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File: 2421.13

June 6, 1979

Mr. Boyce H. Grier, Director
Office of Inspection &
Enforcement, Region
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

Dear Mr. Grier:

SUBJECT: FORKED RIVER NUCLEAR STATION (FRNS)
DOCKET NUMBER 50-363
IE BULLETIN NO. 79-07 RESPONSE

A version of the ADLPIPE Computer Program, which includes an algebraic summation technique has been used for the final design of support for FRNS Containment Spray system. The version of ADLPIPE utilized uses intra modal algebraic summation for codirectional components resulting from multiple earthquake directional motions. The Square Root of the Sum of Squares summation is used to determine the combined response for all modes. Closely spaced modes (within 10%) are summed absolutely.

Burns & Roe, the FRNS Architect Engineer, has directed that computer listings call for in Item 2 for versions of ADLPIPE from 1972 to the present be forwarded to the NRC. It should be noted, however, that ADLPIPE is a proprietary program owned and technically supported by: Arthur D. Little, Inc.; Acorn Park; Cambridge, MA 02140.

For operational piping analyses, Burns & Roe has exclusively used Arthur D. Little piping analysis program, ADLPIPE. This computer program was the only program in the public domain which considered the nuclear piping requirements for the Code, ANSI-B31.7.

In the year 1972, an updated version enabled the user to produce a partial stress report required to meet the requirements of the B&PV ASME Section III, Div. 1 Code, as well as ANSI-B31.1 Code for piping and components. It also contained, for the first time, a spectra modal response analysis for redundant pipe systems. ⑤

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310 107

Arthur D. Little performed the validation of the Code in their support of the ADLPIPE Program. This validation is discussed in Attachment 1.

Burns & Roe also has an ongoing validation program. Typical spectra response and time history analyses from the ADLPIPE Program have been compared with the results from ANSYS and STARDYNE Computer Programs. Minor differences, due to different numerical techniques used within the programs, have been identified but verification has been demonstrated by these comparisons.

In addition, the following comparisons have been made of the different summation options of ADLPIPE against other recognized industry methods and benchmarks.

Comparison of ADLPIPE vs. NUPIPE Computer Program.
This study included eight (8) typical pipe systems having various diameter pipe sizes.

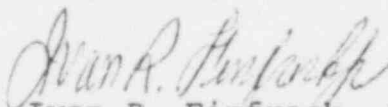
ADLPIPE Algebraic Summation vs. NUPIPE
ADLPIPE Opt. 192 vs. NUPIPE
ADLPIPE Opt. 160 vs. NUPIPE

Secondly, the ADLPIPE Program was used to solve selected problems in report BNL-NUREG-21241-R2 issued by Department of Nuclear Energy Brookhaven National Laboratory.

ADLPIPE Algebraic Summation vs. BNL Hovgaard Problem
ADLPIPE Opt. 192 vs. BNL Hovgaard Problem
ADLPIPE Opt. 160 vs. BNL Hovgaard Problem
ADLPIPE Algebraic Summation vs. BNL Coffee Table Problem
ADLPIPE Opt. 192 vs. BNL Coffee Table Problem
ADLPIPE Opt. 160 vs. BNL Coffee Table Problem

The FRNS Containment Spray system supports will be reanalyzed using option 192 of ADLPIPE prior to commencing construction of this system. In addition, option 192 will be used for support/piping design for other FRNS systems.

Very truly yours,



Ivan R. Finfrock, Jr.
Vice President

asb

Attachment

cc: Director, Office of Inspection &
Enforcement
Division of Reactor Operations &
Inspection
U.S. Nuclear Regulatory Commission
Washington, DC 20555

310 108

VERIFICATION OF ADLPIPE

The following is excerpted from:

Letter from I.W. Dingwell (ADL) to J.B. Mahoney (B&R)
dated April 27, 1979.

Verification of ADLPIPE

Verification of ADLPIPE was undertaken in a series of fundamental checks. In important modifications a supporting document was prepared as an ADLPIPE reference. The verification procedure was as follows.

The thermal and deadweight loadings were checked by a Hovgaard Bend and hand calculated systems given in "Design of Piping Systems", M. W. Kellogg, Second Edition, 1956, and "Formulas of Stress and Strain", R.J. Roark, McGraw-Hill.

The dynamic analyses were checked by "Response of Structural Systems to Ground Shock", Shock and Structural Response, ASME, 1960, in "ADLPIPE Results of Model Given by Young (ADLPIPE Reference 4), and "Dynamic Behavior of a Foundation-Like Structure", Mechanical Independence Methods, ASME, 1958, in "Experimental Verification of ADLPIPE Mod 1" (ADLPIPE Reference 3).

The time history analysis was checked by a separate analytical solution of the problem given in "Analytical Methods of Vibrations," page 395, Leonard Meirovitch, "ADLPIPE Time History Response Compared with a Known Solution for a Heavily Damped System (ADLPIPE Reference 14). A second check was made using "Pressure Vessel and Piping 1972 Computer Progress Verification", ASME, 1972 (Problem 5).

The thermal transient analysis was verified by a separate analysis, "Transient Thermal Gradient Stresses", E. B. Branch, Heating, Piping and Air

Conditioning, Volume 43, 1971, pages 132-136, "ADLPIPE Thermal Transient Analysis" (Reference 15).

The computation of intra and inter modal moment component summation has been verified by a separate computer program for that purpose. A report "ADLPIPE Modal Response Combination for Closely Spaced Modes", is available as ADLPIPE reference 24.

Various calculation procedures required by ASME Section III were verified in ADLPIPE references 10, 11, and 18 entitled "ADLPIPE Computation of Bending Stress in Tees and Branch Connections, ASME Section III, Class 1 Piping", "ADLPIPE Computation of Resultant Moments for Section III Class 2 and 3 Stresses", and "ADLPIPE Stress Computation of Piping Components: A Comparison with Hand Calculations for ANSI B31 and ASME Section III."

In 1978 an independent third party review of ADLPIPE (Section III, Class 1) was performed "Verification of ADLPIPE, ASME Section III, Class 1 Piping Stress Program", Teledyne Engineering Services, Report No. TR-2884-1, August 11, 1978.

ADLPIPE Development Policy

The following policies have been in effect during the development of ADLPIPE:

1. The details of calculation processes are available to the public by free distribution of operating manuals and references. These are tabulated in Appendix I. Each major new feature of ADLPIPE is documented for user review.
2. Program listings are made available to licensees. Licensees are not restricted from making program changes.
3. ADLPIPE is periodically improved and updated and licensees are notified of the modifications at the time of the release of the modified version.
4. ADLPIPE is hand checked wherever possible. When this is not possible, ADLPIPE is checked by experimental results or the results of other calculation procedures. Every modification, large or small, is checked.
5. Special versions of ADLPIPE will be written to a licensee's specification. However, the version of ADLPIPE released to computer service bureaus generally does not have such special additions.
6. Old versions of ADLPIPE are not retained by Arthur D. Little, Inc. Instead, beginning in 1971, all new versions of ADLPIPE were backward integrated. The present version of ADLPIPE

maintains all past features which have been made available
to the users during the period 1971 to 1979.

JW Drigwell

I. W. Drigwell

Arthur D. Little, Inc.

Cambridge, MA 02140

April 19, 1979

310 111