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January 6, 1976

Director of Nuclear Reactor Regulation
ATTN: Mr. R. S. Boyd, Director
Division of Project Management
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: MARK I CONTAINMENT EVALUATION PROGRAM--
IN-PLANT SAFETY/RELIEF VALVE TEST

Dear Mr. Boyd:

As part of the proposed long term program for the evaluation of Mark I Containments, members of the Mark I Owners group have identified a detailed in-plant safety/relief valve test that is to be performed. During the status report meeting held in Bethesda on December 3 and 4, 1975, members of your staff requested a more detailed description of the test. Enclosed is a description of the test which is intended to respond to that request.

Sincerely,

Ivan F. Stuart, Manager
Safety and Licensing

Attachment

cc: L. S. Gifford (GE-BETH)
R. L. Tedesco NRC
R. R. Maccary NRC
W. A. Paulson NRC
V. Stello NRC

:jh

MEN 002-76



D-40

# IN-PLANT SAFETY/RELIEF VALVE TEST

The in-plant safety/relief valve discharge load testing is one of the major activities of the Mark I Long Term Program. Testing at the initial plant will be more extensive than subsequent testing at plants with different structural arrangements. In addition to obtaining strain data for fatigue life evaluation of torus structural response to relief valve discharges, pressure, temperature and water level data will be obtained to evaluate the basic phenomenon of pressurization in the relief valve discharge piping and the torus. The location of these sensors is shown in Figures 8, 10 and 12.

Pressure transducers located on the torus skin will provide transient measurements of surface pressure acting on the torus during single and multiple relief valve actuation. The location of these sensors is shown in Figure 11. Special attention was given to epoxy mounting of sensors directly to the torus skin and protection of instrumentation lead wires by covering with RTV to minimize the potential for loss of instrumentation during the test. Pressure transducers and temperature detectors in the relief valve discharge pipe will provide further data for the forcing function model.

An additional sophistication of these test measurements will be the recording of water level in the discharge piping to evaluate the effect of consecutive valve actuation. The second actuation will occur with the water in a transcient condition as it returns to the discharge pipe. Until the discharge pipe vacuum breaker admits sufficient air to restore the pipe internal pressure to atmospheric, a partial vacuum will exist in the pipe following closure of the relief valve, and the water level may be higher than normal. This higher water level would increase the bubble pressure during a subsequent valve reactuation although the effect may be partially offset by the smaller volume of air in the bubble (because of the partial vacuum). The consecutive valve pop tests will explore this phenomenon further to determine whether it is a valid design concern.

Multiple valve actuations are included in the test series to evaluate the additive effects of more than one valve actuating simultaneously. Pressure data at the torus skin will be utilized to confirm or refine the analytical model for prediction of loads on the torus. Strain gage data from sensors on the torus skin will be utilized in a fatigue life evaluation to determine the design margin of the torus for the full design life expectation of relief valve actuations. The results of single and multiple valve actuations will be utilized in this evaluation. The location of these strain gages is shown in Figures 2, 3, 4 and 5.

Temperature sensors located in the torus pool will be monitored to evaluate local mixing effects in the pool during relief valve actuation. These are shown in Figure 9. This data will be utilized to confirm the adequacy of Technical Specification operating temperature limits for the torus pool water.

Water level probes in the torus pool, shown in Figure 13, will, if successful, monitor the motion of the air bubble after it exits from the rams head. This information will be used to confirm or refine the analytical model for the movement and oscillations of this air bubble.

Strain gages and accelerometers on the relief valve discharge piping and its structural supports will evaluate their response to single and consecutive valve actuations. The location of these sensors is shown in Figures 6 and 7.

Accelerometers, shown in Figure 14, will determine the loads transmitted through the support columns to the foundation mat and other structures. These are not expected to be significant but are being monitored for confirmation.

The number of sensors of each type is tabulated in Table I below.

TABLE I*

| | Torus Wall Suction Header & Torus Columns | Torus Pool | S/R Valve Discharge Pipe and Supports | Pedestal and Basement |
|---|---|---|---|---|
| Strain Gage | 60/138 | -- | 12/20 | -- |
| Accelerometers | 10/26 | -- | 2/3 | 3/9 |
| Lanyard Potentiometer | -- | -- | 6/6 | -- |
| Temperature Sensor | -- | 6/6 | 3/3 | -- |
| Pressure Transducer | -- | 15/15 | 7/7 | -- |
| Water Level/Void Probe | -- | 5/5 | 7/7 | -- |
| Air Flow Probe | -- | -- | 1/1 | -- |
| TOTALS | 70/164 | 26/26 | 38/47 | 3/9 |

* XX/XX denotes sensors/channels.

The torus bay designated as "D" containing valve RV2-71A is most heavily instrumented, and this "A" valve will be involved in most of the tests. Each test will consist of manual actuation of one or more relief valves for a period of approximately five seconds during which the instrumentation is actuated to record the response.

Single valve actuation tests are planned individually with valves A, E, F, D, G and B.

Valves A and F will be actuated simultaneously, and in a separate test valves A and E will be actuated.

Valves A and E will be actuated simultaneously to evaluate the additive effects of operating two adjacent valves.

Valves A, E and G will be actuated simultaneously to evaluate the response to three adjacent valves in the region of maximum instrumentation.

Valve A will be actuated sequentially through a five-second discharge, reclosure for a brief interval followed by a second actuation of five seconds.

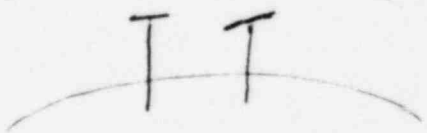
The above constitutes the test as presently planned. Additionally, certain tests will be repeated to the extent necessary to develop confidence in reproducibility of the recorded data. Considering that this testing is being performed on a production facility, the scope of tests is quite extensive. The number of actuations of relief valves imposes a financial exposure due to power availability and potential maintenance outage considerations that may exceed the direct cost of performing the test. We believe that this is an extensive program capable of quantitatively defining the loads and structure responses of interest.

Additional Tests should be conducted as follows:

