SAFETY EVALUATION REPORT

OCONEE UNITS 1, 2 AND 3

SEISMIC QUALIFICATION OF THE AUXILIARY FEEDWATER SYSTEM

Introduction

Since the accident at Three Mile Island, attention has been focused on the ability of pressurized water reactors to provide reliable decay heat removal. While it is recognized that alternate methods may be available to remove decay heat following transients or accidents, heat removal via the steam generators is the first choice for accomplishing a safe shutdown of the plant. Therefore, there should be reasonable assurance that the auxiliary feedwater system (AFW) can withstand the postulated safe shutdown earthquake (SSE).

To address this concern, the NRC developed and initiated Multiplant Action C-14, "Seismic Qualification of Auxiliary Feedwater Systems." The objective of this plan is to increase, to the extent practicable, the capability of those plants without seismically qualified AFW to withstand earthquakes up to the SSE level. This program was implemented with the issuance of NRC Generic Letter 81-14 dated February 10, 1981. Our review of the licensee's responses to this letter is the subject of this evaluation.

Evaluation

The enclosed Technical Evaluation Report (TER) was prepared for us by our consultant, Lawrence Livermore National Laboratory, as part of our technical assistance contract program. The report provides their technical evaluation of the licensee's conformance to the requirements of Generic Letter 81-14. The consultant's report indicates that the AFW may not continue to function during and following a seismic event as great as the safe shutdown earthquake. This conclusion is based upon cited weaknesses in the pumps, piping, valves, initiation and control, and structures/housing. The TER also indicates that the licensee did not conduct a walkdown of the AFW system and did not describe any alternate methods currently available to remove decay heat.

Subsequent to the consultant's review, we requested the licensee, in a letter dat September 8, 1982, to review the consultant's report and provide any comments relevant to our reaching a safety conclusion. The licensee's response, dated October 13, 1982, emphasized their belief that the AFW does have substantial seismic capability in that it would remain functional following an operating basis earthquake (i.e, half the level of the SSE). The response also requested additional consideration of a fully seismically qualified, dedicated shutdown facility, and provided specific comments and information. We have reviewed this supplemental information provided by the licensee, our consultant's technical evaluation, and have performed our own review of the licensee's responses to Generic Letter 81-14 and our request for additional information. Our summary findings are described below.

Pumps and Motors

The turbine-driven AFW pump could fail during a seismic event due to the loss of one of its support systems. There is no retrievable documentation on the seismic capability of the turbine oil system, although the turbine, as a whole, was certified by its manufacturer. The other trains of the AFW include two full capacity seismic Category I electric motor-driven pumps per reactor. Therefore, the potential seismic failure of the turbine-driven AFW train is acceptable on the basis of sufficient unaffected redundancy. (That is, the two motor-driven pumps will be operable). The housing of the pumps in the turbine building is discussed later.

Piping

The piping for the AFW systems is seismically qualified to the SSE level out through the first isolation valves, which are normally closed. Piping beyond these boundary points is not currently seismically qualified. The licensee indicates that this situation is consistent with other safety-related systems at the Oconee station.

Gen ic Letter 81-14 requests licensees t consider the AFW systems as including piping up to and including the second valve which is no ally closed, or capable of automatic closure when the isolation function is required. This system boundary definition is intended to assure that the safety function of the AFW will not be lost during a seismic event, assuming that the seismic event causes the failure of the nonqualified piping concurrent with a single failure in the isolation valve.

The licensee has identified the low pressure service water system (LPSWS) and portions of the AFW system where the boundary between the seismic and nonseismic portions are separated by a single manual isolation valve. The LPSWS provides cooling to the two AFW motor-driven pumps.

