ATTACHMENT 5

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NEUTRON NOISE CAN BE USED TO MONITOR CHANGES IN BWR DYNAMICS

PRESENTED AT THE SURVEILLANCE
AND DIAGNOSTICS REVIEW GROUP MEETING
IN BETHESDA, MARYLAND ON
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INVESTIGATORS ON THIS PROJECT ARE:

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THE OBJECTIVE OF OUR TASK IS TO:

ASSESS A METHOD

TO MONITOR BWR CORE DYNAMICS

BY

COMPARING AN INFERRED CORE STABILITY

PARAMETER (DECAY RATIO) WITH PREDICTIONS

OF A BWR DYNAMICS CODE (LAPUR)

WE HAVE PREVIOUSLY SHOWN:

- THAT MULTIVARIATE ANALYSIS OF NEUTRON AND PROCESS SIGNALS YIELDS THE SAME RESULTS AS UNIVARIATE ANALYSIS OF NEUTRON SIGNALS ALONE,

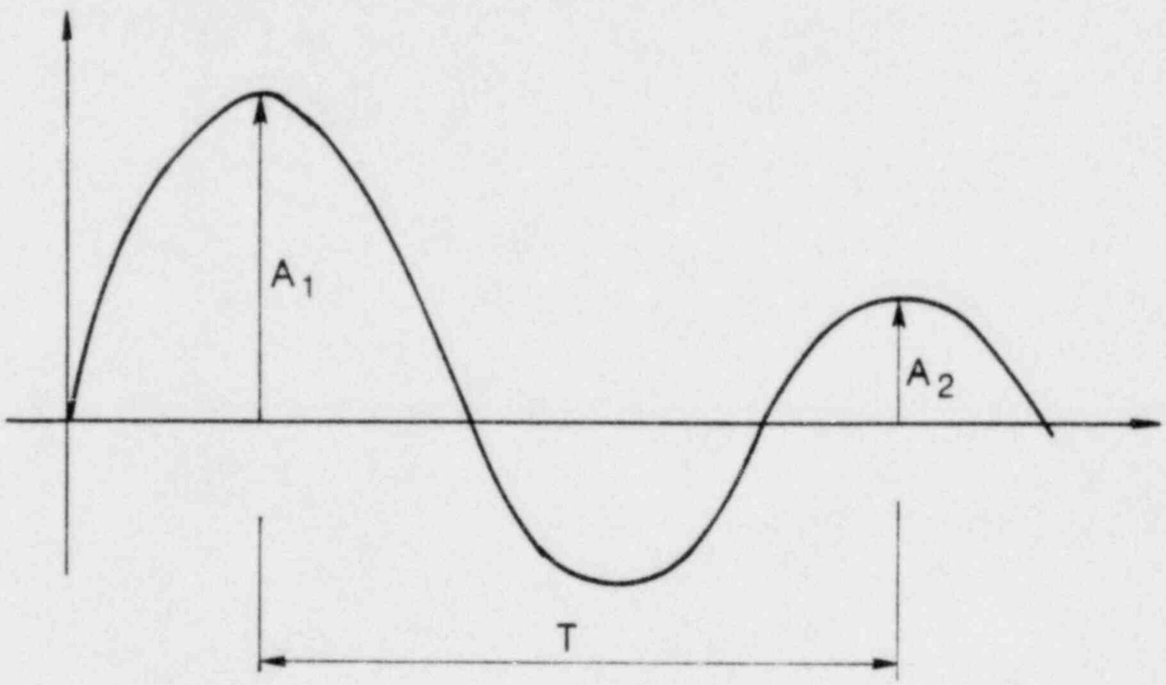
WHERE THE UNIVARIATE MODEL HAS THE FORM

DRIVING NOISE

$$Y(K) = \sum_{I=1}^{N} A_I Y(K-I) + V(K)$$

THIS IS AN <u>EMPERICAL</u> MODEL FIT TO THE DIGITALLY SAMPLED NEUTRON SIGNAL

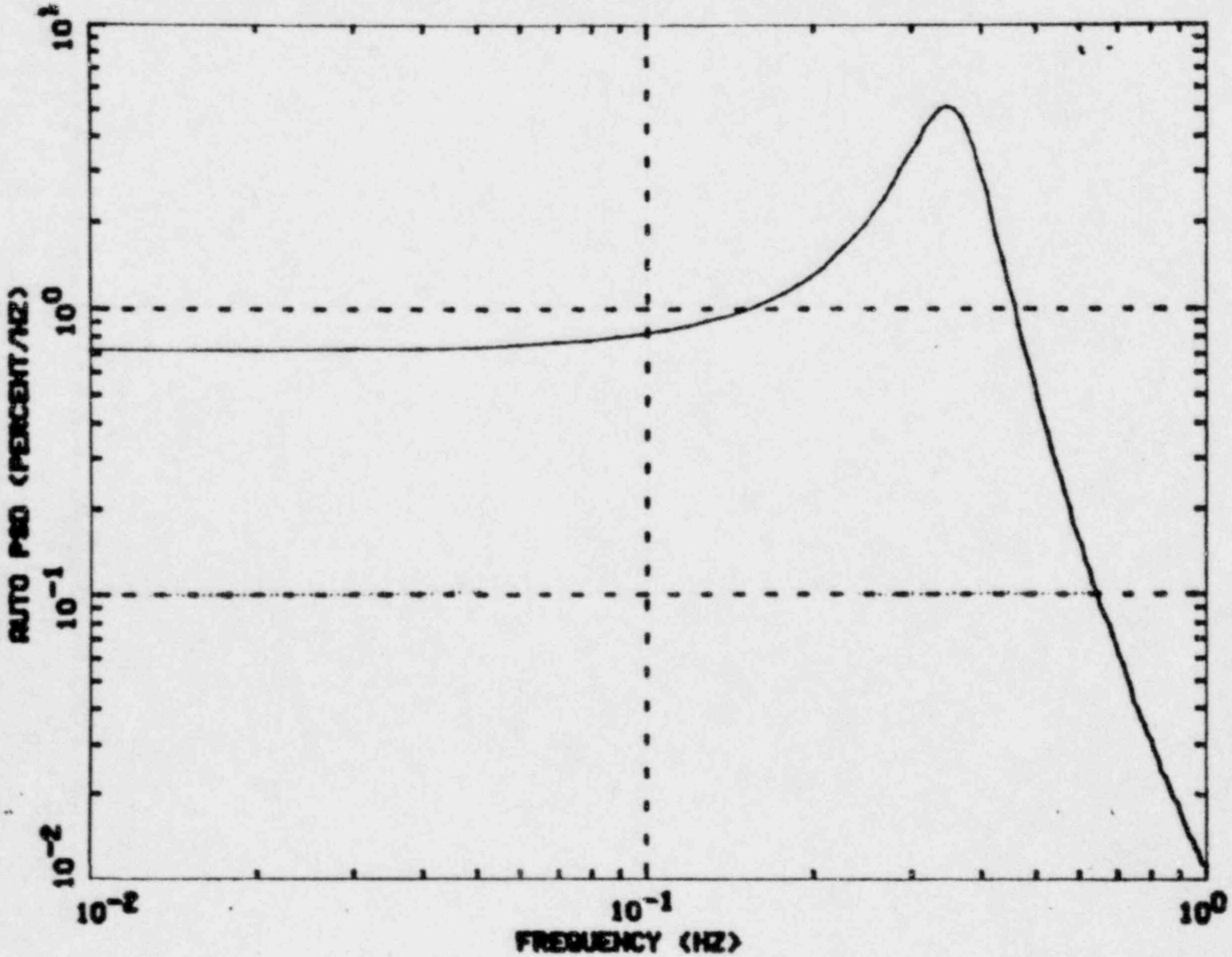
THE DECAY RATIO IS OBTAINED FROM THE IMPULSE RESPONSE