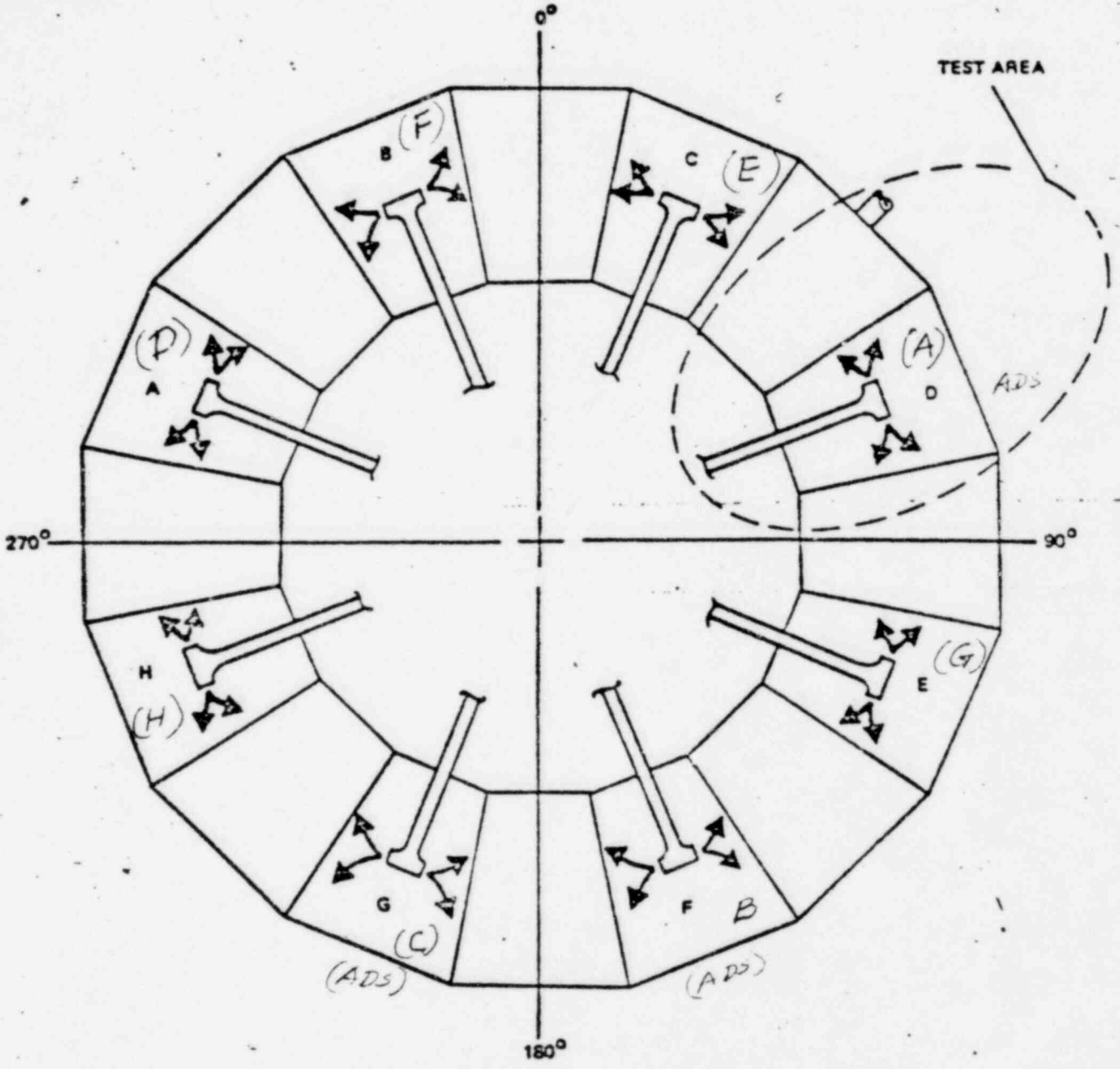
(1) Various ~~types~~ of Reinforced, such as tee ⊥ used for Drawn Annold & possible others.
→ different thrust response

(2) blowout pressure → ~~adjacent~~ varied FL/C on the pipe

(3) Various outlet direction due to installation error



(4) ~~bubble press~~ downcomer response to bubble pressure and vibratory forces → resonance




| BAY | S/R VALVE DESIGNATION | CATEGORY | AZIMUTH (DEGREE) | ACCESS LOCATION |
|---|---|---|---|---|
| A | RV2-71D | | 292-1/2 | |
| B | RV2-71F | | 337-1/2 | |
| C | RV2-71E | | 22-1/2 | |
| D | RV2-71A | ADS | 67-1/2 | 48-in. MANWAY |
| E | RV2-71G | | 112-1/2 | |
| F | RV2-71B | ADS | 157-1/2 | |
| G | RV2-71C | ADS | 202-1/2 | |
| H | RV2-71H | | 247-1/2 | 48-in. MANWAY |

*Figure 1. Orientation of Safety/Relief Valve Discharges*

NOTE: GAGES 1, 2, 3, 4, 6, 9, 10, 12, 13, 15, 16, 17, 53, and 57 ARE TO BE DUPLICATED ON THE INSIDE OF THE TORUS.

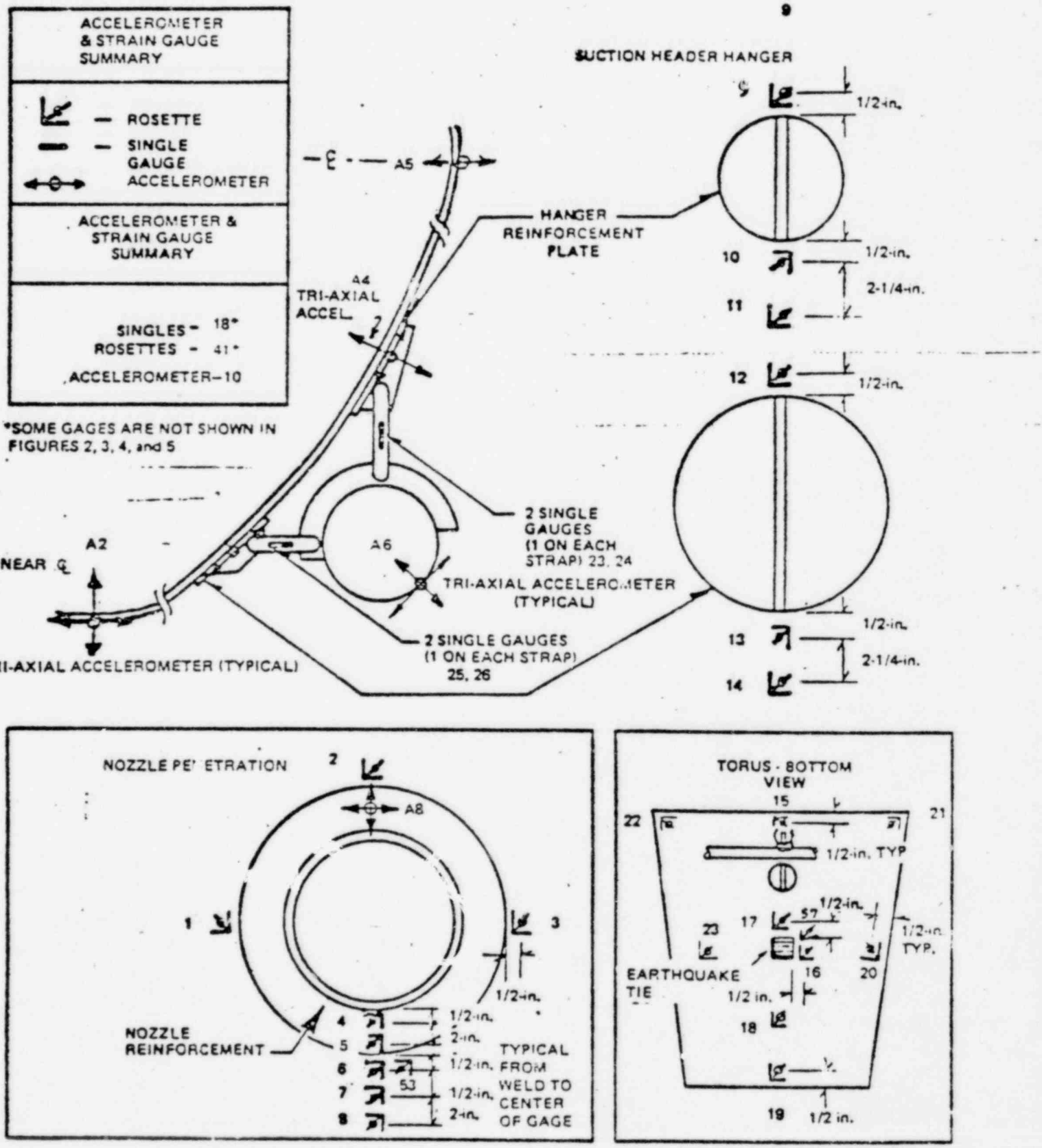



*Figure 2. Location of Strain Gages and Displacement Accelerometers on Torus Wall and Suction Headers*

