Revision 1
April 1974

U.S. ATOMIC ENERGY COMMISSION

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 1.12

INSTRUMENTATION FOR EARTHQUAKES*

A. INTRODUCTION

Paragraph (c) of § 50.36, "Technical Specifications," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," provides that the technical specifications will include surveillance requirements to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions of operation will be met. Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100, "Reactor Site Criteria," requires, in Paragraph VI (a)(3), a suitable program for implementing this requirement with regard to seismic instrumentation needed to determine promptly the seismic response of nuclear power plant features important to safety to permit comparison of such response with that used as the design basis. Such a comparison is needed to decide whether the plant can continue to be operated safely. This guide describes seismic instrumentation acceptable to the AEC Regulatory staff as satisfying the above-stated requirements of Appendix A to 10 CFR Part 100. This guide does not, however, address the need for instrumentation that would automatically scram a nuclear power plant or specify the methods to be used in the analysis of recorded data. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

When an earthquake occurs, it may not be known immediately how severe the effects of the earthquake are on a given nuclear power plant. It is advisable to have triaxial time-history accelerographs [1] installed at appropriate locations to provide data on the seismic input to containment, data on the frequency, amplitude, and phase relationship of the seismic response of the containment structure, and data on the seismic input to other Seismic Category I structures, systems, and components. It is desirable that these strong-motion accelerographs be located so as to facilitate the engineering analysis of the recorded traces following an earthquake.

The acceleration value corresponding to zero period in the containment foundation design response spectra may be referred to as the "acceleration level" of the input design earthquake motion to the containment structure. This acceleration level is an important parameter because the magnitudes of the design response spectra themselves are affected to a large extent by this level, and the plant shutdown requirement as specified in Appendix A to 10 CFR Part 100 is also related to this level. It is therefore necessary to install a triaxial seismic switch at an appropriate location in the basement capable of providing an immediate signal to remotely indicate if the specified zero-period acceleration has been exceeded. This can provide the basis for immediate administrative procedures if needed.

Appendix A to 10 CFR Part 100 requires that all the structures, systems, or components of a nuclear power plant necessary for continued operation without undue risk to the health and safety of the public be designed to remain functional when subject to the Operating Basis Earthquake (OBE). Since the zero-period acceleration of the containment foundation design response spectra representing the OBE may not fully describe the seismic event, it is important to have a triaxial response-spectrum recorder installed at an appropriate location in the basement of the plant capable of providing immediate signals for remote indicating in the control room if any significant portion of the foundation design response spectra has been exceeded. This can provide additional basis for

* This guide is a revision of Safety Guide 12.

[1] See ANSI Standard N18.5, "Earthquake Instrumentation Criteria for Nuclear Power Plants", for definitions. This standard is available from the American Nuclear Society, 244 East Ogden Avenue, Hinsdale, Illinois 60521.

immediate administrative procedures or decisions immediately following an earthquake.

The effects of the seismic motion at a given floor level in a structure can be represented by calculated floor response spectra. In many of the nuclear power plants, calculated floor response spectra are also used to design Seismic Category I systems and components supported on these levels. It is therefore important to install triaxial response-spectrum recorders at the selected support (floor) locations to determine if the calculated floor response spectra have been exceeded. This information will be needed to determine (1) the conservatism in the modeling and design assumptions made for the structure and design input motion to the supported systems and components and (2) the advisability of continuing the operation of the plant without a safety analysis following an earthquake.

The magnitude of the response of the systems and components supported on the containment structure is required in order to verify if the actual response of these parts has exceeded the design basis. This can be monitored by installing triaxial peak accelerographs [2] over selected locations on these parts. In addition, peak response of these parts will be necessary to determine the conservatism in the modeling and design assumptions made for these systems and components.

The severity of response of a given Seismic Category I structure will depend to a large degree on the maximum acceleration of the Safe Shutdown Earthquake at the foundation of the containment structure. It is therefore reasonable to relate the amount of instrumentation desirable to the magnitude of the maximum expected foundation acceleration. For this purpose, Safe Shutdown Earthquakes are divided into two categories: (1) earthquakes with maximum foundation accelerations of less than 0.3 g, and (2) earthquakes with maximum foundation accelerations of 0.3 g or greater. The earthquakes in the first category may be termed as ranging from moderate to strong, and the earthquakes in the second category may be called severe. This guide prescribes appropriate instrumentation for monitoring these categories.

