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September 23, 1983
EF2 - 65,625

Director of Nuclear Reactor Regulation
Attention: Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Youngblood:

Reference: (1) Enrico Fermi Atomic Power Plant, Unit 2
NRC Docket No. 50-341

(2) Letter, Detroit Edison to NRC, EF2-63925, "Submittal of Plant Unique Analysis Report for Torus Attached Piping", June 10, 1983

Subject: Mark I Containment - Torus Attached Piping
Submittal of Additional Information

Attached please find our response to your September 12, 1983 telephone conversation, request for additional information on the Fermi 2 Plant Unique Analysis Report for Torus Attached Piping (Reference 2). Due to the time constraint, the response is submitted in the question/response format. After you have reviewed and accepted our response, we will incorporate the attachment into the Plant Unique Analysis Report (PUAR), revising PUAR pages if applicable.

Should you have any questions regarding the above, please contact Mr. Larry E. Schuerman, (313) 586-4207.

Sincerely,

[signature] for W. H. Jens

Attachment

cc: G. Bienkowski (Princeton University)
M. D. Lynch (NRC DOL)
M. J. Ranlet (Brookhaven National Laboratory)
B. Siegel (NRC ORB)

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Item 1: AAP PUAR Section 2.2.1, AC Section 2.14.3 & 2.14.4

Justify the use of the 0.8 factor used to reduce water jet impingement and air bubble drag loads. The factor previously approved for SRV Torus net vertical forces can be viewed as a ratio of the average pressure on the torus shell to a peak measured pressure and thus, was approved for torus support modifications. However, the use of a reduction factor cannot be accepted, in general, for any TAP analyses independently of the location with respect to the quencher.

Provide sufficient information (include various test data) to illustrate how the factor was arrived at and how its use still provides for a conservative load specification.

Response to Item 1

The load definition and application techniques applied in the evaluation of the Fermi 2 torus attached piping and suppression chamber penetrations provide for a conservative load specification. Additional information is provided in this response to identify and confirm the conservatism in the torus shell motions and submerged structure loads due to SRV actuations. The supporting information includes:

(A) A description in qualitative terms of the conservative elements inherent in the current Fermi 2 SRV load specification.

(B) A discussion of the methodology and test data used to derive the reduction factor.

(C) A description of the test data which will be obtained in the Fermi 2 in-plant test to confirm that the Fermi 2 SRV load specification is conservative.

A. Inherent Conservatisms in the SRV Load Specification

The timing and sequence of the loading conditions used in the evluation of the TAP systems and torus penetrations were defined in Volume 1 of the Plant Unique Analysis Report. Application of these load condition/event sequences provides a very conservative design basis for evaluation of the piping and torus penetrations.

The SRV loads have generally been a significant component in the controlling load combinations for IBA and SBA events in the TAP systems and torus penetration evaluations. The SRV loads utilized

in the TAP evaluations are calculated assuming multiple valve actuation, a minimum SRV opening time, a maximum safety relief valve flow rate, and a maximum discharge line pressure. All of these assumptions maximize the SRV loads. However, in actuality, and when considering plant unique features, the probability of such a maximized SRV loading condition is extremely low.

During IBA and SBA events, conditions leading to maximum pressure (peak drywell pressure) in the discharge line would not occur until late in the event. Since the Fermi 2 SRV control logic includes the Low-Low Set Logic (LLSL) design, the only multiple valve actuations anticipated to occur in this time frame would be due to an ADS actuation. The Emergency Procedure Guidelines and associated operator training will significantly decrease the likelihood of an ADS actuation. The LLSL system design also essentially removes any possibility of a maximum relief valve flow rate with maximum discharge line pressure.

By considering the specific Fermi 2 plant unique features in the SRV load definition approach, an additional reduction of at least 20% in the SRV loads would be anticipated. This magnitude of additional response reduction has also been demonstrated by in-plant tests performed at several other plants. All such tests have confirmed that actual plant responses are significantly less than predicted. The Fermi 2 in-plant SRV tests are expected to confirm similar conservatisms in the SRV load definition and application techniques.

B. Derivation of the Reduction Factor

The 0.8 factor was applied to selected TAP responses to torus shell motions and submerged structure hydrodynamic loads due to SRV actuations. The factor was obtained by comparing SRV in-plant test data with predicted test results at several instrument locations in the test bay. Ratios of test to predicted responses were obtained for submerged structure and torus mounted instruments. The largest resulting ratio of 0.8 was then applied.