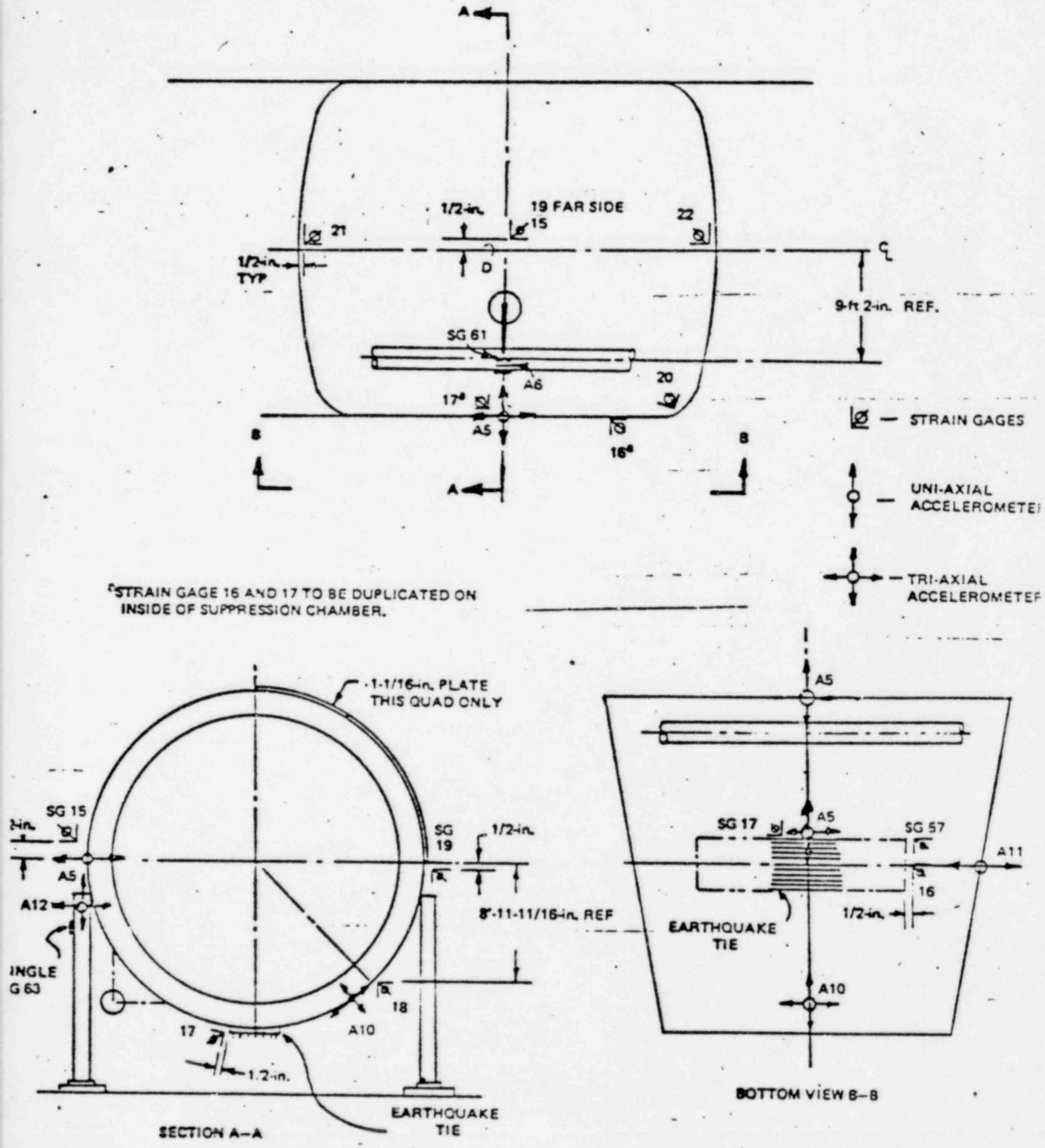



*Figure 3. Location of Strain Gages and Displacement Accelerometers on Torus Wall*