Working Group ANS-2.2 of Subcommittee ANS-2, Site Evaluation, of the American Nuclear Society Standards Committee, prepared ANSI N18.5, "Earthquake Instrumentation Criteria for Nuclear Power Plants," which contains most of the criteria with respect to location and number of instruments, instrument characteristics, and instrumentation station installations specified in this guide.

C. REGULATORY POSITION

Earthquake instrumentation specified in ANSI N18.5, "Earthquake Instrumentation Criteria for Nuclear Power Plants," is acceptable to the Regulatory staff for satisfying the seismic instrumentation requirements indicated in Paragraph VI (a) (3) of Appendix A to 10 CFR Part 100 for assuring the safety of nuclear power plants, subject to the following:

1. The instrumentation called for in Section 4.1 of the Standard should be applied to nuclear power plants with a Safe Shutdown Earthquake maximum foundation acceleration of less than 0.3 g as supplemented by the following:

a. Instead of the locations specified in Section 4.1.2 of the Standard, one triaxial peak accelerograph should be provided at one location of each of the following:

(1) A selected location on the reactor equipment.

(2) A selected location on the reactor piping.

(3) The most pertinent location on one of the following outside of the containment structure:

(a) Seismic Category I equipment.

(b) Seismic Category I piping.

b. One triaxial response-spectrum recorder [3] capable of measuring both horizontal motions and the vertical motion and capable of providing signals for immediate control room indication should be provided at the containment foundation.

c. One triaxial response-spectrum recorder capable of measuring both horizontal motions and the vertical motion should be provided at one location of each of the following:

(1) A selected location on the reactor equipment or piping supports.

(2) The most pertinent location on one of the following outside of the containment structure:

(a) A seismic Category I equipment support or appropriate floor location.

(b) A Seismic Category I piping support or appropriate floor location.

(3) At the foundation of an independent Seismic Category I structure where the response is different from that of the reactor containment structure.

2. Section 4.2 of the Standard should not be used.

3. The instrumentation specified in Section 4.3 of the Standard should be applied to nuclear power plants with a Safe Shutdown Earthquake maximum foundation acceleration of 0.3 g or greater as supplemented by Regulatory Positions 1 and 2 above, and the following:

a. Instead of the locations specified in Section 4.3.2 of the Standard, one triaxial time-history accelerograph should be provided at the most pertinent

[2] ANSI N18.5 for definitions.

[3] An instrument having the capability when actuated of permanently recording peak responses as a function of frequency.

location on one of the independent Seismic Category I structures where the response is different from that of the reactor containment structure.

b. Instead of the locations specified in Section 4.3.3 of the Standard, one triaxial peak accelerograph should be provided at the most pertinent location on Seismic Category I equipment or piping in an independent Seismic Category I structure where the response is different from that of the reactor containment structure.

c. In addition to the locations specified in Regulatory Positions 1.b., 1.c.(1), and 1.c.(3) above, one triaxial response-spectrum recorder should be provided at one location on both items specified in Regulatory Positions 1.c.(2)(a) and 1.c.(2)(b) above.

d. Instead of the locations specified in Section 4.3.4 of the Standard, one triaxial seismic switch should be provided at a selected location on reactor equipment supports or piping supports.

4. The response-spectrum recorders should have the following specifications:

a. **Dynamic Range**–50:1 zero to peak (such as 0.02 g to 1.0 g).

b. **Frequency Range**–minimum coverage from 1 Hz to 30.0 Hz.

c. **Damping**–not less than nominal 2% nor more than nominal 5% of critical damping, controlled to ±0.15 of nominal. The actual amount of damping is to be consistent with the OBE-based design damping for the supported structure or equipment.

5. Instead of the dynamic range specified in Section 5.3.5 of the Standard, a range of 100:1 should be used.