A DESIGN AND ANALYSIS PROCEDURE FOR
SIMPLE ASME SECTION III CLASS 2 & 3 PIPING SYSTEMS

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SUMMARY

In a nuclear power plant, ASME Section III Class 2 & 3 Piping Systems are designed to withstand loadings such as deadweight, pressure, thermal, seismic, anchor displacement and transient loadings. In addition, in-line equipment nozzle load limitations and availability of structures to which piping supports can be attached must be accounted for. To layout a piping system which presents an acceptable balance of piping stresses and nozzle load requirements, may require numerous design and analysis iterations. The cost incurred to produce an acceptable piping system layout is directly related to the number of the design and analysis iterations. A procedure which minimizes the number of iterations results in appreciable savings.

This paper presents a procedure and a consistent method of analysis which addresses this problem. Applicability is presently limited to ASME III Class 2 & 3 and Non-Class piping systems with relatively simple layouts and functional requirements. The design and analysis approach relies heavily on the use of a computer program operated in interactive mode and on an effective cooperation between the piping designer and the stress analyst.

The design guidelines and the consistent analysis method are primarily addressed to the preliminary layout phase which generally is responsible for the excessive number of iterations. Locating thermal restraints to meet the allowable pipe stresses is initially considered. In this phase the procedure encourages the maximum use of rigid thermal restraints to minimize the number of snubbers and the associated in service inspection and reliability problems. The effects of thermal restraints on a piping system are evaluated with the use of a computer program. To expedite this activity a interactive mode computer program (IMAPS) is used. This program offers the user capabilities to (1) generate, modify and check input, (2) run and print selected output for a general loading condition, and (3) easily create input data tapes and/or cards for the successful analyses. All these operations are performed at a remote terminal in the interactive mode thus allowing the designer-analyst team to promptly evaluate alternate designs. Following the verification of the pipe stresses due to deadweight and thermal expansion loadings, the piping system is reviewed for seismic adequacy. The piping designer compares the spans between existing thermal supports and/or anchors with allowable seismic spans and locates seismic supports as required. The allowable seismic spans are calculated according to a desired stress level and the applicable amplified response spectra and are readily provided in interactive mode. At this point the piping system, which, because of the procedure already complies with the thermal and mechanical stress criteria, is reviewed for compliance with the in-line component nozzle load limitations. Again the IMAPS computer code is used. Nozzle loads which were previously calculated for deadweight; thermal and seismic loadings are combined to those due to anchor displacements and then compared to the allowable values. Modification of support locations and/or type is optimized by using the analysis in interactive mode and finally the input data are stored in the form of cards and/or magnetic tape.

In addition to the pipe design procedure this paper presents (a) a brief description of the IMAPS computer code, (b) the approach used to calculate the seismic spans for simple and complex piping configurations, (c) the result verification by means of conventional detailed analysis, and (d) an evaluation of the saving in the computer cost and manhours.