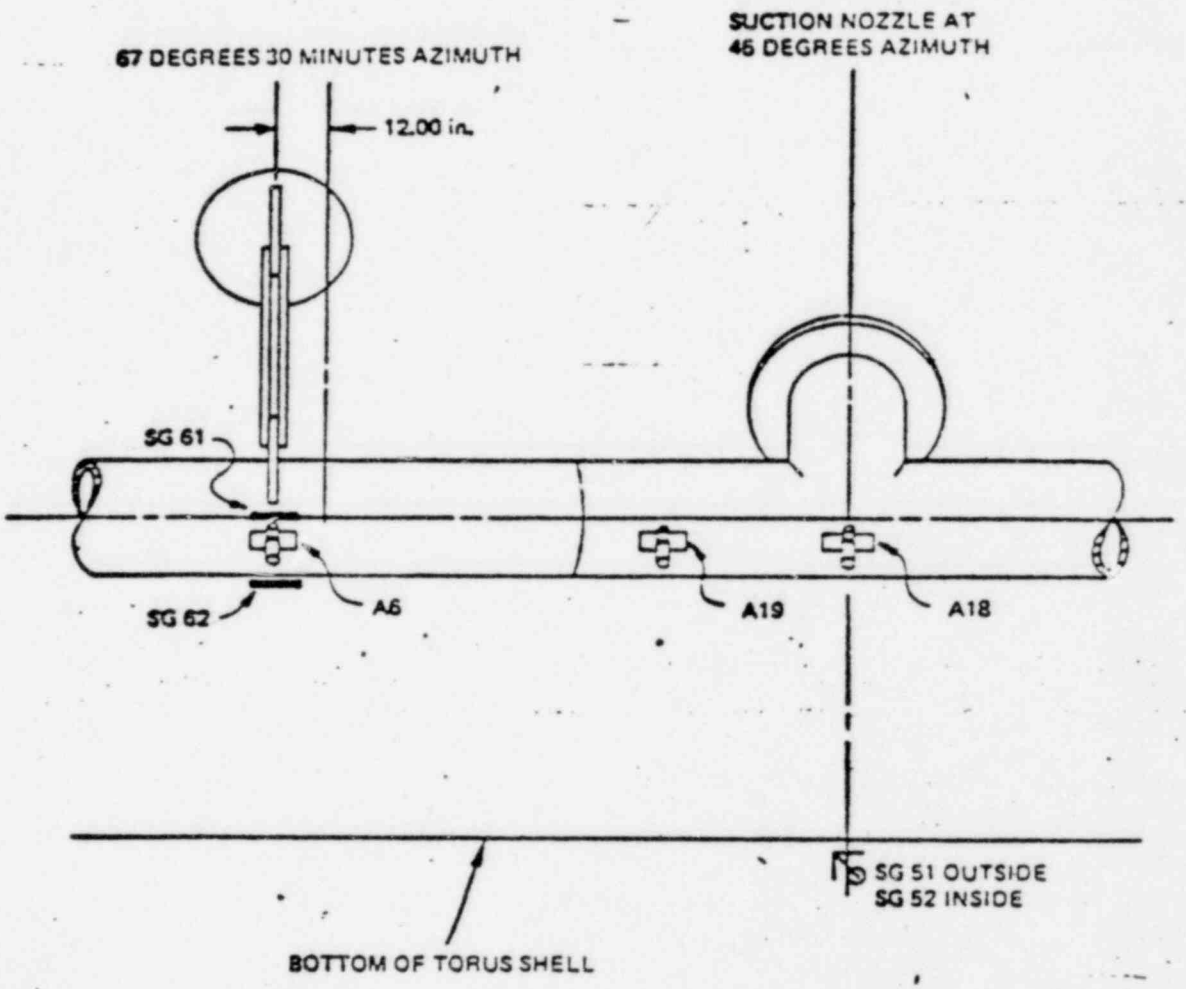



*Figure 4. Location of Strain Gages and Accelerometers on Suction Header*

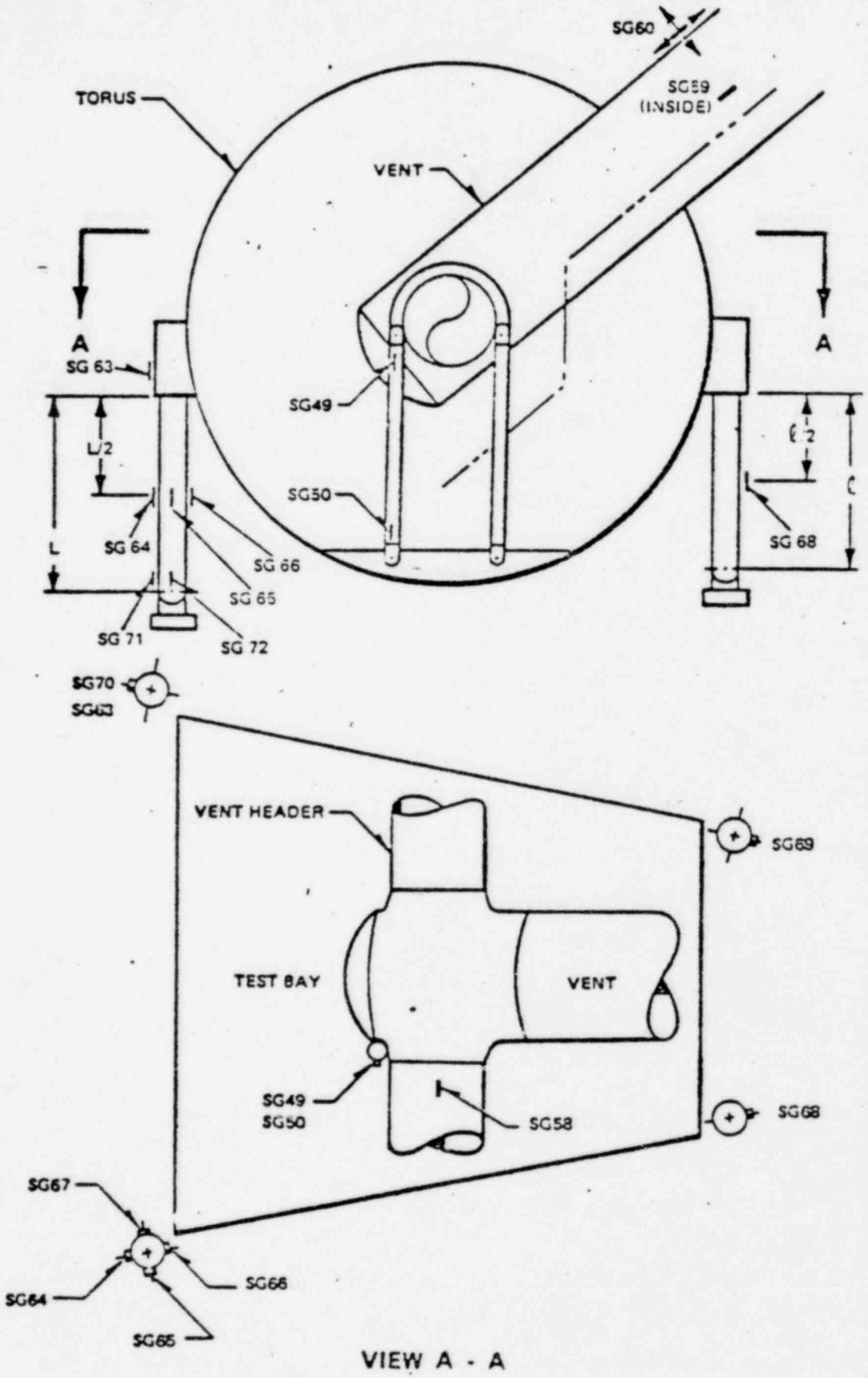



*Figure 5. Location of Strain Gages on Vent Header and Sleeve, Vent Support Column, and Torus Legs*

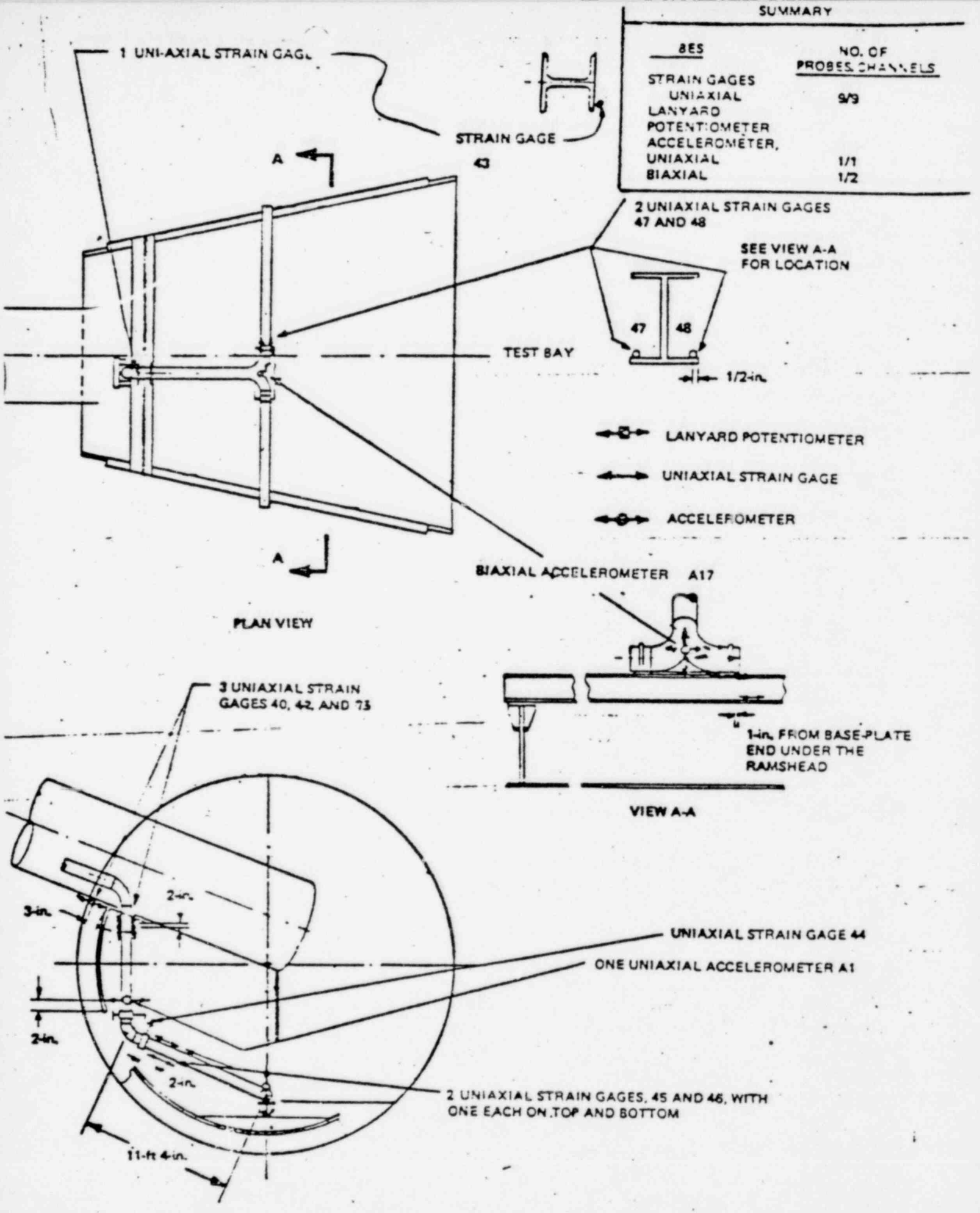



*Figure 6. Location of Strain Gages and Accelerometer on Safety/Relief Valve Discharge Line and Support Structure*

