EXECUTIVE SUMMARY

FOR

AUTOMATIC MONITORING OF VALVE STATUS

**Report to the
U.S. Department of Energy
Deputy Assistant Secretary
for Breeder Reactor Programs
Washington, D.C. 20545**

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The operation of power plants requires the inspection of hundreds of valves. Reliable information regarding the status of all valves is of vital importance to ensure the safe operation of a power plant. The goal of this project is to explore the possibility of employing an autonomous vehicle and non-contacted sensors to identify and determine each valve status.

Power plant valves vary in types, sizes, functions, control mechanisms, etc. and can be operated at various temperatures or pressure systems. The problem associated with determining valve status can be quite complicated. But conceptually it can be easy to detect. One way of detecting the leakage problem requires obtaining the temperature profile of the piping system. Then the temperature gradient can be derived from the temperature profile.

Physically, the thermal gradient is related to the heat transfer process. If one can understand and establish the relationship between the thermal gradient and the valve leaking, then one can determine if the operating valve is internally leaking. If it does leak, one can find to what rate of leakage.

In the earlier report of April 1987, the idea of developing a knowledge-based expert system was proposed to integrate the expertise knowledge from power plant and the knowledge acquisition from simulation results. Approximating the temperature gradient for various flow rates was done by simulation of a piping system or from experimental results. Approximation was made first for finding thermal gradients. A steady-state temperature profile was obtained for reference by using numerical approximation. A finite element model of pipe flow was chosen to approximate temperature distributions, given piping system characteristics such as: valve type and material; pipe material, diameter and thickness; insulation type and thickness; leakage rates, etc. A mock-up of a piping system has been constructed that simulates the conditions of a typical piping section in a power plant. An infrared sensor was used to obtain the temperature profile outside the piping system.

In the report of January 1988, a prototype system was developed to demonstrate how good the finite element simulation based on the proposed model. It was able to detect a defected valve and report the approximated leakage rate to a certain extent. However, an error existed corresponding to the over-simplified leaking model that the finite element simulation adopted. It also proposed a remedy idea for the future research work.

In the planning for modern nuclear power plants, features can be integrated for accommodating a remotely controlled or autonomous vehicle. The user of the remotely controlled vehicle could identify the location of the valve in question. The temperature profile could be obtained by infrared sensor. Leak detection by the analysis and comparison of valve thermal signature could then be done in an automatic fashion. The non-contact valve leak detection and thermal gradient comparison technique can be useful in power plant maintenance. The knowledge-based expert system can be used to integrate both domain operating and maintaining expertise and analytical knowledge. During the course of study, we feel confident that this research can contribute not only in assembling diverse high technology but also be used effectively in solving real-world problems.

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