The licensee has agreed to upgrade or replace any of the AFW isolation valves that are not qualified to remain functional after a safe shutdown earthquake. In their analysis, the licensee has assumed that a single active failure will not change safely positioned manual isolation valves to the unsafe position. This assumption is correct only if the following conditions exist: 1) the valve position is inspected every 30 days or after valve position changes or repairs, and 2) the circuit breaker to any electrical controls for the valve operator is opened and the breaker position is inspected every 30 days or after position changes or repairs. The licensee refuses to open the valve motor operator breakers and proposes to inspect manual valve positions every 90 days or after repairs. If the valve motor operator breakers are not opened and the breakers' and valves' are not inspected every 30 days or after (valve or breaker) position changes or repairs, we conclude that an SSE concurrence with a single active failure in these isolation valves would result in the loss of all of the AFW system. The loss of all of the AFWS would result from the draining of the AFWS through a break in the nonseismic portion of the AFWS. Because of the serious consequences that would result from a total loss of the AFWS, it is our position that the licensee assure that a single active failure will not change a safely positioned manual isolation valve to the unsafe position. The licensee can satisfy this position by meeting the following conditions:

1. Inspect the manual valve positions every 30 days or after valve position changes or repairs, and

2. Open the circuit breaker to any electrical controls for the valve and inspect the breaker position every 30 days or after position changes or repairs.

The licensee contends that the LPSWS is capable of functioning after a safe shutdown earthquake but had made this conclusion without a detailed analysis. In order for us to complete our evaluation of the LPSWS we will require the licensee to submit a detailed justification for concluding that the LPSWS will function after a safe shutdown earthquake.

The licensee is analyzing the effects of a safe shutdown earthquake on plant heating lines, failure of which may affect the functional capability of the AFWS. The licensee has committed to modify these heating lines as required. In order to complete our review we need to know the results of the licensee's analysis of the plant heating lines, including a description of any modifications to these lines.

Valves and Actuators

The following are the only valves in the AFW that are not qualified for the SSE.

1. The oil valves in AFW support systems are not qualified for an SSE.
2. The air-operated valves are not fully qualified.

The licensee has indicated that the areas lacking qualification have no effect on the operability of the AFW. All the oil valves that support the AFW are related to the turbine-driven pump. These valves are acceptable on the basis that the plant can be placed in the cold shutdown condition without the turbine-driven pump.

With regard to the concern for potential failure of the air-operated valves, only two valves in the AFW system per unit must change position to establish and/or control flow to the steam generators. These valves are air-operated, are normally closed, and fail to the open position. Documentation on the seismic qualification of these valves is not available. In order to provide assurance that these valves will be capable of operating following an SSE, the licensee plans to qualify these valves either by analysis or by replacement, as required. Based on the licensee's commitments, we conclude that the auxiliary feedwater system valves and actuator are capable of functioning after a safe shutdown earthquake.

The air operated valve #C-176 isolates the line that connects the suction line of the AFW pumps to the main condenser hotwell. Within 30 to 40 minutes of a loss of the air supply, valve #C-176 will open and begin to drain the upper surge tank (the primary water source for the AFWS) into the main condenser hotwell. This will result in starving the flow to the AFWS approximately 18 minutes after valve #C-176 opens. The operating procedures instruct the operator upon the loss of the air supply to close valve #C-176 and align the AFWS to the alternate water supply which is the condenser hotwell. The operator has between 48 and 58 minutes to perform the operations that prevent starving the flow to the AFWS. This is well within the operator action time requirements (30 minutes); therefore, we conclude that the licensee's method for preventing the starving of flow to the AFWS due to the loss of air supply to valve #C-176 is acceptable.

<u>Power Supplies</u>

Electric power to some of the motor-operated valves and pneumatic sources for air-operated valves are not seismically qualified. For the MOVs, the licensee stated that electric power is not essential since the MOVs fail as-is and are not required to change position to establish flow. While we agree that establishing AFW flow is acceptably independent of electric power, we remain concerned regarding control of AFW flow. The applicant has assured us that the motor-operated valves are not used for AFW flow control; therefore, electric power is not needed for them to perform their safety function. For the air-operated valves, which includes the normal flow control-valves (FCVs) for the AFW, the licensee has provided an automatic bottled nitrogen system which can serve as an alternate to the air source. The licensee has committed to assure that the automatic bottled nitrogen system, including power to the solenoid valves, will withstand a safe shutdown earthquake.

Based on the licensee's commitments, we conclude that the AFWS power supplies are capable of functioning after a safe shutdown earthquake.

