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Report
on the
Meeting of July 11, 1979
of the
Advisory Committee on Reactor Safety
Nuclear Regulatory Commission

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1.0 Combination ofDynamic Loads

1.1 Introduction

The basic purpose of the ACRS meeting held in the afternoon of July 11, 1979, was to review the status of methods used for combination of dynamic loads in seismic analyses of nuclear components. Specifically the meeting was directed toward the seismic analysis of piping in 14 nuclear plants that used the algebraic summation method in combining seismic loads.

1.2 Discussion

Modal forces at a cross section calculated in dynamic analyses which are based on response spectra can not be combined algebraically. Signs and phase relationships are lost in response spectra. Signs of forces at a particular location are arbitrally assigned and depend upon the normalization process used to calculate the eigenvectors (mode shapes). However, it should be emphasized that signs of forces within a mode have a specific relationship to each other.

As a result, in order to combine modal forces, moments or stresses at a particular location in a structure, one of four methods are usually employed:

(1) Absolute Sum of Effects

(2) Square Root Sum of the Squares (SRSS) of effects

(3) SRSS method modified to add closely spaced modal effects absolutely

(4) The NRL Sum which adds the SRSS value of all modal effects except the largest to the largest modal effect absolutely

The NRC requires that either method 1 or 3 be used. Either of these methods will lead to a conservative analysis of seismic loads.

It has been well documented that piping systems that do not support large valves or pumps are inherently shock resistant. Many naval vessels have been shock tested with g forces in the 50 g to 250 g range without damage directly to the piping. Critical areas are the pipe supports, joints and nozzle connections. This data is consistant with the presentation made by Dr. R. L. Cloud.

1.3 Conclusions

If seismic stresses in nuclear piping calculated using the SRSS method accounting for closely spaced modes slightly exceed allowable values (10% to 20%) away from nozzles or pipe bends, the system should be considered safe. Stresses in nozzle regions and pipe supports should be critically reviewed. Established stress limits should not be exceeded. If a pipe supports a large concentrated weight such as a valve, stress limits should not be exceeded.

2.0 D. C. Cook Unit Steam Generator Nozzle Cracking

A number of Westinghouse PWR's reported cracking in the 16" main feedwater line near the steam generator nozzle. Dr. Zudans suggested that the piping may be highly stressed from relative motion between the steam generator and the other anchor point of the feedwater line. In the discussion that followed, it was suggested that the relative motion may be caused by some type of vibrating motion.

I agree with this comment, that this type of vibratory motion may be the cause of the cracking. However, relative motion of the two anchor points may also be caused by thermal expansion. Both steady state and transient conditions associated with start up and power level changes should be thoroughly studied.