MARK III

SRVA REVIEW

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QUESTION 1:

THE BASIS FOR USING 59 MONTE CARLO RUNS TO ARRIVE AT AN OVERALL FORCING FUNCTION WAS TO PROVIDE A 95%-95% CONFIDENCE LEVEL IN THE RESULTING LOADS. THIS APPROACH ASSUMES THAT; (1) THE PROBABILITY DISTRIBUTION FOR EACH RANDOM VARIABLE IS KNOWN WITH A 100% CONFIDENCE LEVEL, AND (2) USING THE FORCING FUNCTION TO CALCULATE DIFFERENT LOADS (E.G., THE LOADS IN THE VERTICAL DIRECTION AND THE OVERTURNING MOMENT) DOES NOT DECREASE THE FINAL CONFIDENCE LEVEL. WE WILL REQUIRE THAT THESE TWO ASSUMPTIONS BE JUSTIFIED AND THE ACTUAL CONFIDENCE LEVELS OF THE PROBABILITY DISTRIBUTIONS BE USED IN DETERMINING THE OVERALL CONFIDENCE LEVEL.

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RESPONSE #1

- PROBABILITY DISTRIBUTIONS ON RANDOM VARIABLES ARE NOT KNOWN TO 100% CONFIDENCE LEVEL, HOWEVER;
  - INPUT DISTRIBUTIONS ARE GOOD REPRESENTATIONS OF THE DATA BASE, AND
  - SENSITIVITY ANALYSIS SHOWS THAT BUBBLE FREQUENCY IS THE ONLY VARIABLE FOR WHICH SIGNIFICANT EFFECTS ARE OBSERVED.
- THE OVERALL CONFIDENCE LEVEL IS UNAFFECTED BY CALCULATION OF FORCES AND MOMENTS;
  - THESE ARE CALCULATED FOR EACH TRIAL AND USED AS THE BASIS FOR RUN SELECTION
- USE OF DESIGN PRESSURES INSTEAD OF NOMINAL INCREASES OVERALL CONFIDENCE LEVEL ABOVE 95%-95%

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RESPONSE #1

- FORCING FUNCTION SPECIFICATION

  - SELECTION FROM 59 TRIALS GIVES 95% - 95% CONFIDENCE LEVEL IN THE CALCULATED SPECTRAL PEAKS
  - SELECT RUNS WHICH PRODUCE PEAK SPECTRAL VALUES IN BASEMAT FORCE AND ROCKING MOMENTS.
  - THREE FREQUENCY INTERVALS ARE SELECTED BASED ON STRUCTURE CHARACTERISTICS:

    4 - 12 Hz MAJOR STRUCTURES
    12 - 20 Hz PIPING
    20 - 28 Hz EQUIPMENT

  - SELECTIONS ARE INDEPENDENT FOR EACH FREQUENCY INTERVAL AND EACH LOAD TYPE (FORCE AND MOMENTS)

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CRITICAL CASE SELECTION

- EXAMPLE FOR ONE LOAD CASE

FREQUENCY	VERTICAL	ROCKING	
		M_X	M_Y
4-12	39*	57*	51
12-20	54*	27*	57
20-28	29*	47	9*

*CRITICAL CASES GIVING HIGHEST SPECTRAL VALUE FOR EITHER VERTICAL FORCE OR ROCKING MOMENT. FOR MOMENTS, THE CASES GIVING THE HIGHEST VALUES FOR EITHER M_X OR M_Y ARE SELECTED AND THE LOADS APPLIED IN BOTH DIRECTIONS.

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RESPONSE #1 (CONT'D)

- INPUT PROBABILITY DISTRIBUTIONS ACCURATELY REPRESENT THE DATA BASE

- DATA BASE

  - VALVE OPENING TIME

    - 408 TESTS ON 102 CROSBY VALVES
    - 50 TESTS ON A SINGLE DIKKERS VALVE (SEE QUESTION 2B RESPONSE FOR DATA)

  - QUENCHER BUBBLE FREQUENCY

    - 132 IN PLANT TESTS

  - VALVE SETPOINT TOLERANCE

    - 2σ VALUE TAKEN FROM TRIP SYSTEM REPEATABILITY ERROR ($\pm$ .25%)

  - PRESSURE RISE RATE

    - RELATIVE FREQUENCY OF EVENTS WITH POTENTIAL TO LIFT 2/3 OF SRV'S

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RESPONSE #1 (CONT'D)
SENSITIVITY RESULTS

- SENSITIVITY OF PEAK SPECTRAL VALUES TO INPUT DATA UNCERTAINTIES IS SMALL.