Initiation and Control

The control to the motor-operated valves other than those in the auto-initiation and auto-control of the AFW system is not seismically qualified. This includes the control to the branch line isolation valves off the main steam header and the electric motor-operated valves in the AFW suction and discharge line which are normally aligned for AFW operation but not normally required to operate. However, the licensee stated that no actuation is required of the motor-operated valves for the AFW flow and the valves will fail as-is upon loss of power. In order for this design to be acceptable, the licensee must commit to open the breakers to these valve operators and verify that the breakers and valves are open every 30 days or after position changes or repairs.

Structures

The turbine building which houses portions of the AFW system is seismic Class II. The licensee has reanalyzed the turbine building and determined that the structure will survive the safe shutdown earthquake. The licensee's reanalysis of the turbine building is presently being evaluated by the staff.

Standby Shutdown Facility

The standby shutdown facility (SSF) system has been constructed to provide a dedicated separate train of auxiliary feedwater in the event the AFWS is simultaneously incapacitated on all three units by a safe shutdown earthquake.

The SSF system is designed to withstand the SSE. Structures supporting or housing the SSE system components include the reactor building and auxiliary building and are seismic Class I. The licensee provided a description of the methodologies and acceptance criteria used for seismic qualification of the SSF system, referring to applicable sections of the FSAR and licensee's letters of March 28, 1980; February 16, 1981; March 31, 1981; and April 13, 1981.

Regarding the AFW system boundary, all connected branch piping and crossover connections among the three units are seismically qualified only through the first valve. We conclude that the AFW system boundary does not fully meet the requirements defined in the Generic Letter.

Regarding the system boundary, some small piping vents and drains, capped lines, tank vents, and a recirculation line from the diesel fuel oil storage tank either have only one normally closed valve or are seismically designed through the first valve. We conclude that the SSF system boundary does not conform to the definition of boundary specified in the Generic Letter. Furthermore, we require that this deviation be evaluated and corrected in order to assure the required safety function of the SSF system.

Our consultant has made the following conclusions regarding the SSF:

1. The licensee did not perform a walkdown of the currently nonseismically qualified areas of the AFW system because the SSF system is designed to withstand the SSE and to serve as the alternate decay heat removal system.

2. Both the AFW and SSF system boundaries do not fully meet the definition specified in GL 81-14.

We do not fully concur with our consultant's conclusion that the SSF is a substitute for the AFWS. In order for the SSF to be considered a substitute for the AFW, it would have to be capable of withstanding an SSE concurrent with a single active failure. The SSF contains only one auxiliary feedwater pump; therefore, if the SSE disables the AFWS for all three units and a single active fa''ure ·sable: the SSF AFW pump, all feedv ter to the three units would be lost.

The licensee not only overlooked the single active failure disabling the SSF AFW pump, but the use of one SSF AFW pump to provide feedwater to all three Oconee units violates General Design Criterion Number 5, which states:

> "Structures, systems and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units."

In the event of an SSE-induced accident, the licensee cannot show that an orderly shutdown of the remaining two units can be performed because the SSE can cause an accident in all three units simultaneously. This situation arises when an SSE ruptures the circulating water line and the resulting internal flood disables all the AFW pumps in the three units. The result is an accident in all three units, namely, the loss of the ultimate heat sink.

The safety significance of connecting the three units to one SSE AFW pump is any perturbation in one unit will cause perturbations in the other two units. Considering that Oconee is a Babcock and Wilcox reactor, thereby extremely sensitive to perturbations in AFW flow, small perturbations in AFW flow in one unit could cause severe transients or accidents in the other two units. General Design Criterion Number 5 was enacted to avoid these very plant interactions.

Because simultaneously putting the three Oconee units on one SSF AFW pump violates General Design Criterion Number 5, it is our position that the licensee provide procedures that restricts the use of the SSF AFW system to one unit for each accident or event. The licensee can satisfy this condition by meeting the following conditions:

1. Qualifying the AFW system to remain functional after a safe shutdown earthquake, and

2. Providing watertight doors, barriers and enclosures between the circulating water lines and the AFW system in order to prevent a seismically-induced circulating water failure from disabling the AFW system for the three Oconee units.