The reduction factors were determined using the following equation:

$$\text{Reduction factor} = \frac{\text{Measured test resonse}}{\text{Predicted response}}$$

B.1 Reduction Factor Based on Torus Shell Motion Responses

Acceleration time history data at three (3) locations were used to generate acceleration response spectra for the frequency range

of 10 to 40 Hertz. This is the range of dominant TAP frequencies. Test data from four (4) single valve actuations (SVA) and four (4) consecutive valve actuations (CVA) were used.

Initial test conditions were used to calculate shell pressure time histories using the LDR methods. These pressure time histories were then applied to the torus structural model to calculate torus shell acceleration response time histories and acceleration response spectra. Reduction factors in the 10 to 40 Hz range were calculated as the ratios of accelerations from test response spectra to accelerations from predicted response spectra at the dominant TAP frequencies. The reduction factors calculated in this manner ranged from 0.50 to 0.80, thus the factor with the least reduction was used.

B.2 Reduction Factor Based on Responses to Submerged Structures Hydrodynamic Loads

This reduction factor was calculated using the following equation:

$$\text{Reduction factor} = \frac{\text{Peak test pressure X DLF}_{\text{Test}}}{\text{Peak predicted pressure X DLF}_{\text{Pred.}}}$$

Where DLF = Dynamic Load Factor

$$= \frac{\text{Maximum dynamic displacement}}{\text{Maximum static displacement}}$$

Pressure time histories of test measurements for eight (8) SRV tests were used to determine this reduction factor. Harmonic analysis was performed with the test data for the 1 to 50 Hz range and net dynamic response was generated. The ratio of this net test dynamic response to the maximum static test response (calculated by applying the peak pressure measurements as a static force) was determined (DLF_{Test}).

Initial test conditions were used to predict the pressure time histories using LDR methods. The net predicted dynamic response was calculated using harmonic analysis in the 1 - 50 Hz range. The ratio of this net predicted dynamic response to the maximum static predicted response was then determined (DLF_{Pred}). The SRV bubble pressure is directly related to the submerged structure loads, thus the reduction factor based on bubble pressure can be treated as the reduction factor for the response to drag loads.

The reduction factors from these comparisons ranged from 0.15 to 0.45. However, a conservative factor of 0.8 was applied to selected TAP responses.

C. Fermi 2 SRV In-Plant Test Data

The objective of the Fermi 2 in-plant SRV discharge test is to confirm that the SRV design loads and associated structural responses reported in the Fermi 2 PUAR are conservative with respect to those which occur during actual SRV discharges. The test program has been developed in accordance with guidelines for in-plant tests contained in NUREG-0661 and NUREG-0763. A complete description of the program was submitted to the NRC in Detroit Edison letter EF2-59029, dated August 18, 1982.

The SRV discharge line (SRVDL) selected for the test is one of the shortest in total length. Utilizing the shortest line will result in air clearing loads which are closer in frequency to the dominant frequency of the suppression chamber. Therefore, dynamic amplification is expected to be maximized and a "wost case" basis for confirming the SRV load specification will be provided.

The instrumentation scheme for the test is similar to those used in the Monticello and other Mark I in-plant tests. The type and quantity of instrumentation being used in the test has been selected to assure that the test will provide a sufficient data base to meet the test objectives. The parameters to be measured and the selected instrument locations are based on NRC guidelines, examination of the Monticello test results to determine the success with which the various parameters have been measured in the past, and consideration of the Fermi 2 unique characteristics.

The type of instruments used in the Fermi 2 SRV test include pressure transducers, strain rosettes, uniaxial strain gauges and accelerometers. The test instrumentation will require approximately 125 recording channels with a maximum frequency response of 200 Hz. The applicable instrumentation and instrument locations that will be used to measure parameters and response to confirm the SRV load specification applied in the torus attached piping evaluations are shown in Figures 1-1 through 1-4. As shown in Figure 1-1, the instrumented locations also include penetration X-212. The 0.8 reduction factor was applied in the penetration analysis and the analysis of selected components in the line attached to the penetration X-212. The measured response of penetration X-212 will be representative of other penetration locations.

In view of the above considerations, the Fermi 2 test program has been designed to confirm that the computed loadings due to SRV discharge are conservative.

