Revision 2
November 1978

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 1.72

SPRAY POND PIPING MADE FROM FIBERGLASS-REINFORCED THERMOSETTING RESIN

A. INTRODUCTION

General Design Criterion 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 requires that measures be established to ensure materials control and control of special processes such as resin molding.

Section 50.55a, "Codes and Standards," of 10 CFR Part 50 requires that design, fabrication, installation, testing, or inspection of the specified system or component be in accordance with generally recognized codes and standards. Footnote 6 to § 50.55a states that the use of specific Code Cases may be authorized by the Commission upon request pursuant to § 50.55a (a)(2)(ii), which requires that proposed alternatives to the described requirements or portions thereof provide an acceptable level of quality and safety.

This guide describes a method acceptable to the NRC staff for implementing these requirements with regard to the design, fabrication, and testing of fiberglass-reinforced thermosetting resin (RTR) piping for spray pond applications. This guide applies to light-water-cooled and gas-cooled reactors. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.*

*Lines indicate substantive changes from previous issue.

B. DISCUSSION

The ASME Boiler and Pressure Vessel Committee publishes a document entitled "Code Cases."[1] Generally, a Code Case explains the intent of rules in the ASME's Boiler and Pressure Vessel Code (the Code)[1] or provides for alternative requirements under special circumstances. Most Code Cases are eventually superseded by revisions to the Code and then are annulled by action of the ASME Council. Code Case N-155-1 (1792-1), referred to in this guide, is limited to Section III, Division 1, of the Code and is oriented toward design and fabrication of RTR piping. The Code Case does not prescribe a lower temperature limit, primarily because the American Society for Testing and Materials (ASTM) specifications do not contain a lower temperature limit, but RTR piping systems would normally be qualified for the intended service temperature condition.

It is planned that after Revision 2 of this guide is issued, the acceptability of future minor revisions to Code Case N-155 (1792) will be noted in Regulatory Guide 1.84, "Design and Fabrication Code Case Acceptability--ASME Section III Division 1." Major revisions to the Code Case will, however, result in a revision to this guide (1.72). Filament-wound structures have mechanical properties superior to fiberglass-filled laminates, and they are considered more desirable when intended for safety-related pressure components.

The Code Case obtains an allowable design stress from the hydrostatic design basis (HDB) strength as derived from either Procedure A

[1] Copies may be obtained from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.

point B), constitute the acceleration region of the horizontal Design Response Spectra. For frequencies higher than 33 cps, the maximum ground acceleration line represents the Design Response Spectra.

The vertical component Design Response Spectra corresponding to the maximum *horizontal ground acceleration* of 1.0 g are shown in Figure 2 of this guide. The numerical values of design displacements, velocities, and accelerations in these spectra are obtained by multiplying the corresponding values of the maximum *horizontal ground motion* (acceleration = 1.0 g and displacement = 36 in.) by the factors given in Table II of this guide. The displacement region lines of the Design Response Spectra are parallel to the maximum ground displacement line and are shown on the left of Figure 2. The velocity region lines slope downward from a frequency of 0.25 cps (control point D) to a frequency of 3.5 cps (control point C) and are shown at the top. The remaining two sets of lines between the frequencies of 3.5 cps and 33 cps (control point A), with a break at the frequency of 9 cps (control point B), constitute the acceleration region of the vertical Design Response Spectra. It should be noted that the vertical Design Response Spectra values are 2/3 those of the horizontal Design Response Spectra for frequencies less than 0.25; for frequencies higher than 3.5, they are the same, while the ratio varies between 2/3 and 1 for frequencies between 0.25 and 3.5. For frequencies higher than 33 cps, the Design Response Spectra follow the maximum ground acceleration line.

The horizontal and vertical component Design Response Spectra in Figures 1 and 2, respectively, of this guide correspond to a maximum horizontal ground acceleration of 1.0 g. For sites with different acceleration values specified for the design earthquake, the Design Response Spectra should be linearly scaled from Figures 1 and 2 in proportion to the specified maximum horizontal ground acceleration. For sites that (1) are relatively close to the epicenter of an expected earthquake or (2) have physical characteristics that could significantly affect the spectral pattern of input motion, such as being underlain by poor soil deposits, the procedure described above will not apply. In these cases, the Design Response Spectra should be developed individually according to the site characteristics.