In summary, our evaluation concludes that the licensee's AFW system does not possess an overall seismic capability for withstanding an SSE. This oversight can easily be corrected by minor plant modifications and rewriting some operating procedures. Because of the importance of the AFW system, we believe the qualification of the AFW system to the Seismic Category I classification should be a high priority for the licensee.

August 27, 1982

TECHNICAL EVALUATION REPORT

OCONEE NUCLEAR STATION UNITS 1, 2, AND 3

SEISMIC QUALIFICATION OF AUXILIARY FEEDWATER SYSTEM

1. INTRODUCTION

Since the accident at Three Mile Island, considerable attention has been focused on the capability of nuclear power plants to reliably remove decay heat. The NRC has recently undertaken Multiplant Action Plan C-14 "Seismic Qualification of AFW Systems" [Ref. 1], which is the subject of this evaluation.

To implement the first phase of Action Plan C-14, the NRC issued Generic Letter No. 81-14 "Seismic Qualificaton of AFW Systems" [Ref. 2], dated February 10, 1981, to all operating PWR licensees. This letter requested each licensee (1) to conduct a walk-down of non-seismically qualified portions of the AFW system and identify deficiencies amenable to simple actions to improve seismic resistance, and (2) to provide design information regarding the seismic capability of the AFW system to facilitate NRC backfit decisions.

The licensee of Oconee Nuclear Station responded with a letter dated January 28, 1982 [Ref. 3]. The licensee's response was found not to be complete and a Request for Additional Information was issued by the NRC, dated April 8, 1982 [Ref. 4]. The licensee provided a supplemental response in a letter dated May 25, 1982 [Ref. 5].

This report provides a technical evaluation of the information provided in the licensee's responses to the Generic Letter, and includes a recommendation regarding the need for additional analysis and/or upgrading modification of this plant's AFW system.

2. EVALUATION

Information provided in licensee's responses included:

- o Specification of the overall seismic capability of the AFW system.
- o Identification of AFW system components that are currently non-seismically qualified for SSE.
- o Discussion of levels of seismic capability of non-seismically qualified components.
- o Specification of overall seismic capability of the Standby Shutdown Facility (SSF) system which will serve as an alternate decay heat removal system.
- o Description of methodologies and acceptance criteria for the seismic design of the SSF system, which is determined to be seismically qualified for the SSE level by the licensee.
- o Description of the AFW and SSF system boundary.
- o Status of compliance with seismic related NRC Bulletins and Information Notices.
- o Additionally, schematic sketches of the AFW and SSF systems.
- o Additionally, identification of areas of modification of the AFW system that will be performed under the SSF project.
- o Additionally, description of methodologies and acceptance criteria for seismically qualified components of the AFW system.

We have reviewed the licensee's responses, and a point-by-point evaluation of licensee's responses against Generic Letter's requirements is provided below.

(1) Seismic Capability of AFW System

Except for those items identified in the following, the AFW system has been designed, constructed and maintained to withstand an SSE utilizing methods and acceptance criteria consistent with that applicable to other safety-related systems in the plant. Presently, those items identified by the licensee as not being fully seismically qualified are evaluated below:

- Pumps/Motors - Portions of the turbine-driven pump oil system and oil cooling system, including the oil pumps and water cooling pumps do not have retrievable seismic documentation. However, we judge by experience that the pumps/ motors possess a less than OBE level of seismic capacity.
- Piping - The portion of all connected branch piping beyond the first valve is currently non-seismically qualified. We believe that the AFW system piping is likely to possess an OBE level of seismic capacity.
- Valves/Actuators - (a) Oil valves in the support system. However, the licensee indicated that credit for seismic design is not necessary because they are equipped with handwheels for manual operations. (b) Pneumatic control valves and their backup nitrogen bottles. However, the licensee indicated that these valves will fail open upon loss of gas pressure or they can be bypassed by aligning the AFW flow through the main feedwater startup line into the normal or AFW steam generator nozzles on either steam generator. (c) Certain valves do not have retrievable seismic documentation. The licensee stated, however, that such valves were built to at least the ANSI B 31.1.0 criteria and were modeled into the stress analyses as equivalent pieces of pipe for structural purposes. Based on the above information, we believe that the valves/actuators are likely to possess an OBE level of seismic capacity.
- Power Supplies - Power to the electric motor-operated valves and pumps, except for the motor-driven AFW pumps and the lower pressure service water pumps, is currently non-seismically qualified. However, the licensee stated that seismic design credit is not necessary for the power to the electric motor-operated valves because these valves can be manually operated with handwheels. We judge that the power supplies possess a less than OBE level of seismic capacity.
- Water Source(s) - None
- Initiation/Control Systems - The control to the motor-operated valves other than those in the auto-initiation and auto-control of the AFW system is not seismically qualified. This includes the control to the branch line isolation valves off the main steam header and the electric motor-operated valves in the AFW suction and discharge lines which are normally aligned for AFW operation but not normally required to operate. However, the licensee stated that no actuation