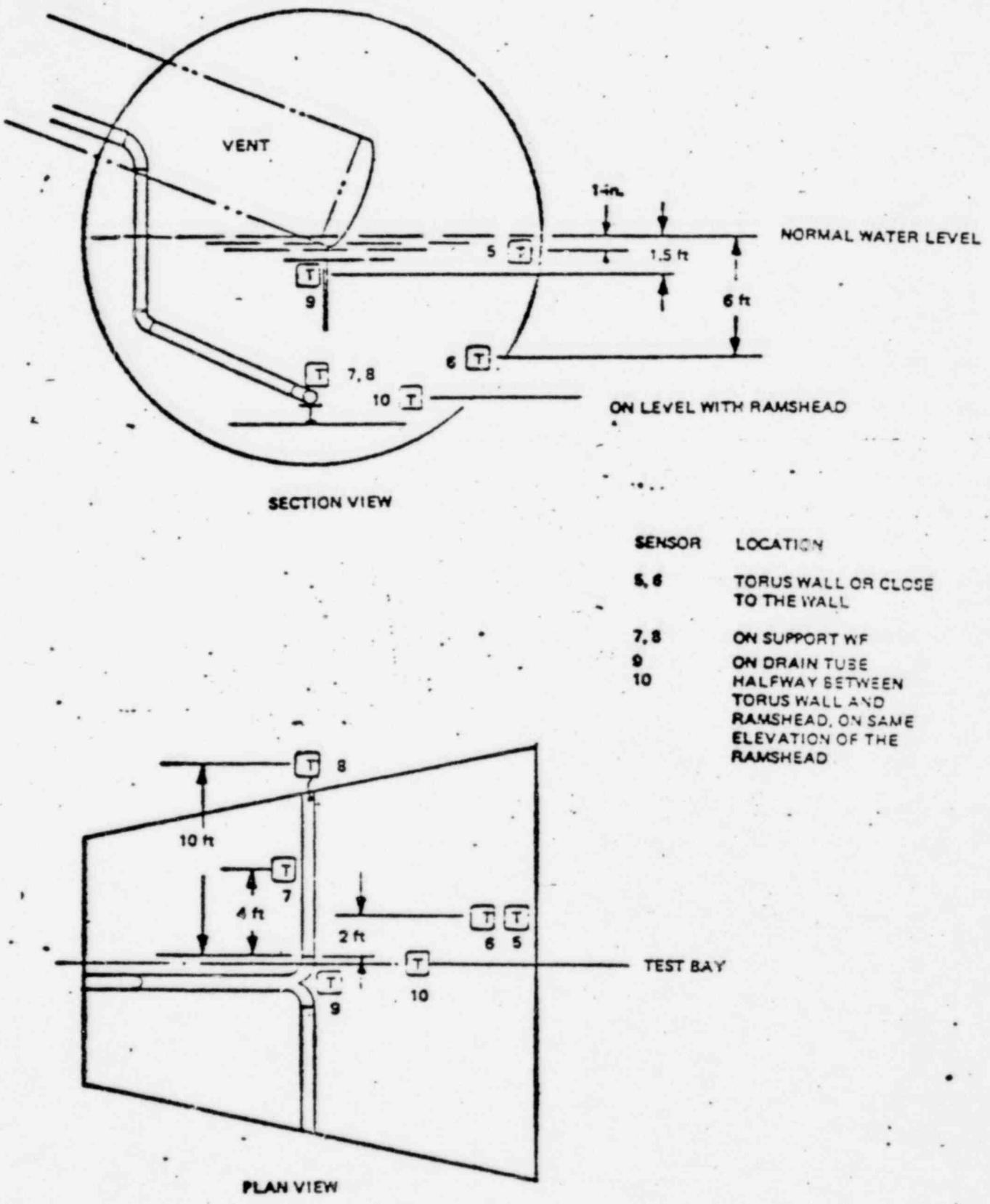
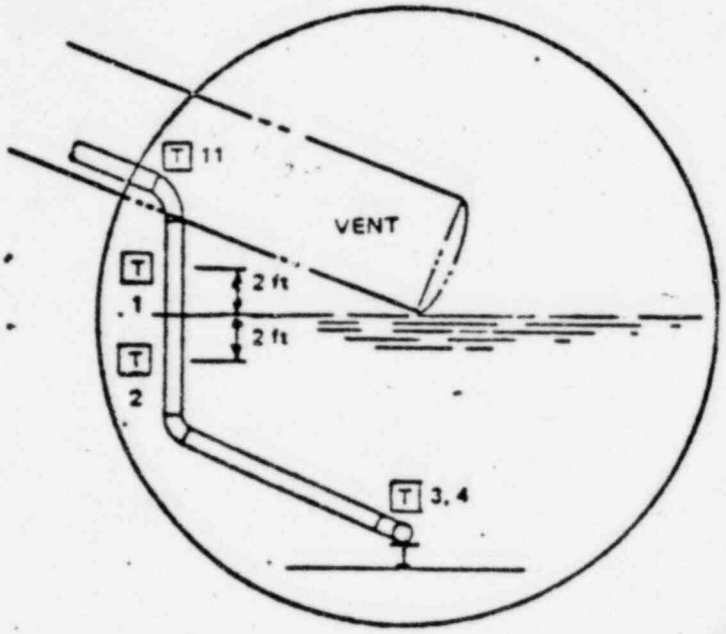


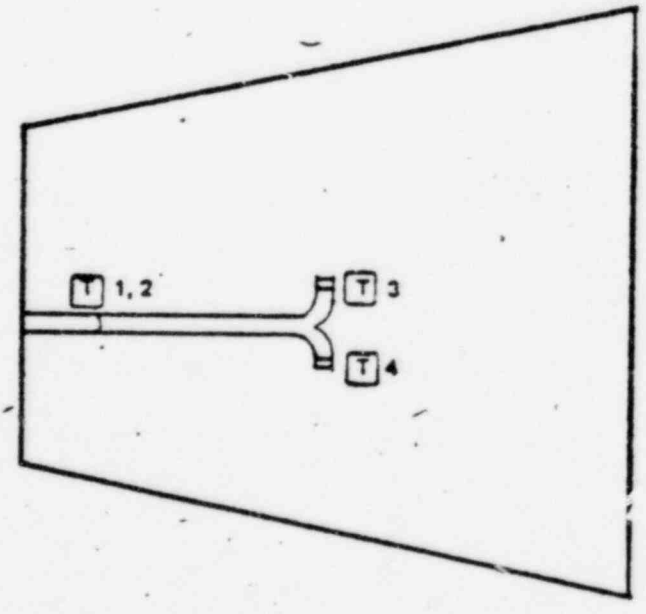

*Figure 9. Location of Temperature Sensors in Torus Pool*




SECTION VIEW

NOTE: RTDs ARE TO BE LOCATED SO AS TO MEASURE WATER/STEAM/AIR TEMPERATURE IN PIPE. SENSORS 3 AND 4 ARE AT THE RAMS-HEAD EXITS.

DISCHARGE WATER AND AIR CLEAR OF THE PIPE WITHIN 1 SECOND.




PLAN VIEW

*Figure 8. Location of Temperature Sensors in Safety/Relief Valve Discharge Line*

