CONF-9010330--1
BNL-NUREG-44785

SEISMIC COMPONENT FRAGILITY DATA BASE FOR IPEEE*

K. Bandyopadhyay and C. Hofmayer
Brookhaven National Laboratory, Upton NY 11973

BNL-NUREG--44785

DE91 009448

ABSTRACT

Seismic probabilistic risk assessment or a seismic margin study will require a reliable data base of seismic fragility of various equipment classes. Brookhaven National Laboratory (BNL) has selected a group of equipment and generically evaluated the seismic fragility of each equipment class by use of existing test data. This paper briefly discusses the evaluation methodology and the fragility results. The fragility analysis results when used in the Individual Plant Examination for External Events (IPEEE) Program for nuclear power plants are expected to provide insights into seismic vulnerabilities of equipment for earthquakes beyond the design basis.

1.0 INTRODUCTION

As part of the IPEEE Program licensees of most nuclear plants will perform either a seismic probabilistic risk assessment (PRA) or a seismic margin study. Both the PRA and the margin study will require a reliable data base of seismic fragility of various equipment classes, especially those that are important for safety of the plant and, at the same time, have low seismic capacities. Based on a prioritization study conducted by Lawrence Livermore National Laboratory[1], Brookhaven National Laboratory has selected a group of equipment and generically evaluated the seismic fragility of each equipment class by use of existing test data. The progress in this effort and partial results were presented at earlier Water Reactor Safety Information Meetings[2,3]. This paper briefly discusses the evaluation methodology and provides fragility results on additional equipment pieces. It also includes a summary of earlier results for completeness of the data base. The following is a complete list of equipment: Motor Control Center, Switchgear, Panelboard, Switchboard, Power Supply, NSSS I&C Panels, Transmitters, Indicators, Switches, Transformers, BOP I&C Panels, Miscellaneous Instruments, Batteries, Battery Chargers, Inverters, Motors, Electrical Penetration Assemblies.

2.0 EVALUATION METHODOLOGY

Existing test data from various sources and for various models of a particular equipment class have been compiled and evaluated for each failure mode. The fragility has been defined as the threshold of occurrence of a failure and the corresponding vibration level has been measured in terms of the test response spectrum (TRS). The zero period acceleration (ZPA) and an average of the spectral accelerations (ASA) of the TRS in the frequency range of 4-16Hz have been used to represent each TRS. The ZPA's and ASA's for all models of the same equipment class have been statistically analyzed for determination of the median and variances due to uncertainties and randomness of the data. Finally,

* This work was performed under the auspices of the U.S. Nuclear Regulatory Commission.

Received by OSTI

MAR 2 1991

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

TABLE 1
FRAGILITY ANALYSIS RESULTS[a]

Equipment Type	Failure Mode	Indicator	Median	HCLPF
MOTOR CONTROL CENTER	Chatter	ZPA	1.3	0.8
		ASA	3.0	1.7
	Changed State	ZPA	1.7	1.0
		ASA	4.0	2.1
	Structural	ZPA	2.5	1.6
		ASA	5.0	3.2
SWITCHGEAR	Chatter	ZPA	0.6	0.2
		ASA	1.8	0.7
	Changed State	ZPA	1.4	1.0
		ASA	3.9	2.9
	Breaker	ZPA	2.0	1.4
		ASA	6.3	4.5
	Structural	ZPA	3.5	2.5
		ASA	8.5	6.0
PANELBOARD	Breaker	ZPA	2.5	1.0
		ASA	6.6	3.2
	Structural	ZPA	2.6	2.1
		ASA	6.9	4.2
SWITCHBOARD	Breaker	ZPA	3.5	1.8
		ASA	7.5	3.9
DC POWER SUPPLY	Accuracy	ZPA	3.6	2.6
		ASA	9.0	6.5
I&C PANELS (NSSS)	Functional	ASA	6.8	3.5
	Structural	ASA	9.0	4.7
I&C PANELS[b] (BOP)	Structural	ASA	6.3	3.3
TRANSMITTERS[b]	Accuracy	ASA	15.0	8.0
INDICATORS[b]	Accuracy	ASA	14.7	7.6
SWITCHES[b]	Discontinuity	ASA	10.0	4.5
TRANSFORMERS[b]	Structural	ASA	8.0	4.2

TABLE 1 (continued)
FRAGILITY ANALYSIS RESULTS

Equipment Type	Failure Mode	Indicator	Median	HCLPF
BATTERIES ON RACKS[b]	Discharge	ASA	10.0	3.0[c]
	Structural	ASA	10.0	5.0
BATTERY CHARGERS[b]	Structural	ASA	6.0	3.0
INVERTERS[b]	Structural	ASA	7.7	4.0
MISC. CONTROL INSTRUMENTS[b] (BISTABLES, CONVERTERS, SENSORS, SIGNAL MONITORS)	Accuracy	ASA	13.0	5.0

a. Relays should be evaluated separately.
b. Requires further verification.
c. Estimates based on artificially aged batteries.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

a high confidence value (HCLPF 95%-5%) has been computed for ready use in margin studies. If the available data points were considered inadequate for mathematical computation, the statistical parameters were obtained by use of judgment on the test results. Typical conditional fragility curves of an equipment are shown in Figure 1. The spectral accelerations were computed at a damping value of 2%. All acceleration values are at the location of the equipment. Most data base tests were conducted in the time period 1975-80.

