UNITED STATES
NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

FROM: Robert B. Minogue, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER 122
"IMPEDANCE TESTING AT THE KUOSHENG NUCLEAR POWER STATION"

Introduction

The Kuosheng Nuclear Power Station consists of two units and is located on the northern tip of Taiwan near the port city of Keelung. The plant was constructed by the Bechtel Power Corporation for the Taiwan Power Company (Taipower), and is equipped with General Electric BWR 6/Mark III reactors and containments. Kuosheng is scheduled to be the world's first operational BWR 6/Mark III.

In 1980, the Division of Reactor Safety Research negotiated a cooperative agreement with Taipower to make analytical predictions for the Safety Relief Valve (SRV) discharge tests to be conducted in the Spring of 1981. This effort is undertaken as a part of RES involvement in co-operative foreign research and provides information useful for the licensing review of BWR 6/Mark III plants in the United States.

At the request of the Division of Engineering, NRR, impedance tests to determine dynamic-response characteristics (frequencies, mode shapes, and damping) were conducted on selected equipment as an adjunct to the SRV discharge tests. Impedance tests involve the use of mechanical exciters in conjunction with sophisticated electronic analyzers which, by monitoring response in real time, provide the sought after dynamic-response characteristics. The impedance test results are valuable in two ways:

1. in interpreting equipment response to SRV discharge loads in BWR 6/ Mark III plants and in validating computer models to estimate such equipment response, and

2. by themselves since they provide independently acquired in-situ impedance test data which may be used to confirm information submitted by applicants in FSARs.

This RIL concerns itself with the second case. A later RIL will be prepared to address the first case.

RES authorized EG&G, Idaho to conduct mechanical impedance testing at Kuosheng on December 16, 1980. Because of fuel loading and suppression-pool flooding and draining schedules at Kuosheng, impedance testing could only be conducted during the period January 15 to 31, 1981. To meet these constraints, Transitek, Inc. of Santa Clara, California, was contracted by EG&G. Transitek had performed previous impedance tests at the Zimmer and La Salle plants and was familiar with BWR equipment. With assistance from the NRC in obtaining the necessary export licenses for sensitive electronic equipment, a crew of four with 2 tons of equipment arrived in Taiwan in early January 1981. A senior project engineer from EG&G, Idaho was also dispatched to Taiwan to represent the NRC and coordinate, monitor, and control the performance of the tests. Testing began on January 18, 1981, and was concluded on January 27, 1981.

Results

The original plan called for the acquisition of impedance test data at two force levels to determine how frequencies, mode shapes, and damping values (eigenparameters) changed with the level of excitation. For this reason, and also because the sizes, masses, and stiffness of the tested components differed, hammers, electro-mechanical shakers and hydraulic shakers were employed during the testing. However, due to constraints placed on the tests by Taipower, only one force level was employed, except for excitation of the 3-inch motor operated valve. The components tested, the excitation source and the test axes are indicated in the table below:

Component	Excitation Source	Test Axes
3-inch motor-operated valve	Hammer	Three Orthogonal
Jet Pump Instrument Panel	EM Shaker/Hammer	Two Horizontal
RHR Pump	Hydraulic Shaker	Two Horizontal
Recirculation-Control Valve	Hydraulic Shaker	One Horizontal and One Vertical
480-Volt Motor-Control Center	Hydraulic Shaker	One Horizontal

Detailed results of the impedance testing are given in the enclosure to this RIL. In using these frequencies, mode shapes and damping values

in licensing safety evaluations, the following cautions should be observed:

1. Test response levels were generally in the range of 0.2g to 0.4g. Eigenparameters, particularly damping, can be expected to change with the level of excitation.

2. Support conditions for equipment are generally believed to be identical or similar to U.S. BWR 6/Mark III plants. However, any divergencies can be expected to lead to different eigenparameters.

3. To a great extent, whether fluid systems contained water and whether electrical and hydraulic connections had been installed and completed also had an influence on measured eigenparameters.

Evaluation

These test data may be used in the FSAR safety assessment of Grand Gulf and other U.S. BWR 6/Mark III plants. On short notice and with minimal costs, impedance testing at the Kuosheng Nuclear Power Station has been successfully completed. The data obtained are useful in themselves and provides confirmatory information for use in the FSAR review of plants in the United States. These tests, in addition, support NRC's generic research on SRV discharge-load evaluation. The equipment discussed in this RIL will be monitored during the SRV discharge tests.

The achievement of these results depended heavily on the cooperation of the staff and management of Taipower as well as that of our contractor, EG&G, Idaho and their subcontractor, Transitek, Inc.

Additional information on this work may be obtained from Dr. John O'Brien (x35860) of the Mechanical/Structural Engineering Branch.

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Enclosure: EG&G report