it required of the motor-operated valves for the AFW flow and the valves will fail as-is upon loss of power. We therefore judge that the initiation/control systems possess the capacity to withstand an SSE.

- Structures - The turbine building is seismic Class II. We therefore judge that the structures supporting or housing the AFW system components are capable of withstanding an OBE.

Based on our evaluation, those areas of the AFW system judged not to possess an SSE seismic capability are identified below:

o Pumps/Motors	Less than OBE
o Piping	OBE
o Valves/Actuators	OBE
o Power Supplies	Less than OBE
o Water Source(s)	None
o Initiation/Control Systems	None
o Structures	OBE

In summary, our evaluation indicated that the licensee's AFW system does not possess an overall seismic capability that can withstand an SSE.

Because the primary water source is seismically qualified for the SSE, a switchover to a seismically qualified secondary water source is not involved.

The Standby Shutdown Facility (SSF) system, being constructed to provide a dedicated separate train of auxiliary feedwater, will provide an alternate decay heat removal system when it becomes operational. No procedure is available at this time to switch from the AFW system to the SSF system. Such procedure will be developed on a schedule commensurate with the SSF system startup. The licensee did not indicate the completion date of the new SSF system.

The SSF system is designed to withstand the SSE. Structures supporting or housing the SSF system components include the reactor building and auxiliary building and are seismic Class I. The licensee's provided a description of the methodologies and acceptance criteria used for seismic qualification of the SSF system, referring to applicable sections of the FSAR and licensee's letters of March 28, 1980; February 16, 1981; March 31, 1981; and April 13, 1981.

Regarding the AFW system boundary, all connected branch piping and crossover connections among the three units are seismically qualified only through the first valve. We judge that the AFW system boundary does not fully meet the requirements defined in the Generic Letter.

Regarding the SSF system boundary, some small piping vents and drains, capped lines, tank vents, and a recirculation line from the diesel fuel oil storage tank either have only one normally closed valve or are seismically designed only through the first valve. We judge that the SSF system boundary does not conform to the definition of boundary specified in the Generic Letter. Since the existing AFW system is not fully seismically qualified, we feel that this deviation needs to be evaluated and/or corrected in order to assure the required safety function of the SSF system.

The licensee stated that both the AFW and SSF systems were included within the scope of the seismic related NRC Bulletins 79-02, 79-04, 79-07, 79-14, 80-11, and IE Information Notice 80-21.

(2) <u>Walk-Down of Non-Seismically Qualified Portions of AFW System</u>

The licensee stated that no walk-down was performed for the non-seismically qualified items of the AFW system due to reliance on the SSF system though the walk-down is requested by GL 81-14. We feel that a walk-down is required if the new SSF system does not become operational within a reasonable period of time.

(3) <u>Additional Information</u>

The licensee provided a schematic sketch of the AFW and SSF systems including the water source(s), heat sink, suction and discharge piping, major mechanical equipment, and structures supporting and housing the AFW and SSF system items.

Additionally, licensee's responses provided a description of the methodologies and acceptance criteria that were used in the design of the seismically qualified portions of the AFW system, by referring to the applicable sections in the FSAR.

The licensee identified the areas of the AFW system where modification/upgrade will be performed for the tie-in between the SSF and AFW systems. Because the construction of the SSF system is underway, the licensee stated that no additional modification to the AFW system is necessary due to reliance upon the SSF system.