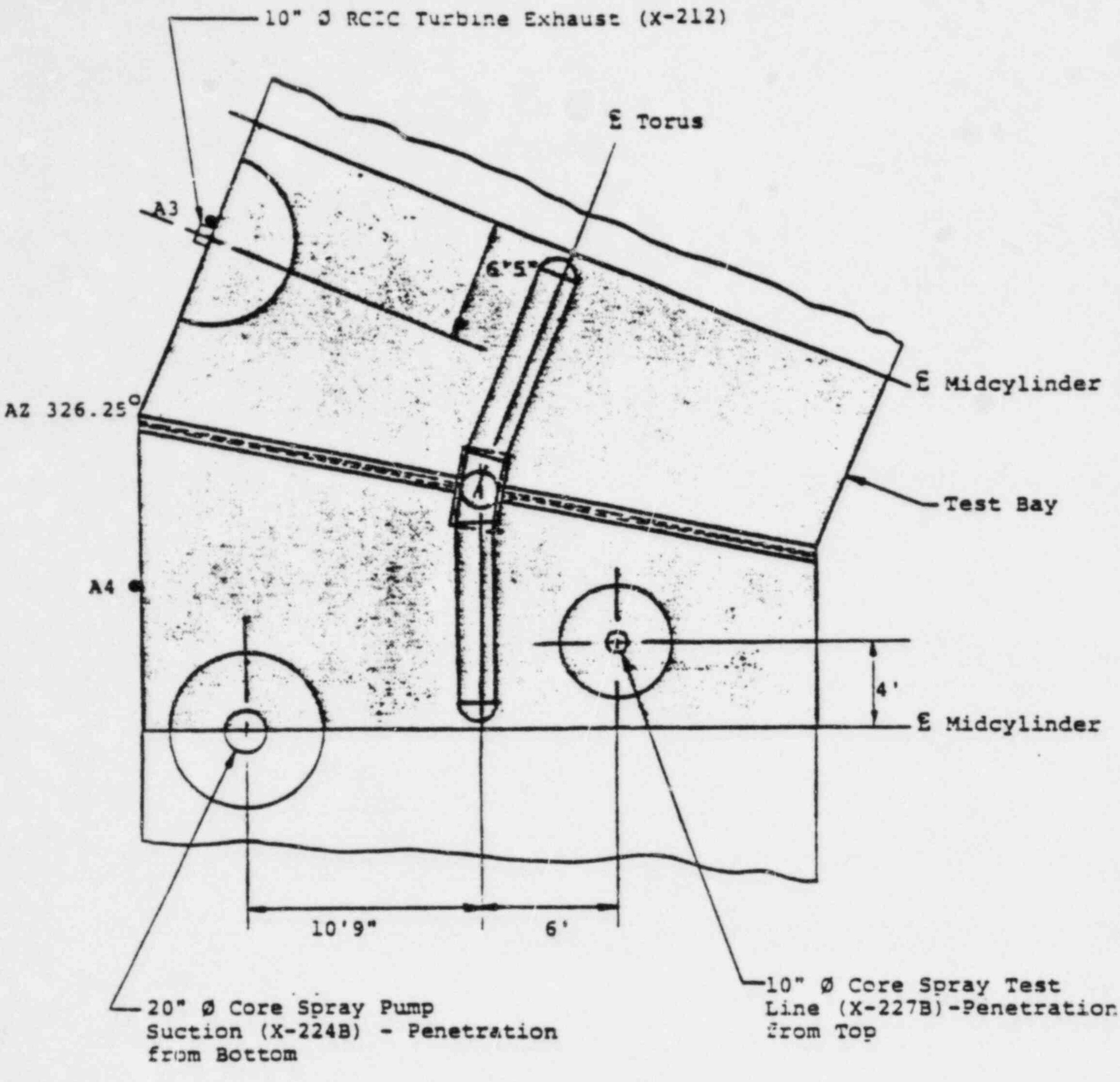

Figure 1-1

ACCELEROMETERS ON FERMI-2 TORUS ATTACHED

PIPING PENETRATIONS AND TORUS SHELL - PLAN VIEW

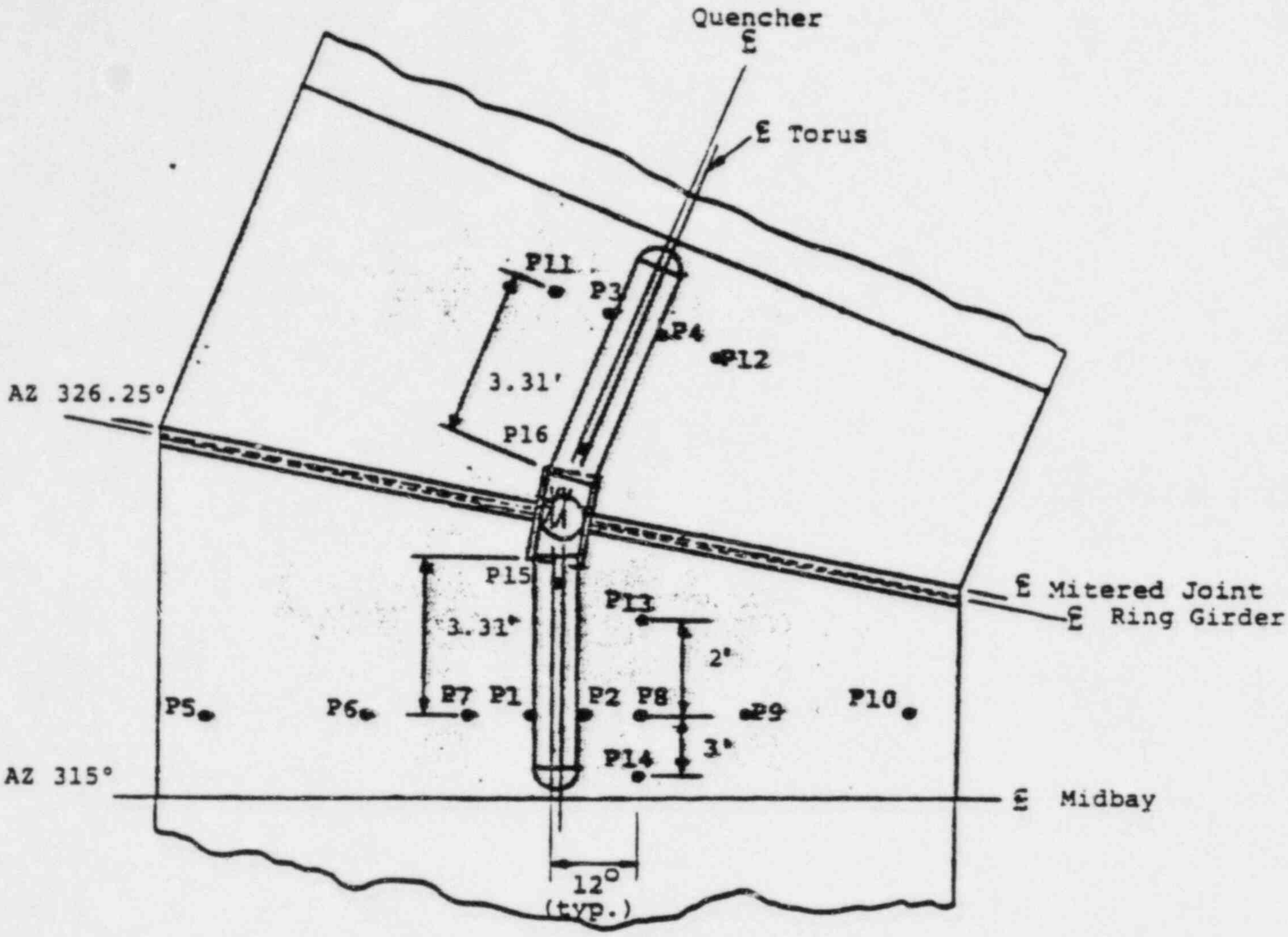

Figure 1-2

FERMI-2 TORUS SHELL AND QUENCHER ARM

PRESSURE TRANSDUCERS IN TEST BAY - PLAN VIEW

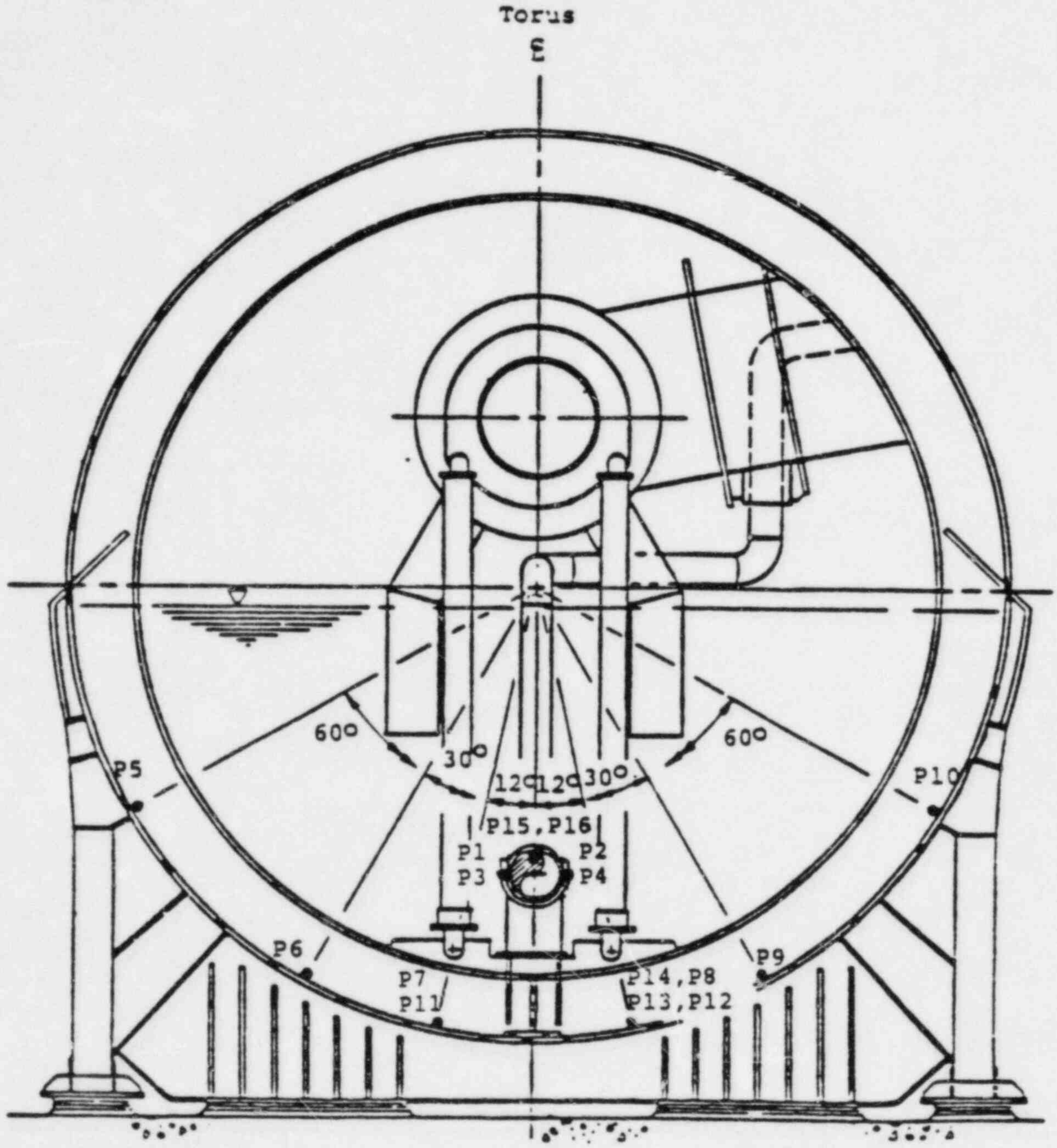

Figure 1-3

FERMI-2 TORUS SHELL AND QUENCHER ARM PRESSURE TRANSDUCERS IN TEST BAY - ELEVATION VIEW