C. REGULATORY POSITION

1. The horizontal component ground Design Response Spectra, without soil-structure interaction effects, of the SSE, 1/2 the SSE, or the OBE on sites underlain by rock or by soil should be linearly scaled from Figure 1[2] in proportion to the maximum horizontal ground acceleration specified for the earthquake chosen. (Figure 1 corresponds to a maximum horizontal ground acceleration of 1.0 g and accompanying displacement of 36 in.) The applicable multiplication factors and control points are given in Table I. For damping ratios not included in Figure 1 or Table I, a linear interpolation should be used.

2. The vertical component ground Design Response Spectra, without soil-structure interaction effects, of the SSE, 1/2 the SSE, or the OBE on sites underlain by rock or by soil should be linearly scaled from Figure 2[2] in proportion to the maximum horizontal ground acceleration specified for the earthquake chosen. (Figure 2 is based on a maximum *horizontal ground acceleration* of 1.0 g and accompanying displacement of 36 in.) The applicable multiplication factors and control points are given in Table II. For damping ratios not included in Figure 2 or Table II, a linear interpolation should be used.

---

[2]This does not apply to sites which (1) are relatively close to the epicenter of an expected earthquake or (2) which have physical characteristics that could significantly affect the spectral combination of input motion. The Design Response Spectra for such sites should be developed on a case-by-case basis.

DEFINITIONS

Response Spectrum means a plot of the maximum response (acceleration, velocity, or displacement) of a family of idealized single-degree-of-freedom damped oscillators as a function of natural frequencies (or periods) of the oscillators to a specified vibratory motion input at their supports. When obtained from a recorded earthquake record, the response spectrum tends to be irregular, with a number of peaks and valleys.

Design Response Spectrum is a relatively smooth relationship obtained by analyzing, evaluating, and statistically combining a number of individual response spectra derived from the records of significant past earthquakes.

Maximum (peak) Ground Acceleration specified for a given site means that value of the acceleration which corresponds to zero period in the design response spectra for that site. At zero period the design response spectra acceleration is identical for all damping values and is equal to the maximum (peak) ground acceleration specified for that site.

TABLE I

HORIZONTAL DESIGN RESPONSE SPECTRA RELATIVE VALUES OF SPECTRUM AMPLIFICATION FACTORS FOR CONTROL POINTS

Percent of Critical Damping	Amplification Factors for Control Points			
	Acceleration[1,2]			Displacement[1,2]
	A(33 cps)	B(9 cps)	C(2.5 cps)	D(0.25 cps)
0.5	1.0	4.96	5.95	3.20
2.0	1.0	3.54	4.25	2.50
5.0	1.0	2.61	3.13	2.05
7.0	1.0	2.27	2.72	1.88
10.0	1.0	1.90	2.28	1.70

[1] Maximum ground displacement is taken proportional to maximum ground acceleration, and is 36 in. for ground acceleration of 1.0 gravity.

[2] Acceleration and displacement amplification factors are taken from recommendations given in reference 1.

VERTICAL DESIGN RESPONSE SPECTRA
RELATIVE VALUES OF SPECTRUM AMPLIFICATION FACTORS
FOR CONTROL POINTS

Percent of Critical Damping	Amplification Factors for Control Points			
	Acceleration[1, 2]			Displacement[1, 2]
	A(33 cps)	B(9 cps)	C(3.5 cps)	D(0.25 cps)
0.5	1.0	4.96	5.67[3]	2.13
2.0	1.0	3.54	4.05	1.67
5.0	1.0	2.61	2.98	1.37
7.0	1.0	2.27	2.59	1.25
10.0	1.0	1.90	2.17	1.13

[1] Maximum ground displacement is taken proportional to maximum ground acceleration and is 36 in. for ground acceleration of 1.0 gravity.

[2] Acceleration amplification factors for the vertical design response spectra are equal to those for horizontal design response spectra at a given frequency, whereas displacement amplification factors are 2/3 those for horizontal design response spectra. These ratios between the amplification factors for the two design response spectra are in agreement with those recommended in reference 1.

[3] These values were changed to make this table consistent with the discussion of vertical components in Section B of this guide.

REFERENCES

1. Newmark, N. M., John A. Blume, and Kanwar K. Kapur, "Design Response Spectra for Nuclear Power Plants," ASCE Structural Engineering Meeting, San Francisco, April 1973.