3. CONCLUSIONS

The information contained in licensee's responses is complete. The licensee did not perform walk-down of the currently non-seismically qualified areas of the AFW system because the SSF system, being under construction, is designed to withstand the SSE and to serve as the alternate decay heat removal system. The switchover procedure from the AFW to the SSF system will be established commensurate with the startup operation of the SSF system. Both the AFW and SSF system boundaries do not fully meet the definition specified in GL 81-14.

Based upon the submitted information, we conclude that the AFW system does not presently possess the seismic capability to withstand an SSE. The ability of the SSF system to perform the required safety function following the occurence of an SSE is also in question because the SSF system boundary does not fully conform to the boundary definition specified in GL 81-14. In conclusion, we recommend that the NRC considers requiring the licensee (a) to submit the estimated completion date of the SSF system and perform a walk-down of the existing AFW system if it is determined that the SSF system will not become operational within a reasonable period of time and (b) to evaluate and/or correct the deviation of the SSF system boundary in order to assure the required safety related function.

REFERENCES

1. D. G. Eisenhut, U.S. Nuclear Regulatory Commission, memorandum to H. R. Denton, "Multiplar Action Plan C-14: Seismic Qualification of Auxiliary Feedwater Systems," February 20, 198..

2. U.S. Nuclear Regulatory Commission, Generic Letter No. 81-14 to all operating pressurized water reactor licensees, "Seismic Qualification of Auxiliary Feedwater Systems," February 10, 1981.

3. W. O. Parker, Jr., Duke Power Company, letter to H. R. Denton of U.S. Nuclear Regulatory Commission, January 28, 1982.

4. J. F. Stolz, U.S. Nuclear Regulatory Commission, letter to W. O. Parker, Jr., of Duke Power Company, "Request for Additional Information on Seismic Qualification of the Auxiliary Feedwater System, Oconee Nuclear Station Units 1, 2, and 3, April 8, 1982.

5. W. O. Parker, Jr., Duke Power Company, letter to H. R. Denton, U.S. Nuclear Regulatory Commission, May 25, 1982.

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ENCLOSURE II

REQUEST FOR ADDITIONAL INFORMATION
OCONEE NUCLEAR STATION
AUXILIARY SYSTEMS BRANCH

1. Provide a probabilistic risk assessment (PRA) which demonstrates that the probability of significant damage to the emergency feedwater system, following a missile strike resulting from tornadoes and other high winds and assuming loss of offsite power, is less than or equal to a median value of 1×10^{-7} per year or a mean value of 1×10^{-6} per year. Also provide a description of the methodology, modeling, assumptions, and error bounds used in your PRA.

   Your PRA should use the probability of windspeeds that is provided in Figure 1. Significant damage is defined as damage that would prevent meeting the design basis safety function.

2. You stated that in the event of a tornado induced loss of both the main and emergency feedwater system, the steam generator inventory would be expected to be boiled off within a few minutes. Ample time would be available for opening the manual dump valves on at least one steam generator to maintain a low back pressure for the auxiliary service water pump. Blowdown of the steam generators would not be necessary.