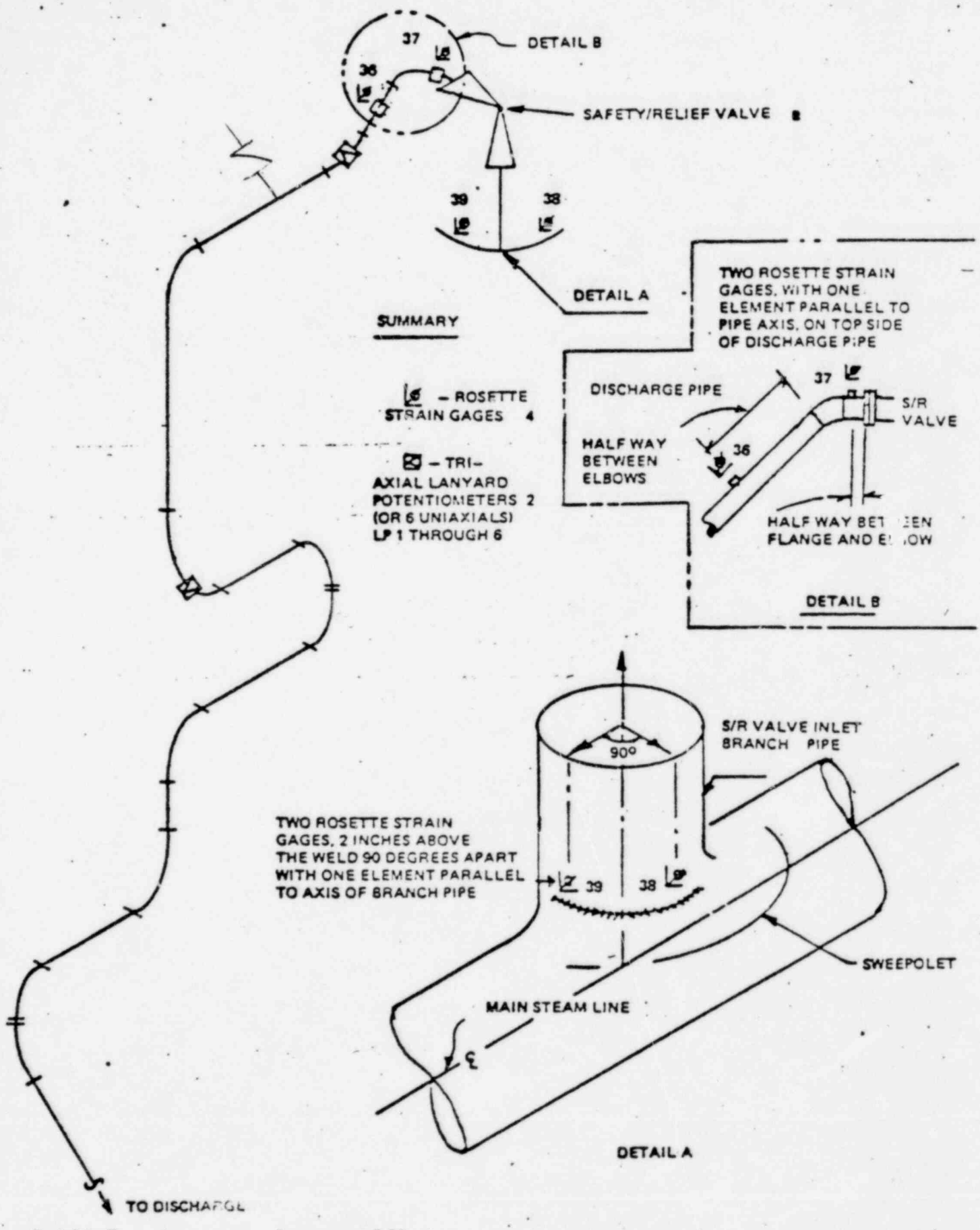
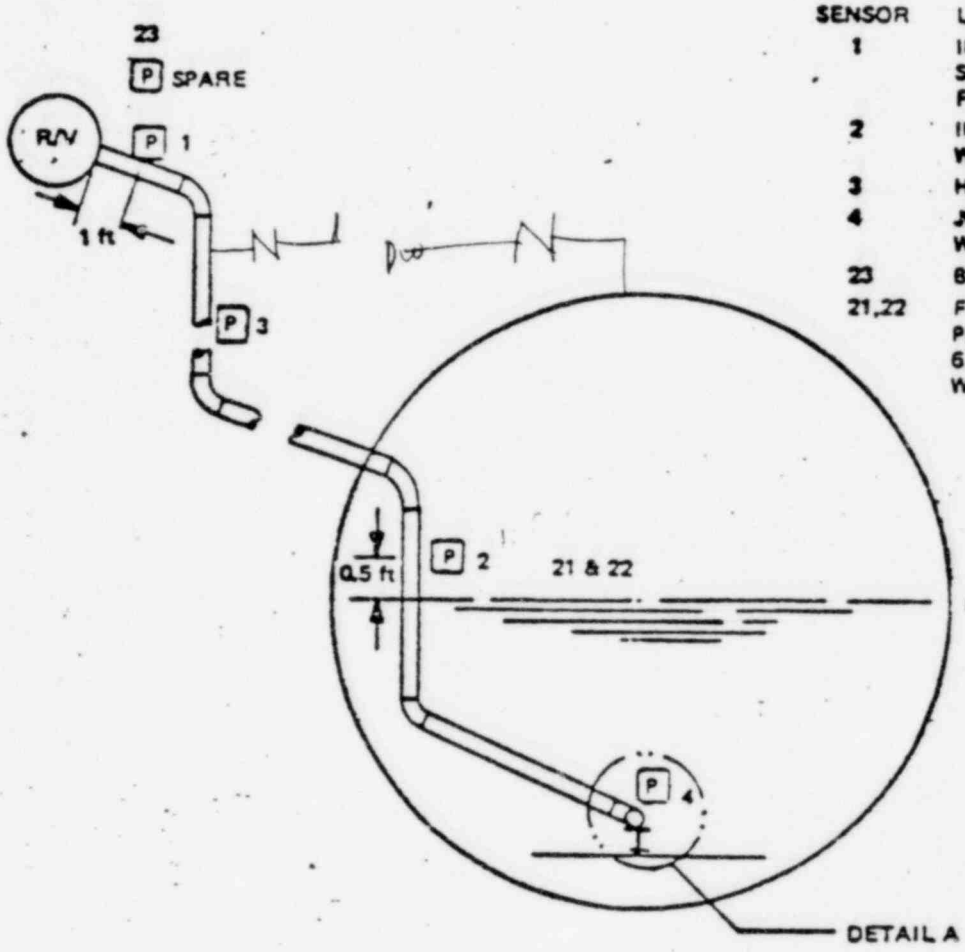
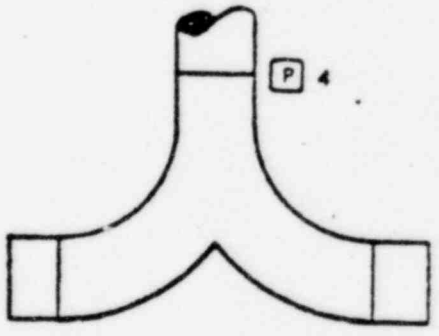



*Figure 7. Location of Strain Gages and Lanyard Potentiometers on Safety/Relief Valve Piping in Drywell*

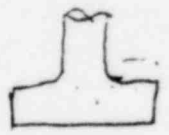



| SENSOR | LOCATION |
|---|---|
| 1 | IMMEDIATELY DOWNSTREAM OF S/R VALVE. DIMENSION IS SHOWN FOR REFERENCE ONLY. |
| 2 | IMMEDIATELY UPSTREAM OF WATER LEVEL. |
| 3 | HALFWAY BETWEEN 1 AND 2 |
| 4 | JUST UPSTREAM OF RAMS-HEAD WELD JOINT. |
| 23 | BACK-UP OF P1 |
| 21,22 | FOR RV2-71F, AND RV2-71H PIPE LINES, RESPECTIVELY, AT 6 INCHES ABOVE MAXIMUM WATER LEVEL. |