VARIABLE AND VALUE $\pm 2\sigma$		PEAK SPECTRAL VALUES SENSITIVITY
• VALVE OPENING TIME		
MEAN	59 ± 3 Msec	NONE
STD. DEVIATION	9 ± 3 Msec	NEGLIGIBLE (-0.1% PER Msec)
• VALVE SETPOINT TOLERANCE	2.1 PSI	NEGLIGIBLE (-1% PER PSI)
• BUBBLE FREQUENCY		
MEAN	8.1±.3 Hz	FREQUENCY SHIFT
STD. DEVIATION	1.7±.3 Hz	AREA UNDER PEAK IS PRESERVED
• PRESSURE RISE RATE		
RANGE	40-140 PSI/SEC	NO CONSISTANT TRENDS (SEE RESPONSE TO QUESTION 10)

CONCLUSION: UNCERTAINTIES IN THE SHAPE OF THE INPUT PROBABILITY DISTRIBUTIONS ARE NOT IMPORTANT.

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RESPONSE #1 (CONT'D)

- CONCLUSIONS
  - 95% - 95% CONFIDENCE LEVEL IS FOR PEAK SPECTRAL VALUES PRODUCED IN REPEATED MONTE CARLO TRIALS, NOT FOR THE LOADS.
  - DESIGN LOADS BOUND MEASURED LOADS WITH LARGE MARGINS IN CAORSO:
    - FACTOR OF 2 IN PEAK PRESSURE
    - FACTOR OF 3 IN ARS (SEE QUESTION 9)
  - INPUT PROBABILITY DISTRIBUTIONS ADEQUATELY REPRESENT THE DATA
    - PEAK SPECTRAL VALUES ARE INSENSITIVE TO MOST INPUT DATA UNCERTAINTIES
- FORCING FUNCTION SELECTION IS BASED ON CALCULATED FORCES AND MOMENTS:

  INDEPENDENT SELECTION FROM 59 TRIALS GIVES 95%-95% CONFIDENCE FOR EACH SELECTION
- USE OF DESIGN PRESSURES INCREASES OVERALL CONFIDENCE LEVEL IN LOADS ABOVE 95%-95%

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QUESTION 4:

THE SENSITIVITY OF THE LOADS TO THE FORM OF THE RANDOM VARIABLE PROBABILITY DISTRIBUTIONS SHOULD BE SUPPLIED. IN PROVIDING THIS INFORMATION THE STUDIES SHOULD BE EXPANDED TO INCLUDE THE EFFECT OF CHANGES IN THE MEAN QUENCHER BUBBLE FREQUENCY (QBF).

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RESPONSE #4

- RESULTS OF SENSITIVITY STUDIES ARE PROVIDED IN WRITTEN RESPONSES AND SENSITIVITY RESULTS ARE SUMMARIZED IN QUESTION 1 RESPONSE

- CONCLUSIONS

  - PEAK SPECTRAL VALUES ARE INSENSITIVE TO INPUT DATA UNCERTAINTIES

  - EFFECT OF CHANGING MEAN BUBBLE FREQUENCY IS TO SHIFT THE ENVELOPE OF SPECTRAL PEAKS, HOWEVER THIS IS ADEQUATELY COVERED BY THE GESSAR METHOD:

    - LINE VOLUMES ACCOUNTED FOR
    - SUBMERGENCE EFFECTS NEGLIGIBLE
    - ADS EFFECT ~1 Hz
    - MARGINS NOT SIGNIFICANTLY AFFECTED
    - PEAK BROADENING APPLIED TO RESPONSE SPECTRA

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QUESTION 5:

WE BELIEVE THAT ONLY THE PRESSURES ASSOCIATED WITH THE ENVELOPE OF THE FOURIER SPECTRA OF THE 59 MONTE CARLO SIMULATIONS CAN BE CONSIDERED TO BE THE "BOUNDING" FORCING FUNCTION IN THE 95%-95% CONFIDENCE LEVEL SENSE. WE ACKNOWLEDGE THAT SUCH A FORCING FUNCTION CAN BE SYNTHESIZED ADEQUATELY WITH A SUBSET OF THE 59 TRIALS, PARTICULARLY IF SOME FREQUENCY SPREADING OF THE AMPLIFIED RESPONSE SPECTRA (ARS) IS EMPLOYED AT LATER STAGES OF THE ANALYSIS. THE PROCEDURE DESCRIBED TO SELECT THAT FORCING FUNCTION(S) WHICH IS TO BE USED FOR DESIGN DOES NOT APPEAR TO SATISFY THESE REQUIREMENTS. ACCORDINGLY, COMPARE THE SELECTED TRIALS WITH THE FOURIER SPECTRA OF ALL 59 TO SHOW WHAT EXTENT THEY DO OR DO NOT REPRESENT AN ENVELOPE.