2. N. M. Newmark Consulting Engineering Services, "A Study of Vertical and Horizontal Earthquake Spectra," Urbana, Illinois, USAEC Contract No. AT(49-5)-2667, WASH-1255, April 1973.

3. John A. Blume & Associates, "Recommendations for Shape of Earthquake Response Spectra," San Francisco, California, USAEC Contract No. AT(49-5)-3011, WASH-1254, February 1973.

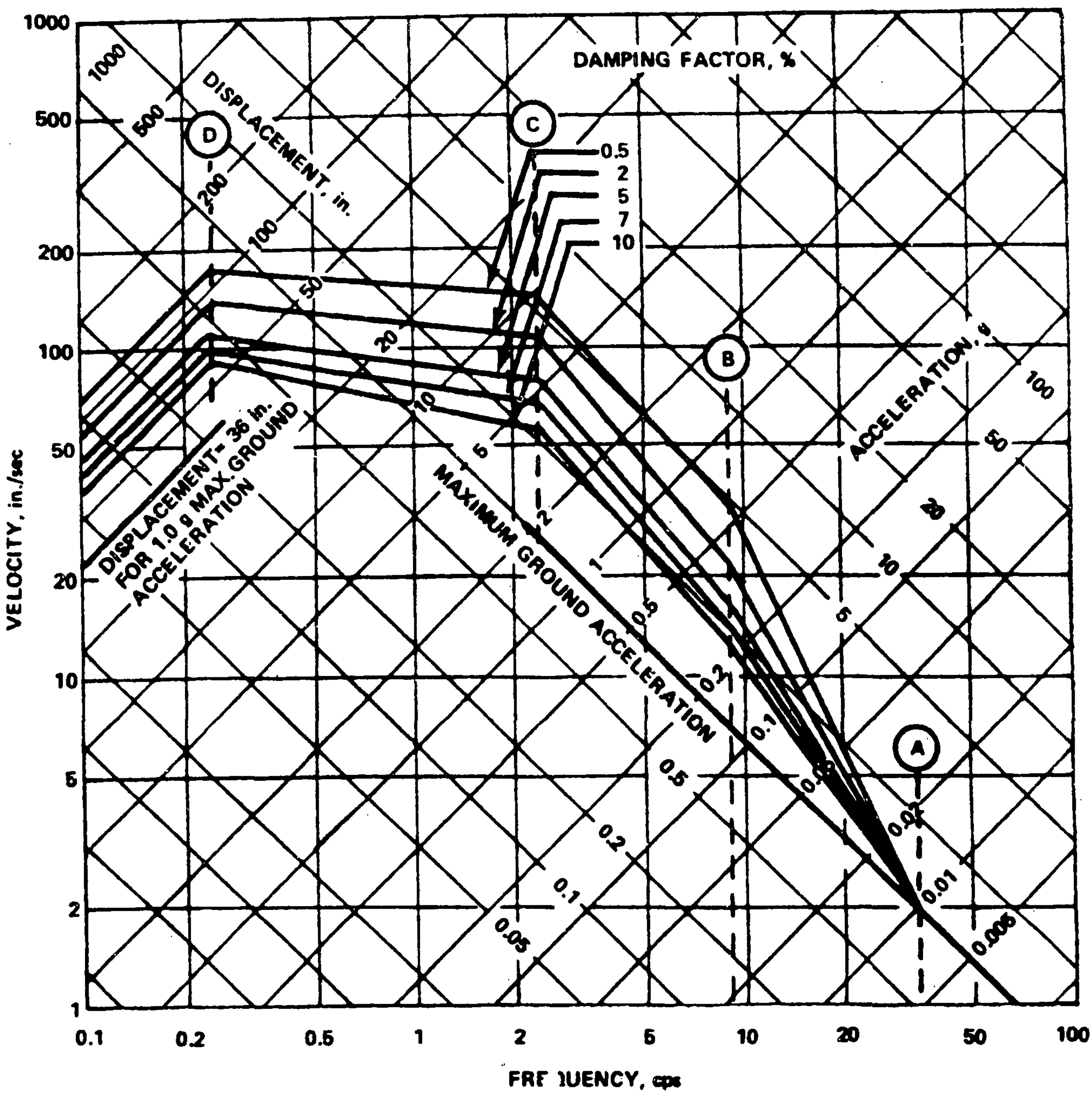