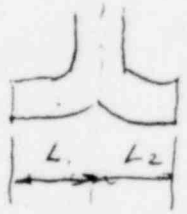

DETAIL A

Test should be conducted on the following geometries



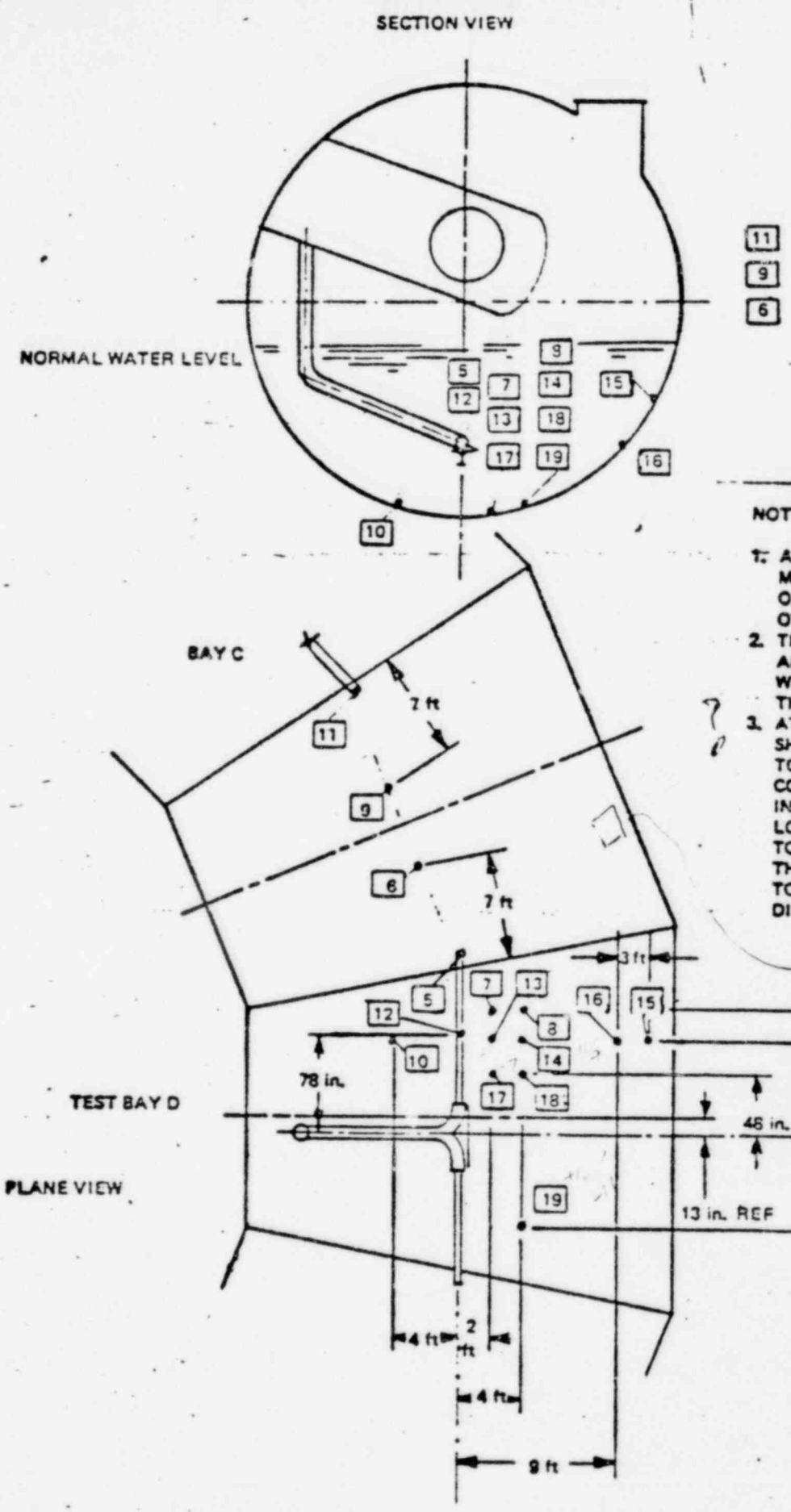
Damme Arnold & others

&




$L_1 > L_2$

*Figure 10. Location of Pressure Transducers in Safety/Relief Valve Discharge Line*



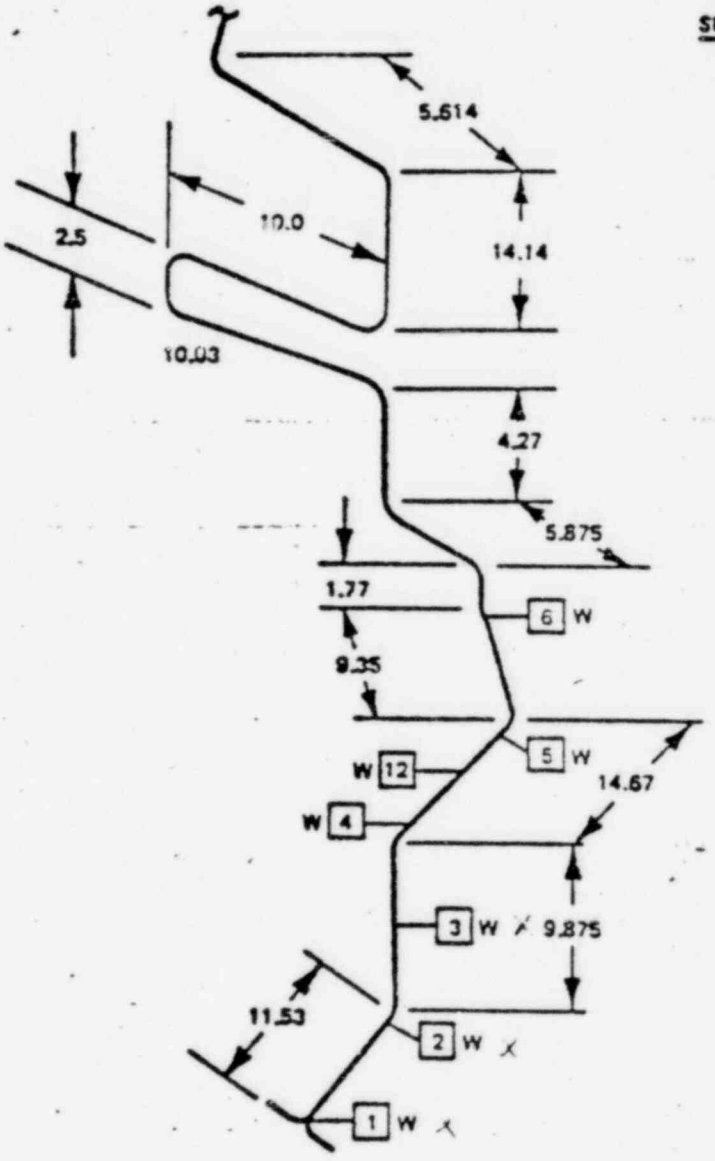

NOTES:

1. ALL TRANSDUCERS ARE MOUNTED ON TORUS WALL OR CLOSE TO IT EXCEPT OTHERWISE NOTED.
2. TRANSDUCERS P5 AND P12 ARE TO BE MOUNTED FLUSH WITH THE TOP SURFACE OF THE SUPPORT WIDE FLANGE.
3. AT LEAST TWO TRANSDUCERS SHOULD BE MOUNTED ONTO THE TORUS WALL DIRECTLY IN CONTACT, FREE OF POOL WATER IN-BETWEEN. THESE SHOULD BE LOCATED CORRESPONDING TO STRAIN GAGES OUTSIDE OF THE WALL WHICH MAY BE CLOSE TO BUT NOT EXACTLY AT THE DIMENSIONS SHOWN.

add pressure transducer here to verify that the pressure at this point will not be larger than the screen pressure