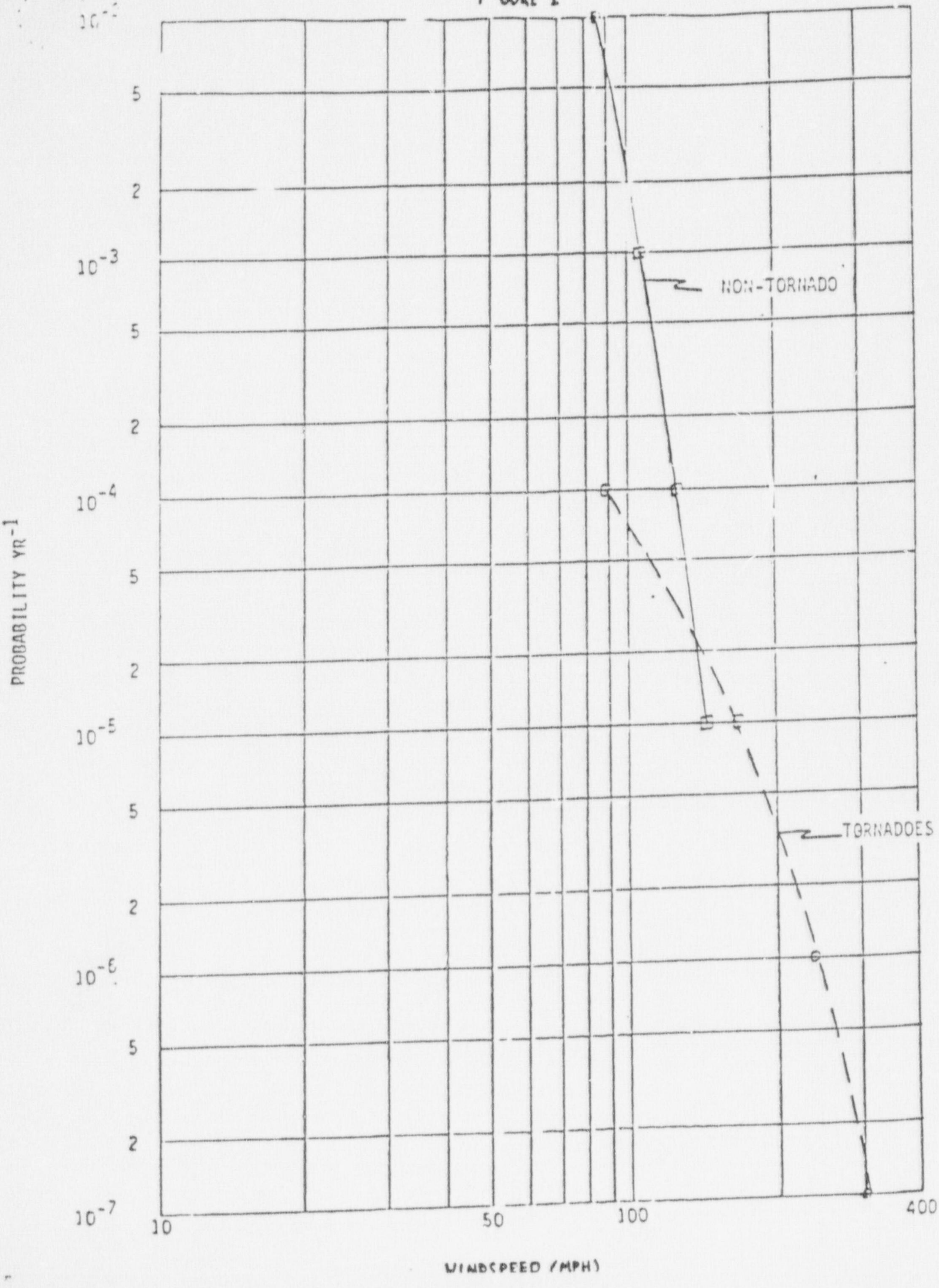
   Provide the results of an analysis which demonstrates that adequate decay heat removal can be continuously maintained through the use of the existing auxiliary service water system, and that such a cooldown method will not result in an accidental overpressurization of the auxiliary service water system or the excessive loss of reactor coolant. As a minimum, the following points should be addressed:

   a. Since the effectiveness of water injection into the steam generator (SG) is of some concern because of the low heat capacity of the ASWS, discuss the SG pressure that must be attained in order to provide sufficient ASWS flow into the SG to ensure adequate decay heat removal. Further, provide the dump valve capacity at rate ASWS pressure, and the time period assumed for operator action of the manual dump valves.

   b. Provide a discussion and analytical results (plots if appropriate) of the transient following a reactor trip utilizing the ASWS to remove decay heat. The discussion should include reactor coolant system pressure and temperature, SG pressure, SG water level/flow rate, and decay heat removal versus time. Provide the time at which the secondary steam dump capacity will match decay heat load following a reactor trip provided that the steam generators are at the ASWS operating pressure. Following the reactor trip during the time for which decay heat is greater than the removal capability of the steam dumps at ASWS pressure, provide the mass loss through the reactor system safety valves.

   c. Discuss the effects of cold shocking the steam generator as a result of injecting cold water into a relatively dry steam generator.

F GURE 1



PROBABILITY YR-1
10-3
10-4
10-5
10-6
10-7
5
2
10
50
100
400
NON-TORNADO
TORNADOES
WINDSPEED (MPH)