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

SAFETY EVALUATION
REACTOR TRIP FOLLOWING DE-ENERGIZATION OF A 125 V DC BUS
NORTHEAST NUCLEAR ENERGY COMPANY
MILLSTONE NUCLEAR POWER STATION, UNIT 2
DOCKET NO. 50-336

I. INTRODUCTION

On January 2, 1981, at 0050 hours, Millstone Unit No. 2 tripped while operating at one hundred percent power. The trip was caused by a plant equipment operator who mistakenly opened breaker D0103, instead of operating the ground detector switch. This de-energized DC Bus 201A and removed DC power from all "Facility Z1" equipment. A series of events was triggered by this removal of DC power. The Station Superintendent's Report (Reference 1), dated January 20, 1981, discussed the series of events associated with the reactor trip. NRC Region I reported the events in Reference 2. The NRC Office for Analysis and Evaluation of Operational Data (AEOD) published its study of the events on June 18, 1981 (Reference 4).

NRC Region I conducted an announced inspection on October 19-21, 1982 (Reference 9) to review the licensee's technical bases for the information provided in Reference 6 and to assure that AEOD's recommendations, Reference 8, were implemented at the facility. The inspection included review of substantiating licensee documents, discussion with cognizant licensee engineers, and independent verification of licensee's conclusions.

II. EVALUATION

A. Technical Bases for Licensee's Responses (Reference 6)

NRC, in Reference 3, requested that Northeast Nuclear Energy Company (NNECO) provide additional information in nine specific areas. We have reviewed the licensee's technical bases for each of the responses. An item-by-item discussion of the responses is given below.

Question No. 1

Provide the results of an analysis that demonstrates the capability of the design against the requirements of General Design Criterion (GDC) 17 as discussed in Enclosure 2 (to Reference 3). This analysis can be made part of the long term corrective action that NNECO proposed regarding this event, as documented in a letter dated January 20, 1981.

Evaluation of Response No. 1

The licensee has furnished the results of his design review against the Power Systems Requirements of GDC 17. In addition, the licensee clarified that his preferred source is the off-site connection, which is a full capacity source. Following a generator trip, the facility's power system would be connected to this preferred source by means of a high speed transfer. Should this source fail, the station 4.16 kV emergency buses would be automatically energized by the on-site diesel generator. A second source of off-site power is from Millstone Unit 1 Reserve Station Service Transformer. The licensee also identified another source from the off-site system through the Normal Station Service Transformer, for which he has taken no credit.

During the licensee's review, a cross connection between independent divisions was identified. This had the potential for compromising independency. NNECO has already made a design change to remove this cross connection and to fully separate each of the independent divisions of Electrical Power System.

The NRC has independently verified the licensee's analysis by reviewing the electrical drawings and the system descriptions. We conclude that the modified system meets the Power System Requirements of GDC-17. Therefore, we consider this matter to be closed.

Question No. 2

Insufficient information is available to determine whether the DC power feed to the close and trip circuits associated with the breakers through which offsite power is supplied to the emergency buses are independent. It is our concern that a single failure in the DC power feed to these breakers may result in the loss of capability to open the breakers when required and thus prevent the emergency power supplies from being connected to these buses. This will result in a station blackout. Verify that this is not the case and provide the results of such a verification.

Evaluation of Response No. 2

NNECO has provided the required information to establish independence of the DC power feed. It was also demonstrated how the modification discussed in Question 1 above makes the DC power feeds completely independent.

The NRC has independently reviewed the modified system and electrical operation and concluded that the modification would correct the interdependency problem and would provide complete independence for the DC power feeds. Since the licensee has provided all the required information and demonstrated the independency, we consider this item to be closed.

Question No. 3

Examine the design of the diesel generators and either demonstrate that tripping a running generator during abnormal and accident conditions is acceptable upon restoration of DC power or modify the present design to prevent this occurrence from happening. The design modifications must satisfy the positions set forth in BTP ICSE (PSB) 17.

