DESIGN EVALUATION OF REACTOR COMPONENTS FOR SEISMIC DISTURBANCES

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SYNOPSIS

Nearly half of India lies within the active to moderate seismic zones. It is necessary to consider the effect of earthquake as an important parameter in the design of nuclear power stations. The reactor components in the existing nuclear power stations located in non-seismic zones are designed for small values of acceleration. A modified design of reactor components which is more suitable for seismic zones is evaluated.

SUMMARY

In the existing pressure tube type heavy water cooled and moderated 200 MWe nuclear power reactors the reactor assembly consists of three horizontal cylindrical components namely calandria and two end shields. These components are independently supported from the reactor vault ceiling by means of support rods having hinged connections at the top. Calandria and end shields are connected axially by means of calandria keys. To provide some restraint against axial displacement a number of spring loaded key blocks with one end attached to the periphery of end shield and other end bolted to the concrete vault are used. It is found that the number of key blocks already provided was adequate for small earthquake accelerations occuring simultaneously with single pressure tube rupture accident.

Adequacy of a similar reactor component layout for the future 500 MWe units which may be located in seismic areas is examined. To evaluate this a peak ground acceleration of 0.4g for the Site is assumed. The reactor assembly is assumed to be housed in a building similar in essential details to the actual reactor building. Soil-structure interaction based on certain average properties of soil and certain embedment of reactor building are considered while estimating the raft motion. This analysis indicates that the existing reactor component assembly will experience unacceptably large deflections. However the deflections can be brought down to an acceptable value by increasing the number of key blocks. Increasing the number of key blocks will be difficult because of additional space requirement. To overcome this problem a new design consisting of an integral calandria-end shield assembly with annular plate supports is evaluated. In this modified design the integral calandria-end shield assembly is welded to the inner edge of the annular plates and the outer edges are grouted to the walls of the reactor vault. These annular plates are designed in such a way that they are flexible enough to limit the compressive stresses in calandria-end shield assembly due to thermal expansion of the assembly, and at the same time they are strong enough to withstand severe earthquakes. This type of design results in acceptable deflection and stresses in the reactor component supporting structures of 500 MWe reactors planned for future. The improved concept of integral calandria-end shield assembly with annular plate supports is already adopted for a 200 MWe nuclear power station which is being built in a seismic zone.

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