FIGURE 1. HORIZONTAL DESIGN RESPONSE SPECTRA – SCALED TO 1g HORIZONTAL GROUND ACCELERATION

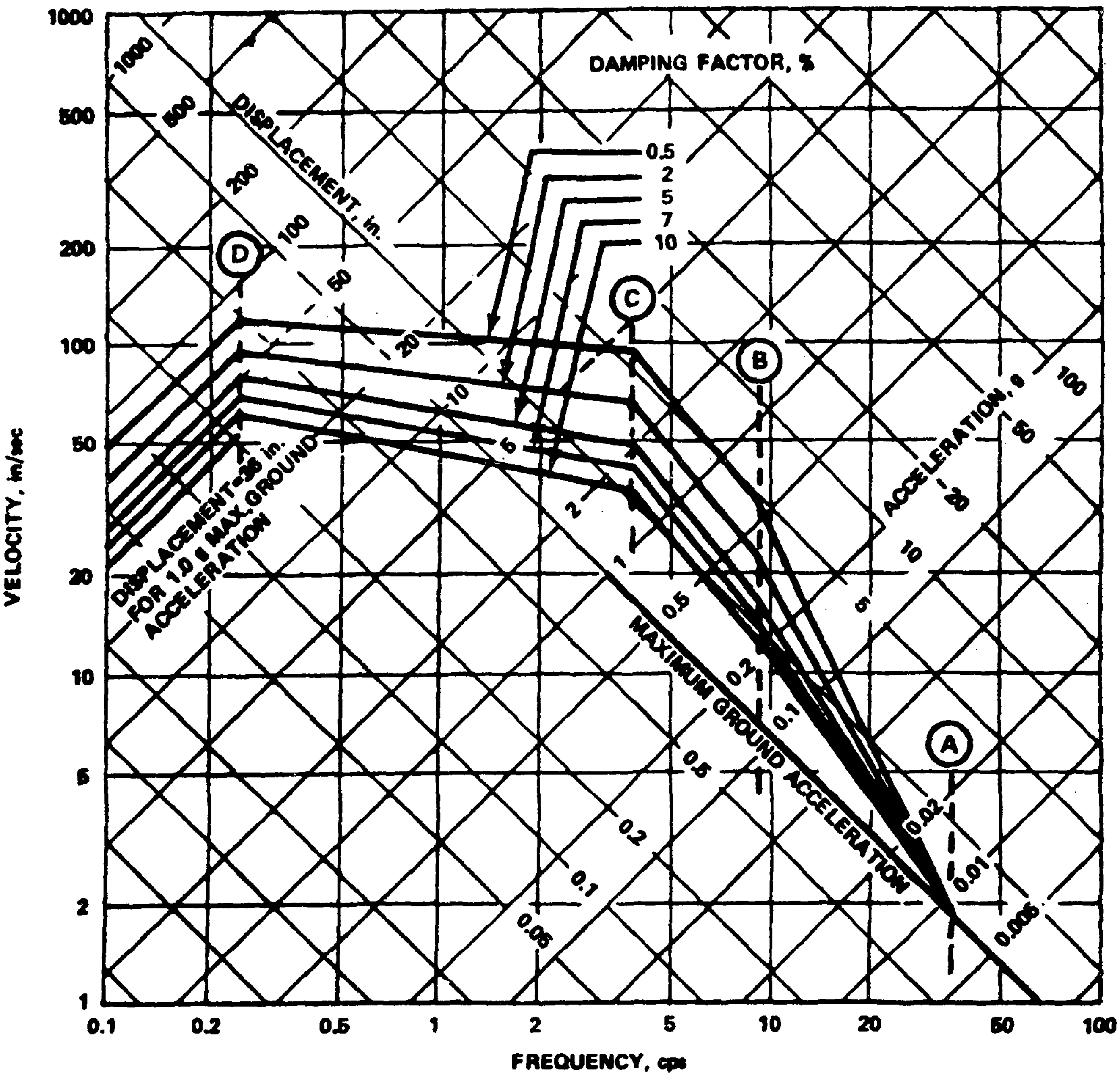

FIGURE 2. VERTICAL DESIGN RESPONSE SPECTRA – SCALED TO 1g HORIZONTAL GROUND ACCELERATION

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

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

FIRST CLASS MAIL
POSTAGE & FEES PAID
USNRC
WASH D C
PERMIT No G 67