16 +8/-4

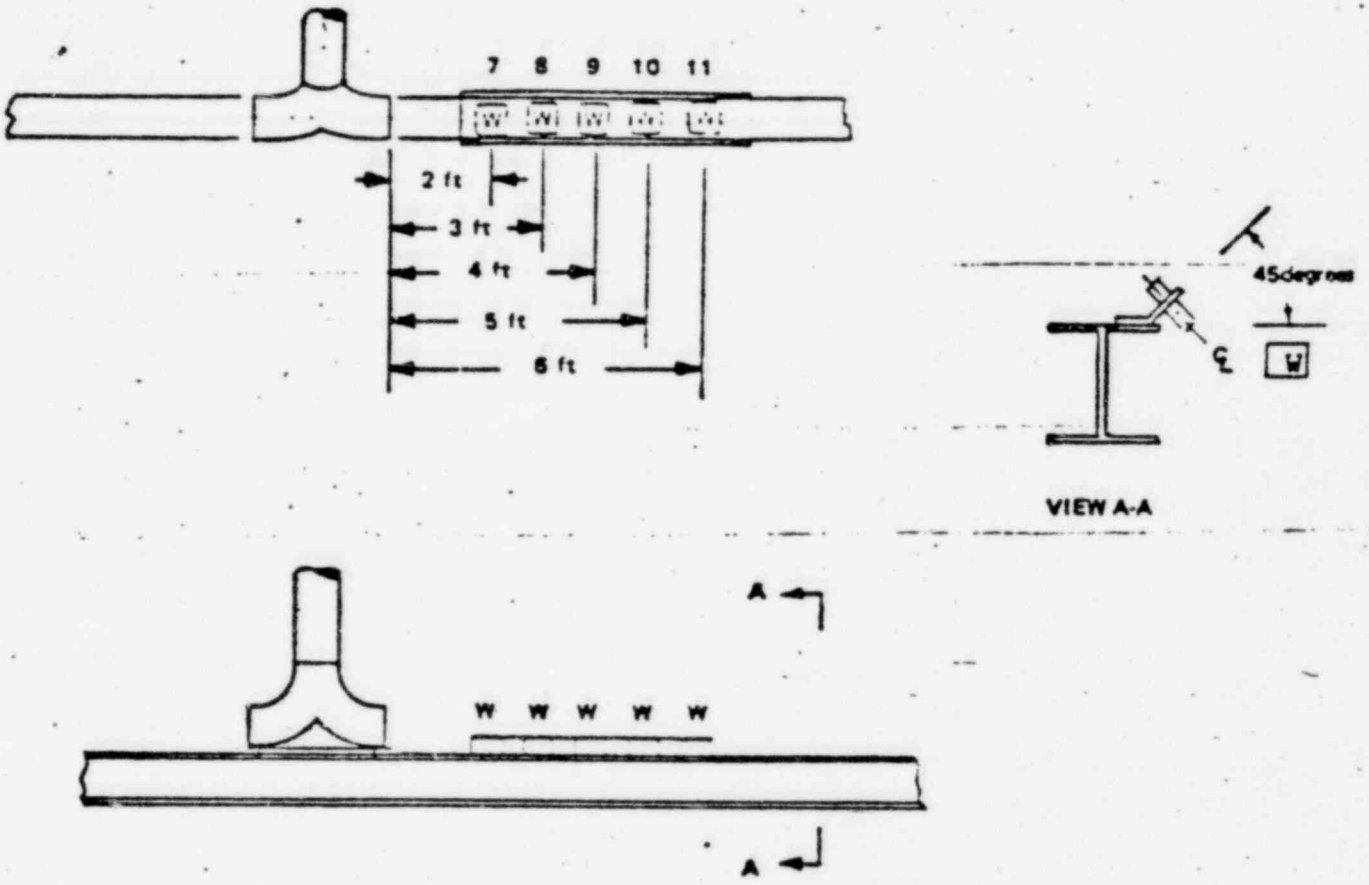
*Figure 11. Location of Pressure Transducers P5 through P19 in Torus Pool*




| SENSOR | LOCATION |
|---|---|
| W1 | AT WELD JOINT OF RAMS HEAD |
| W2 | HALFWAY BETWEEN W1 AND W3 |
| W3 | ONE FOOT ABOVE HIGH WATER LEVEL |
| W4 | AT THE ENTRANCE TO VENT PIPE |
| W5 | AT DRYWELL SIDE OF VENT |
| W6 | AT WELD JOINT AS SHOWN |
| W12 | MIDWAY BETWEEN W4 AND W5 |

NOTE: ALL DIMENSIONS IN FEET

*Figure 12. Location of Water Level Probes in Safety/Relief Valve Discharge Line*




NOTE: SENSOR SUPPORT IS TO BE RIGID YET NOT DISRUPT EITHER BUBBLE FORMATION OR STEAM JET

*Figure 13. Location of Water Level Probes in Torus Pool (Void Sensors)*

| ACCELEROMETER | NUMBER OF METERS/CHANNELS |
|---|---|
| 1 TRIAXIAL ON TORUS LEGS, A12 | 1/3 |
| 2 TRIAXIAL ON BASEMAT BY EARTHQUAKE TIE OF THE TEST BAY, A13 | 1/3 |
| 3 TRIAXIAL AT PEDESTAL TOP, A15, A16 | 2/6[a] |
| TOTAL | 4/12 |

NOTES: ALL SENSORS ARE TO BE PLACED NEAREST TO THE RELIEF VALVE UNDER TESTING

[a] NO ACCELEROMETERS LOCATED ON SAME ELEVATION 90 DEGREES APART

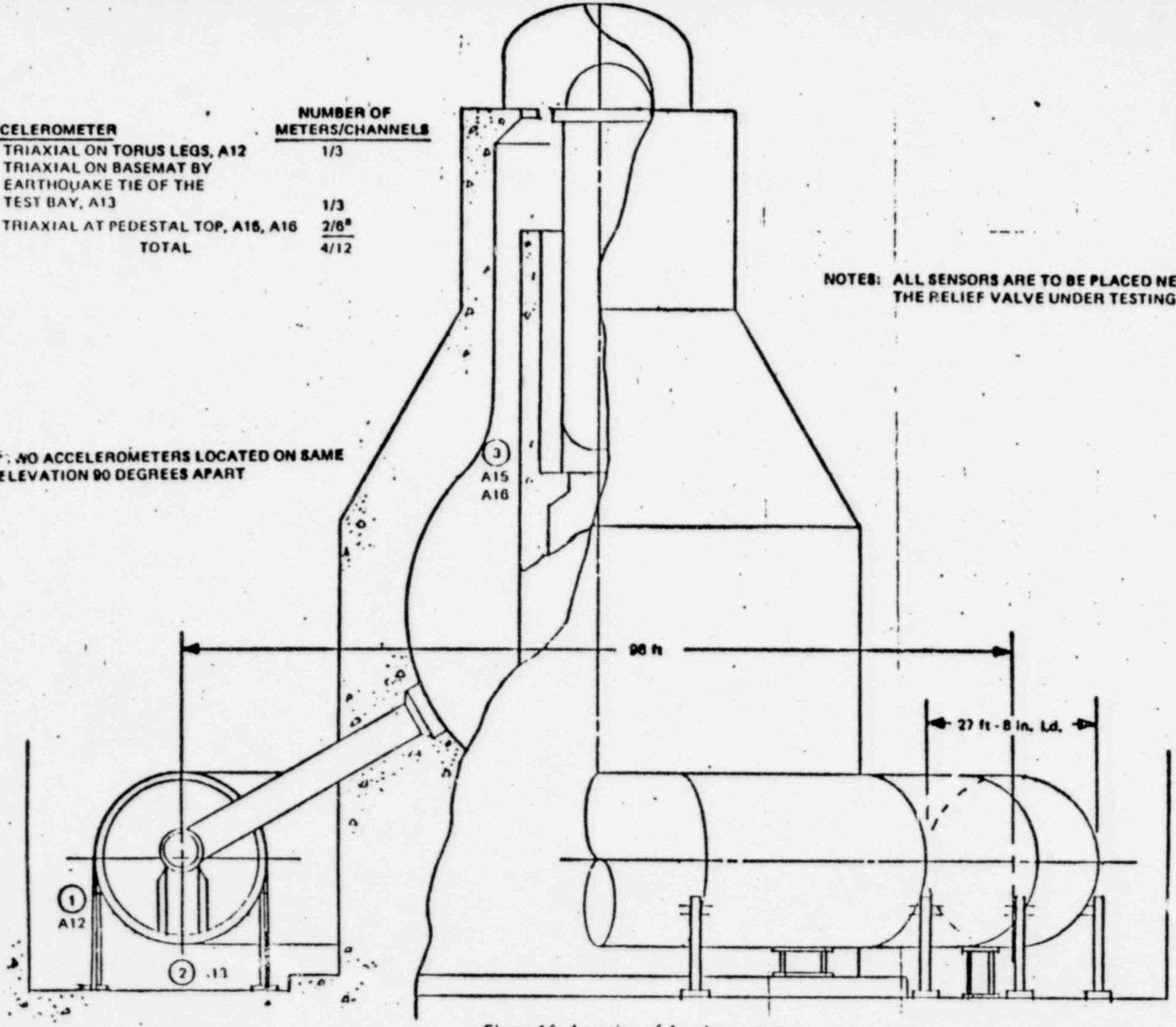



*Figure 14. Location of Accelerometers*