Evaluation of Response No. 3

NNECO has demonstrated that the tripping of a running diesel generator, as it occurred during the event, was consistent with the assumptions of the facility's safety analyses. On page 8.3-11 of the facility's original FSAR, the licensee assumes credit for the remaining diesel generator when the DC control power is lost to one diesel generator. It should be noted that the Branch Technical Position ISCB (PSB) 17, now position 7 of Regulatory Guide 1.9 (Revision 2), is applicable to construction permits docketed after December 1979. Since the docket date for Millstone Unit 2 construction permit is much earlier than December 1979, we have conducted our review on the facility's licensing bases as stated in the FSAR. Based on our review, we concluded that the above scenario (tripping of an inoperable diesel generator) was consistent with the assumptions of the facility FSAR. On that basis, this item is closed. However, we note from Reference 10 that the licensee is considering further modifications to increase availability of the emergency diesel generator.

Question No. 4

Confirm that the Millstone Unit No. 2 design includes the capability for the automatic reinstatement of the undervoltage load shedding feature at the 4.16 kV emergency bus level. Submit a typical electrical elementary diagram that depicts the undervoltage load shedding feature inclusion in the control circuits of a 4.16 kV safety related load.

Evaluation of Response No. 4

NNECO has provided all the information required to confirm the capability of the Unit for the automatic reinstatement of the undervoltage load shedding feature at the 4.16 kV emergency bus level. In addition, NNECO has furnished the requested electrical elementary diagram depicting the undervoltage load shedding feature.

The NRC has independently verified the automatic reinstatement of the undervoltage load shedding feature by reviewing the elementary diagrams and system descriptions. We have also reviewed a report of the operational verification of the above feature. Based on the above we consider this item to be closed.

Question No. 5

If the automatic reinstatement of the load shedding feature is included in the design, explain why the load shed signal associated with system "B" diesel generator was overriden as indicated in the sequence of events prepared by NNECO.

Evaluation of Response No. 5

In NNECO's response, it was established that the above override was caused by operator action. We have independently reviewed the licensee's loss of normal power scheme and its relationship to the overriding of the load shed signal for "B" diesel generator and concluded that the sequence of events described in the licensee's response would override the load shed signal.

Based on the clarification provided by the licensee and our own independent review, we consider this item to be closed.

Question No. 6

State whether any safety loads were automatically sequenced to system "B" diesel generator. Identify these loads, if any.

Evaluation of Response No. 6

NNECO stated that "B" diesel generator was loaded via bus 24D load sequencer. The licensee has also identified the loads that were sequenced to the "B" diesel generator.

Therefore, this item is closed.

Question No. 7

Explain the reasons why no evaluation or test was performed to demonstrate that the capability of the safety related instrumentation loops connected to the vital 120 volt AC buses and associated battery chargers and inverters in system "B" have not been degraded below an unacceptable level as a result of this underfrequency event, even though blown fuses were not found.

Evaluation of Response No. 7

NNECO stated: The safety related instrumentation was fed from 120 V DC vital buses. These buses are equipped with the automatic frequency control feature which will become effective if the frequency drifts outside the range 59.4 Hz through 60.6 Hz. The inverters are powered via 125 V DC and as such not exposed to underfrequency excursion. A pair of battery chargers were exposed to underfrequency excursion. The power diodes were the "weak links" with respect to overcurrents. The diodes are protected by fuses. During the transient the above fuses remained intact. Operational experience of these battery chargers indicated that the underfrequency excursions had no impact on the functioning and the reliability of the battery chargers.

We consider the above statements to be responsive to the concern. Thus this item is closed.

Question No. 8

Examine the design and recommend modifications (including Technical Specification changes) that will preclude supplying either manually or automatically vital buses in supposedly independent systems from a single non-safety related balance of the plant (BOP) battery at the same time.

Evaluation of Response No. 8

NNECO has provided adequate clarification in this matter. It was stated that the existing connections from inverters 5 and 6 to panels IAC-1 and IAC-2 respectively,were not power connections. These connections are for sensing frequency for synchronization purposes. Thus, the panels IAC-1 and IAC-2 cannot be powered from inverters 5 and 6 respectively. The BOP battery was not safety related and thus not qualified to meet any requirements. In addition, the licensee did not take any credit for the design feature that depends on the BOP battery in the safety analysis.

Based on the clarification provided by the licensee and our own independent verification, we consider this item to be closed.

Question No. 9

Review the design and verify whether the electrical and air aspects of it for each main steam line isolation valve are independent from those associated with its redundant counterpart. If they are not, the licensee must either demonstrate that the safety consequences of an electrical or air related failure disabling both valves are acceptable, or modify the design accordingly. Support the justification of the design with a simplified functional diagram showing the electrical and air interfaces for the main steam line isolation valves.