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RESPONSE #5

- THE REQUESTED COMPARISON HAS BEEN PROVIDED
- THE GESSAR RUN SELECTION METHOD PROVIDES A GOOD APPROXIMATION TO THE ENVELOPE OF SPECTRAL PEAKS FROM 59 RUNS
- PEAK BROADENING OF THE RESPONSE SPECTRA WILL PROVIDE FURTHER BOUNDING OF THE ENVELOPE
- NOT APPROPRIATE TO USE PRESSURES ASSOCIATED WITH THE ENVELOPE
  - NOT REPRESENTATIVE OF AN SRVA EVENT (WRONG TIME HISTORY)
  - ENERGY CONTENT IN THE ENVELOPE IS THREE TIMES THE AVERAGE

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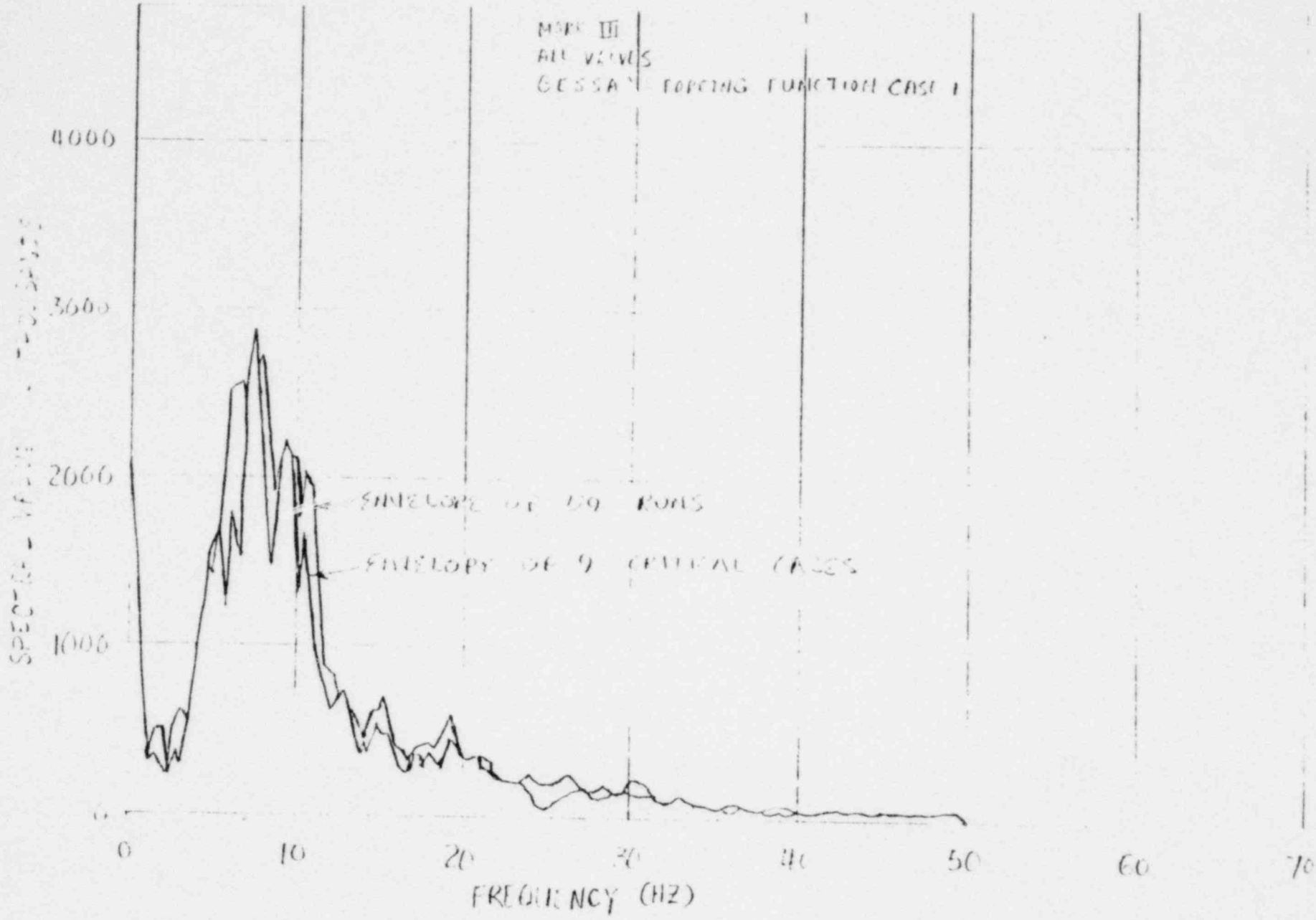
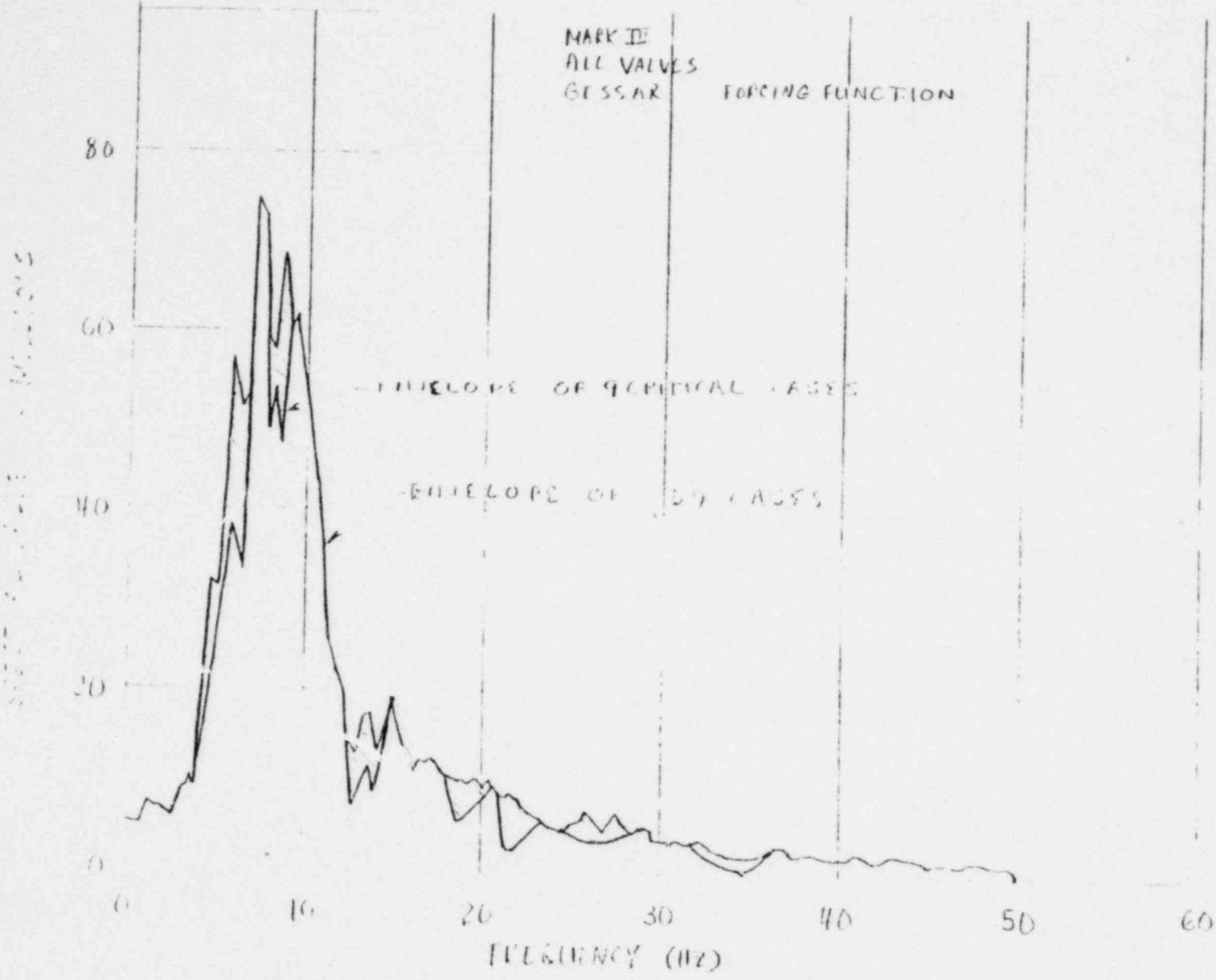
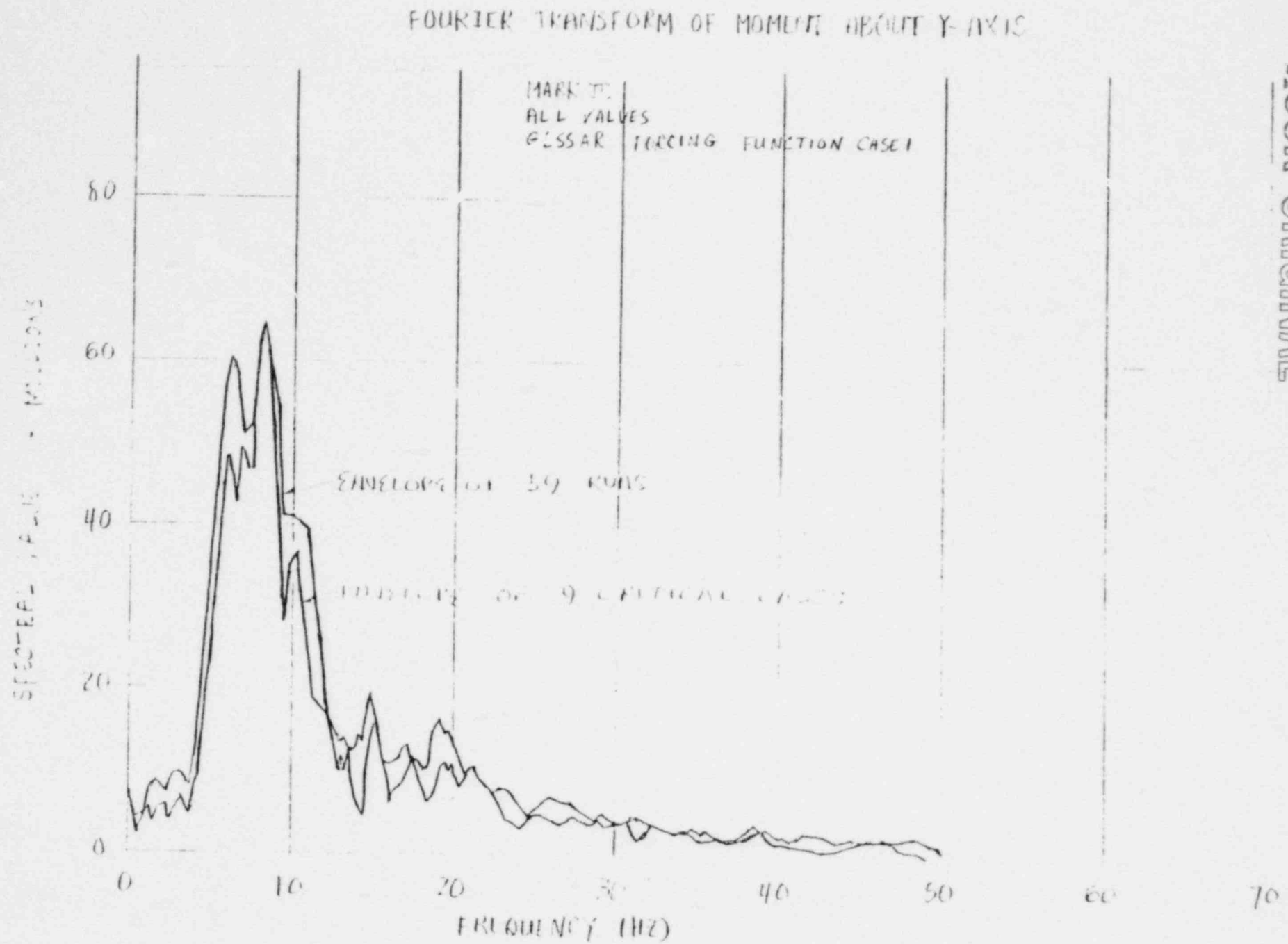
FOURIER TRANSFORM OF BASEMAT FORCE



