SEPARATION OF CATEGORY I PIPELINES IN GRANULAR SOIL

by

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For a nuclear power plant, in order to provide for the safety and operational reliability of underground pipelines, classified Category I, a redundant system is installed. It is required that the two systems be physically separated to assure that failure in one system will not cause any adverse effect on the individual integrity of the redundant system. This paper deals with the theoretical determination of the minimum spacing required to separate two such Category I pipeline systems buried in granular soil.

The basic criterion used for such a determination is that, if a rupture occurred in one system, a large volume of fluid under pressure would be discharged into the surrounding soil. If the soil supporting the redundant system becomes quick due to the induced pore pressure, its bearing capacity would be destroyed and the redundant system would settle substantially, thereby losing its functional capability. Thus, the minimum spacing at any depth of embedment in the granular soil is that distance where the induced pore pressure due to pipe rupture is equal to the buoyant unit weight of a unit soil volume.

A mathematical model is used that assumes a steady-state flow condition following a pipe rupture. With such an assumption, the flow condition can be approximately described by the Laplacian equation in spherical coordinates. As a boundary value problem, the solution of the equation should satisfy the boundary conditions. The solution of the equation relates the pore pressure introduced in the medium at any distance from the pipe rupture to the pressure in the pipe, the diameter of the pipe, and the distance from the pipe at which the induced pore pressure will be zero. Such a distance would be obtained by trial, whereby different values would be assumed and the one which introduces the highest pore pressure distribution in the medium is used in the calculation.

Thus, for a given pipe diameter and for a given pipe pressure, a curve showing the relation between the depth of embedment and the distance of separation is obtained. Such a curve will show that as the depth of embedment increases, the required distance of separation decreases. This type of curve, combined with engineering judgment, provides a rational approach to a safe and economical decision with regard to the distance of separation of buried pipelines.

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