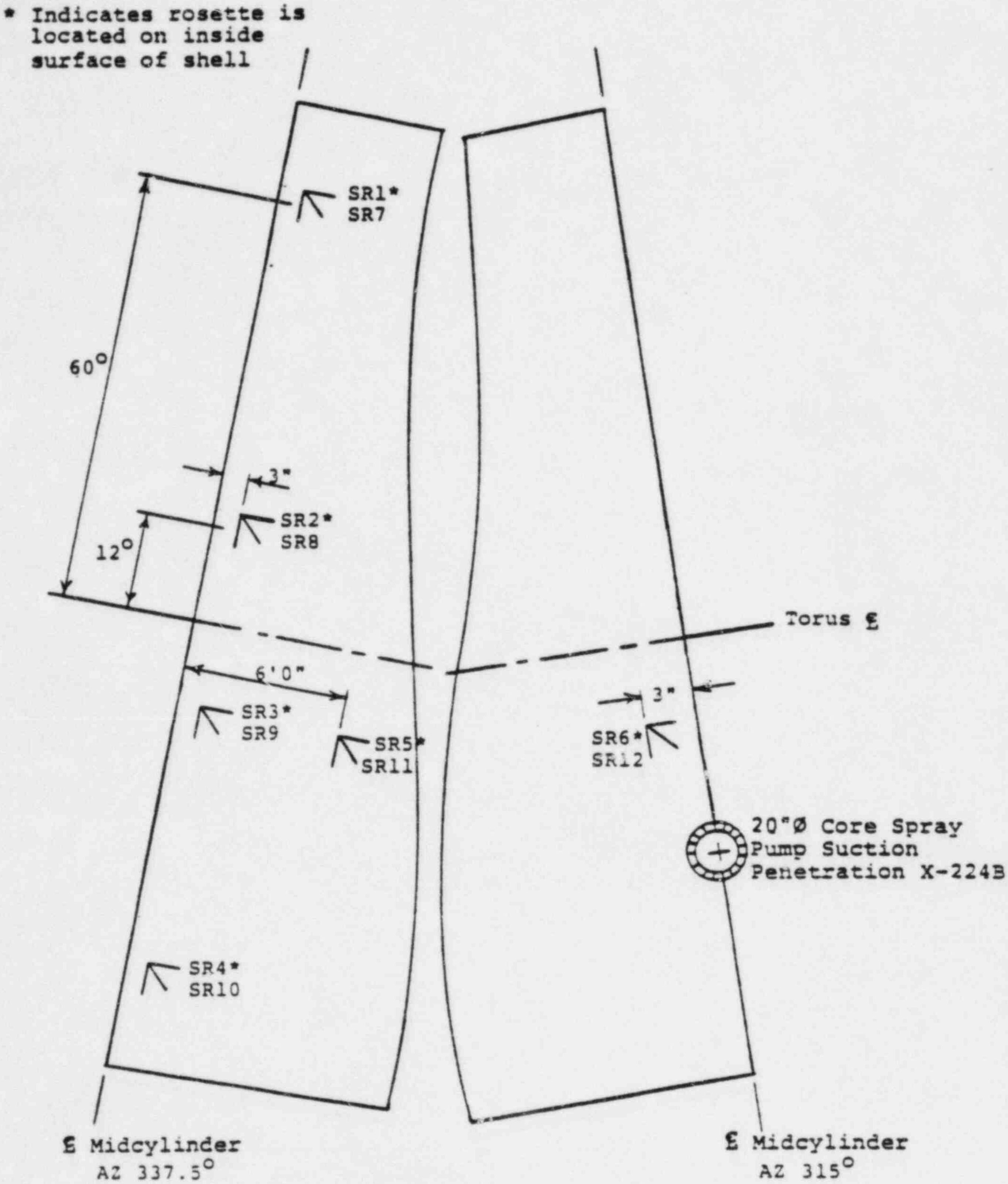

Figure 1-4

STRAIN ROSETTES ON FERMI-2 TORUS SHELL IN

TEST BAY - LOWER HALF DEVELOPED VIEW

Item 2: TAP PUAR Section 2.4.4 and AC Section 2.11.1

The CO torus motion load case for TAP (Page 2.80-2.81) utilized a random phasing technique to sum the harmonic responses. The use of the 1.15 factor in conjunction with a set of random phase angles differs from the procedure used and previously approved for torus loads in the Fermi 2 major modification PUAR.

Provide sufficient information to justify the use of the random phasing technique in this application and describe which amplitude alternates were used in the 4 to 16 Hertz frequency range.

Response to Item 2

The random phasing technique used to evaluate TAP response due to the CO torus motions is based on studies of FSTF CO data performed by R. Kennedy of Structural Mechanics Associates. Harmonic amplitudes corresponding to FSTF test M-12 (CO load alternate 4) are utilized in conjunction with a set of random phase angles. A scalar factor of 1.15 is applied to the sum of the 50 randomly phased harmonic responses resulting in the CO torus motion time history as required to evaluate TAP response in the time domain.