FOURIER TRANSFORM OF MOMENT ABOUT X-AXIS





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QUESTION 8:

DATA AND ANALYSIS SUGGEST THAT THE LOCAL HYDRAULIC PRESSURE AT THE QUENCHER CENTERLINE HAS A STRONG INFLUENCE ON QUENCHER BUBBLE FREQUENCY. VARIATIONS IN THIS PARAMETER CAN RESULT DUE TO DIFFERENCES IN SUBMERGENCE AS WELL AS FROM DIFFERENCES IN WETWELL PRESSURE. FOR THE ADS TRANSIENT THE LATTER IS APPROXIMATELY A THREE-FOLD FACTOR HIGHER THAN THE CONDITIONS UNDER WHICH QBF DATA WAS OBTAINED.

THE PROPOSED METHODOLOGY DOES NOT APPEAR TO ADDRESS THOSE EFFECTS PROVIDE JUSTIFICATION FOR NEGLECTING THESE EFFECTS OR INDICATE HOW THEY WILL BE CONSIDERED.

QUESTION 2(D):

WE BELIEVE THAT THE DATA BASES FOR VALVE OPENING TIME (VOT), VALVE SETPOINT TOLERANCE (VST) AND QUENCHER BUBBLE FREQUENCY (QBF) HAVE YET TO BE PRESENTED IN A DOCUMENTED FORM SUITABLE FOR FINAL REVIEW AND EVALUATION. ACCORDINGLY, THE FOLLOWING INFORMATION SHOULD BE PROVIDED IN ACCORDANCE WITH THE FOLLOWING GUIDELINES AND FORMAT:

D) A COMPARISON OF THE BACKPRESSURE USED IN THE TEST VS. ACTUAL CONDITIONS SHOULD BE PROVIDED AND ANY DIFFERENCE JUSTIFIED.

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RESPONSE #8

- EFFECT OF BACKPRESSURE
  - LOCAL HYDROSTATIC PRESSURE AFFECTS BUBBLE FREQUENCY THROUGH ITS EFFECT ON BUBBLE RADIUS AND pV WORK.
- COMPARISON OF TEST VS. MARK III CONDITIONS

o TEST RANGE		1.33 - 1.52 ATM
o MARK III NON ADS		1.41 ATM
	ADS	1.75 ATM

  - SUBMERGENCE EFFECT NEGLIGIBLE
    - $\sim$.1 Hz PER FOOT OF SUBMERGENCE
- CONTAINMENT PRESSURIZATION EFFECT
  - ADS COMBINED WITH SBA LOCA GIVES + 5 psi IN MARK III
  - $\sim$ 1 Hz IN BUBBLE FREQUENCY
- NOT SIGNIFICANT FOR LOAD DEFINITION

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QUESTION 10:

WE BELIEVE THAT THE USE OF THE REACTOR PRESSURE RISE RATE (PRR) AS A RANDOM VARIABLE MAY NOT RESULT IN THE "WORST" CASE FOR SRV LOADS. TO DEMONSTRATE THAT THE "WORST" CASE HAS BEEN CONSIDERED, COMPARE THE FORCING FUNCTION CALCULATED BY ASSUMING THE PRR AS A RANDOM VARIABLE WITH THE FOLLOWING:

(1) THE FORCING FUNCTION CALCULATED BY USING THE MAXIMUM PRR;

(2) THE FORCING FUNCTION CALCULATED BY USING A PRR WHICH WILL RESULT IN THE MOST PROBABLE "IN-PHASE" BUBBLE OSCILLATION BETWEEN THE SECOND AND THIRD SRV's SETPOINT GROUPS. TO MAXIMIZE THE POTENTIAL FOR BUBBLE OSCILLATION IN-PHASE, THE MEAN VALUES OF BUBBLE FREQUENCIES AND SRV LINE VOLUME SHOULD BE USED TO DETERMINE THE PRR.

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RESPONSE #10

- SENSITIVITY STUDIES SHOW MAXIMUM LOADS DO NOT ALWAYS OCCUR WITH MAXIMUM PRESSURE RISE RATE.

- BOTH CASES REQUESTED ARE INCLUDED IN SENSITIVITY STUDIES

  - MOST PROBABLE IN-PHASE OSCILLATION OCCURS WITH PRR = 80 PSI/SEC

- THE GESSAR METHOD IS MORE CONSERVATIVE THAN SELECTION OF ANY SINGLE VALUE FOR PRESSURE RISE RATE.