3.0 RESULTS

For each equipment, the median fragility data and the HCLPF value are presented in this paper. The results are obtained for each failure mode. For electrical equipment, electrical malfunction occurs at a vibration level lower than that required for an overall structural failure. A summary of the fragility evaluation results is presented in Table 1.

4.0 CONCLUDING REMARKS

The fragility analysis of the remaining equipment classes will be completed in FY 1991 and the complete results will be published as a NUREG report. Since the data base relies on test data and has been intensively compared with other current studies (e.g., EPRI/ANCO data base for the A-46 Program), the fragility analysis results when used in the IPEEE Program are expected to provide dependable information regarding verification of equipment for earthquakes beyond the design basis.

REFERENCES

1. G.S. Holman and C.K. Chou, "Component Fragility Research Program: Phase I Component Prioritization," NUREG/CR-4899, June 1987.

2. K. Bandyopadhyay and C. Hofmayer, "Synthesizing Seismic Fragility of Components by use of Existing Data," Proceedings of the Fourthteenth Water Reactor Safety Information Meeting, NUREG/CP-0082, Vol. 3, February 1987.

3. K. Bandyopadhyay, et al, "Seismic Fragilities of Selected Electrical Equipment," Proceedings of the Fifteenth Water Reactor Safety Information Meeting, NUREG/CP-0091, Vol. 3, February 1988.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. John O'Brien of the USNRC for his support in this Program. In addition the authors greatly appreciate the cooperation of all the individuals and organizations who have shared their expertise and test data with BNL.

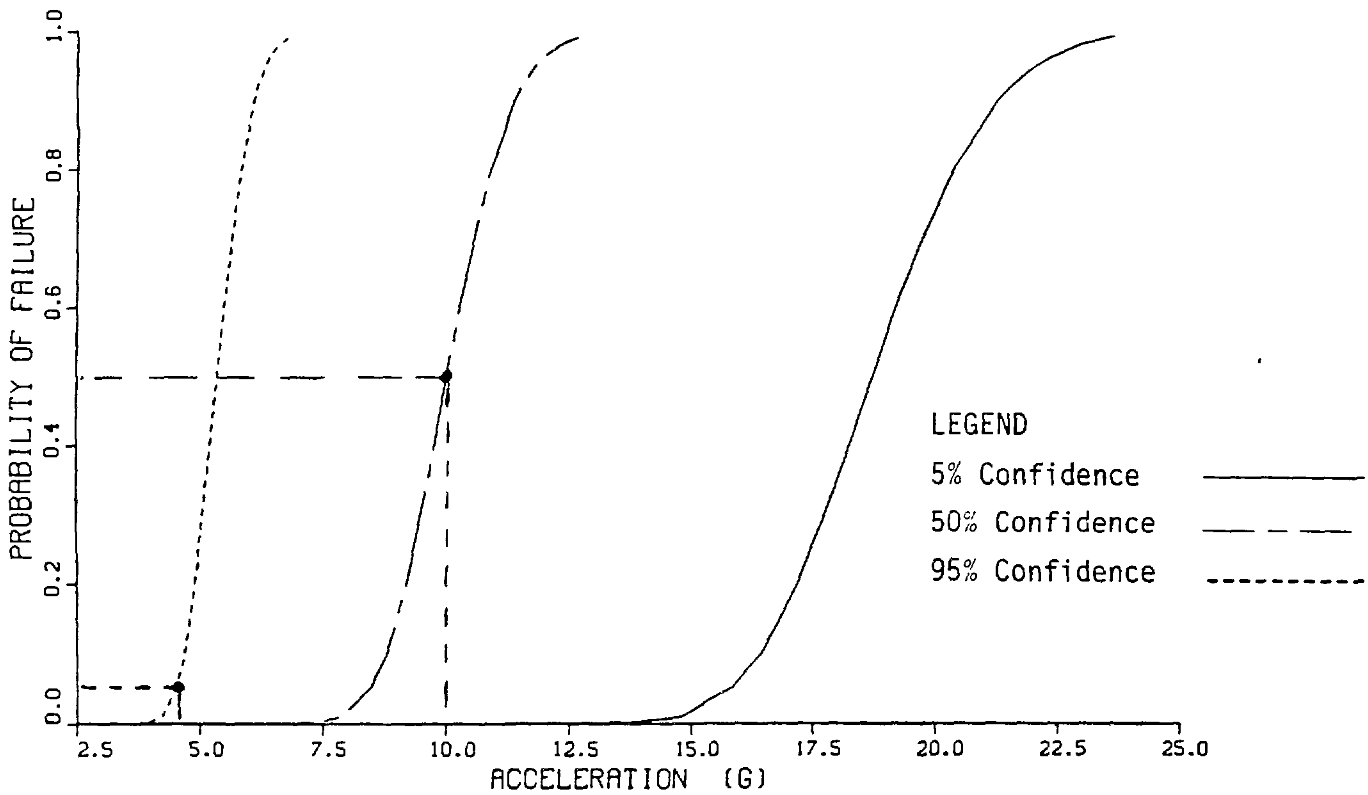

FIGURE 1 FRAGILITY CURVES FOR SWITCHES