Evaluation of Response No. 9

The licensee demonstrated that the electrical and air aspects for each Main Steam Isolation Valve (MSIV) are independent. They also determined that the MSIV circuits performed their intended safety functions during the loss of DC event. They have also provided the necessary logic diagrams to explain the functions.

We have independently reviewed the licensee's design documents and concluded that the air and electrical supplies to the MSIVs are independent. Based on the licensee's response and our own independent review, we consider this item to be closed.

B. Comparison of Licensee's Actions to AEOD Recommendations (Reference 8)

1. The need to revise procedures of operating plants to address the recovery from a loss of a DC bus event by including the effects of re-energization of the lost bus.

   Section 2 of the current revision (Revision 4) of Procedure OP 2519, Electrical Emergency (Loss of Main DC Bus), adequately describes the recovery from a loss of DC bus event, including the effects of re-energization of the lost bus. This procedure adequately satisfies the need identified above.

2. The need to inform plant operators of problems that could be encountered when diesel generators are running in an emergency mode, and the need to add corrective actions in appropriate procedures to counter these problems.

   Procedure OP 2503 (Revision 7) adequately discusses the potential problems associated with a diesel generator running in an emergency mode and specifies the required operator actions under the circumstances. This procedure is responsive to the need stated above.

3. The need to make plant operators aware that during partial pump operation certain pump combinations may exist which will not provide adequate spray flow to the pressurizer. (See item 4 below).

4. The need to familiarize plant operators with the potential for non-equilibrium pressurizer behavior when normal spray flow is unavailable.

   A Caution Statement was added in Procedure OP 2502 (Rev. 12), Section 5.9 to make the plant operators aware of certain pump combinations that will not provide adequate spray flow to the pressurizer. In addition, it alerts the operator to the non-equilibrium pressurizer behavior when normal spray is unavailable. Therefore, the licensee has satisfied both recommendations identified above.

5. The need to familiarize operators with core conditions that produce significant quantities of non-condensibles.

   Tab. 10 of "Mitigating Reactor Core Damage Lesson" plan for reactor operator training discusses, in detail, the core conditions that produce non-condensibles (gases). This is responsive to the need identified above.

III. CONCLUSIONS

We conclude that NNECO has been responsive in investigating this event and making changes in the emergency power system to reduce the probability of a similar event in the future. We also find that these changes and the associated modifications of procedures are acceptable.

IV. REFERENCES

1. Letter from E. J. Mroczka (NNECo) to J. F. Opeka (NNECo) dated January 20, 1981. Subject: Report on the Reactor Trip of Unit 2 on January 2, 1981.

2. Letter from E. J. Brunner (NRC, Region I) to W. G. Counsil (NNECo) dated April 22, 1981. Subject: Combined Inspections 50-245/81-01 and 50-336/81-01

3. Letter from R. A. Clark (NRC - NRR) to W. G. Counsil (NNECo) dated June 16, 1981. Subject: Request for Additional Information.

4. Memorandum from C. Michelson (NRC) to H. R. Denton (NRC) dated June 17, 1981. Subject: Millstone Unit 2 Loss of 125V DC Bus Event.

5. Letter from W. G. Counsil (NNECo) to R. A. Clark (NRC) dated July 28, 1981. Subject: NNECo's initial response to Reference 3 above.

6. Letter from W. G. Counsil (NNECo) to R. A. Clark (NRC) dated October 9, 1981. Subject: Response to Reference 3 above.

7. Letter from E. L. Zebroski (Institute of Nuclear Power Operations) to C. Michelson (NRC) dated October 27, 1981. Subject: Partial Loss of DC Power

8. Memorandum from C. Michelson (NRC) to H. R. Denton (NRC) dated November 5, 1981. Subject: Millstone Unit 2 - Reactor Trip Following De-energization of A 125V DC Bus.

9. Letter from T. T. Martin (NRC, Region I) to W. G. Counsil (NNECo) dated November 19, 1982. Subject: Inspection 50-336/82-23.

10. Letter from W. G. Counsil (NNECo) to T. T. Martin (NRC, Region I) dated January 27, 1983. Subject: Diesel Generator Circuit Modifications.

Principal Reviewers: Dr. P. K. Eapen, Region I
E. L. Conner, NRR
P. H. Leech, NRR