exceeds the current output from the bus as a result of the fault on the bus. Technically speaking, this is the best and most expensive scheme, requiring the longest lead time for installation.

The second option is to increase the loss of voltage time delay from 0.5 seond to 3.2 seconds to provide adequate overcurrent and undervoltage relaying coordination. If the undervoltage time delay is increased, the overall time for the undervoltage relays to operate can be as long as 13.2 seconds which is greater than the FSAR EDG start time of 12 seconds. This requires further analysis and, therefore, is the least recommended.

The third option is to install newer, fast-acting overcurrent relays, such that if a bus fault occurs on Division A following the LOCA, excessive current will flow on the faulted Division A, the overcurrent relay will isolate the fault before the undervoltage relays have time to trip both the Class 1E buses.

The staff relies on the exercise of good engineering practice by the designers of electrical power systems at nuclear power plants to provide for the proper functioning of protective devices. Protective devices should isolate only that portion of the system where the abnormality occurs. The staff, therefore, finds the design at Millstone 2 to be inadequate in that the fault is not isolated and will result in a premature trip of both Class 1E buses from the preferred offsite power supply. Therefore, it is prudent for the licensee to employ a bus differential scheme or the fast acting overcurrent relays so as to isolate only the faulty bus.

4.0 CONCLUSION

We have concluded the following:

1. Since the requirements of GDC 17 for the offsite power system do not assume a single failure (such as a Class 1E bus fault) coincident

with an accident and loss of onsite power supplies, Millstone Unit 2 design complies with the requirements of GDC 17 and is, therefore, acceptable.

2. Protective devices should isolate only that portion of the system where the abnormality occurs. The staff finds the design at Millstone, Unit 2, to be inadequate in that the fault is not isolated and will result in a premature trip of both the Class 1E buses from the preferred offsite power supply. Therefore, it will be prudent for the licensee to employ a bus differential scheme or the fast acting overcurrent relays so as to isolate only the faulted bus.

(61)

RECORD OF ALLEGATION PANEL DECISIONS

SITE: Millstone

PANEL ATTENDEES:

ALLEGATION NO.: RI-91-A-0092

Chairman - J. T. Wiggins

DATE: 8 MAY 91 (Mtg. 1 2 3 4 5)

Branch Chief - E. C. Wenzinger

PRIORITY: High Medium Low

Section Chief (AOC) - E. M. Kelly

SAFETY SIGNIFICANCE: Yes No Unknown

Others - C. W. White R. C. Brady

CONCURRENCE TO CLOSEOUT: DD BC SC

J. S. Stewart R. L. Fuhrmeister

CONFIDENTIALITY GRANTED: Yes No
(See Allegation Receipt Report)

R. G. Schaaf

IS THEIR A DOL FINDING: Yes No

IS CHILLING EFFECT LETTER WARRANTED: Yes No

HAS CHILLING EFFECT LETTER BEEN SENT: Yes No

HAS LICENSEE RESPONDED TO CHILLING EFFECT LETTER: Yes No

ACTION:

1) Refer to OIG

2)

3)

4)

5)

NOTES:

E/70

62

RECORD OF ALLEGATION PANEL DECISIONS

SITE: Millstone

ALLEGATION NO.: RI-91-A-0093

DATE: 8MAY91 (Mtg. 1 2 3 4 5)

PRIORITY: High Medium Low

SAFETY SIGNIFICANCE: Yes No Unknown

CONCURRENCE TO CLOSEOUT: DD BC SC

CONFIDENTIALITY GRANTED: Yes No
(See Allegation Receipt Report)

PANEL ATTENDEES:

Chairman - J.T. Wiggins

Branch Chief -

Section Chief (AOC) - E.M. Kelly

Others - J.P. Durr

J.S. Stewart

R.L. Fuhrmeister

IS THEIR A DOL FINDING: Yes No

IS CHILLING EFFECT LETTER WARRANTED: Yes No

HAS CHILLING EFFECT LETTER BEEN SENT: Yes No

HAS LICENSEE RESPONDED TO CHILLING EFFECT LETTER: Yes No

ACTION:

1) Turn over to licensee

2)

3)

4)

5)

NOTES:

E/71