THE ECONOMIC AFFECT OF INCREASED SEISMIC LOAD ON NUCLEAR POWER PLANT DESIGN AND CONSTRUCTION COSTS

J. D. STEVENSON

J. D. Stevenson, Consultants — Division of A. G. McKee & Company, 6200 Oak Tree Boulevard, Cleveland, Ohio 44131, U.S.A.

SUMMARY

In this paper the incremental percentage increase in the cost of design and construction of nuclear power plant safety class components and structures as a function of seismic design requirements in excess of an Operational Basis Earthquake, OBE, equal to 0.10 g acceleration used as a datum in the OBE range from 0.1 g to 0.3 g are evaluated (OBE assumed equal to one-half SSE). Specific areas considered in the cost evaluation are as follows:

a. Site Preparation and Foundation Costs
b. Costs of Building Structures, Including the Affect on Plant Layout
c. Cost of Safety Class (seismic Category I) Mechanical Components, Including Vessels, Tank Heat Exchanges, Pumps, Valves, and Fans
d. Cost of Safety Class (Seismic Category IE) Electrical Components, Including Generators, Control Cabinets, Switch Gear, and Motors
e. Cost of Safety Class (Seismic Category I) Mechanical and Electrical Distribution and Control Systems, Including Piping, Tubing, Ventilation Duct, Electrical Conduit, and Raceways

All of the five categories listed have their own particular problems with respect to incremental seismic design costs. Cost increments tend to be highly nonlinear for Categories a. through d. with little or no change in cost until a particular design limit is reached resulting in a discontinuous jump which then remains constant until a new limit is reached and another jump is encountered. For the distribution systems of Category e., costs tend to vary continuously as the square root of the applied g level. In addition, the methods of engineering analysis used in evaluating components to determine seismic design adequacy tend to become more rigorous as a function of increased g level. Also, it should be understood that while engineering design costs typically range between 3 to 12 percent of the total cost of a typical component or structure, seismic analysis cost particularly for relatively small, usually mass produced items can in some instances equal or greatly exceed the total cost of the item since the item supplied is no longer standard.

Actually, the increased seismic costs associated with Categories c. and d. are usually quite minimal because such components as a class are typically qualified for some upper bound by the manufacturer in order to be able to supply a broad range of nuclear plant site applications and the cost of such qualification distributed to all units equally. This study except for Categories a. and d., where the Safe Shutdown Earthquake, SSE, tends to control, design concentrates on the Operational Basis Earthquake, OBE, design requirements since the application of typical design code requirements and safety margins causes the OBE rather than the SSE to control design.

Actual costs are based on the detailed analysis as a function of g level of a limited number of specific sites, structures, components, and distribution systems. Cost differential thus determined are then applied to total safety-related qualities determined for typical 1100 MWe LWR systems to determine the overall cost effects.