$$\text{Decay Ratio} = \frac{A_2}{A_1}$$

$$\text{PEAK FREQUENCY} = \frac{1}{T}$$

THE POWER SPECTRUM OF THE APRM SIGNAL HAS A RESONANCE BETWEEN 0.3 AND 0.4 HZ



THE IMPULSE RESPONSE OF THE EMPERICAL MODEL HAS DECAY RATIO OF 0.29

AND 0.37 HZ PEAK FREQUENCY

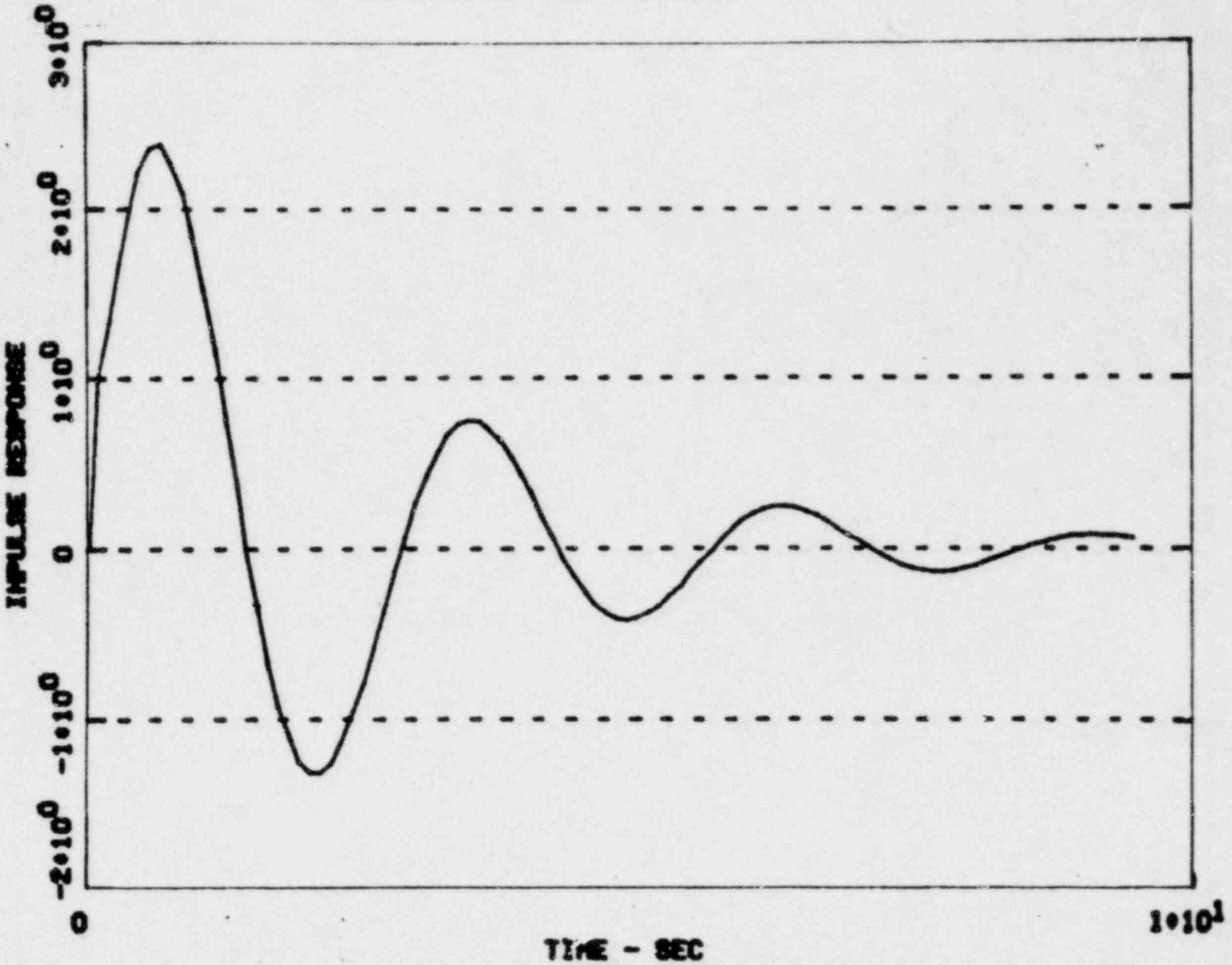


Figure 5a. Impulse Response of APRM (81) Detector Signal Model.

MODEL PREDICTIONS

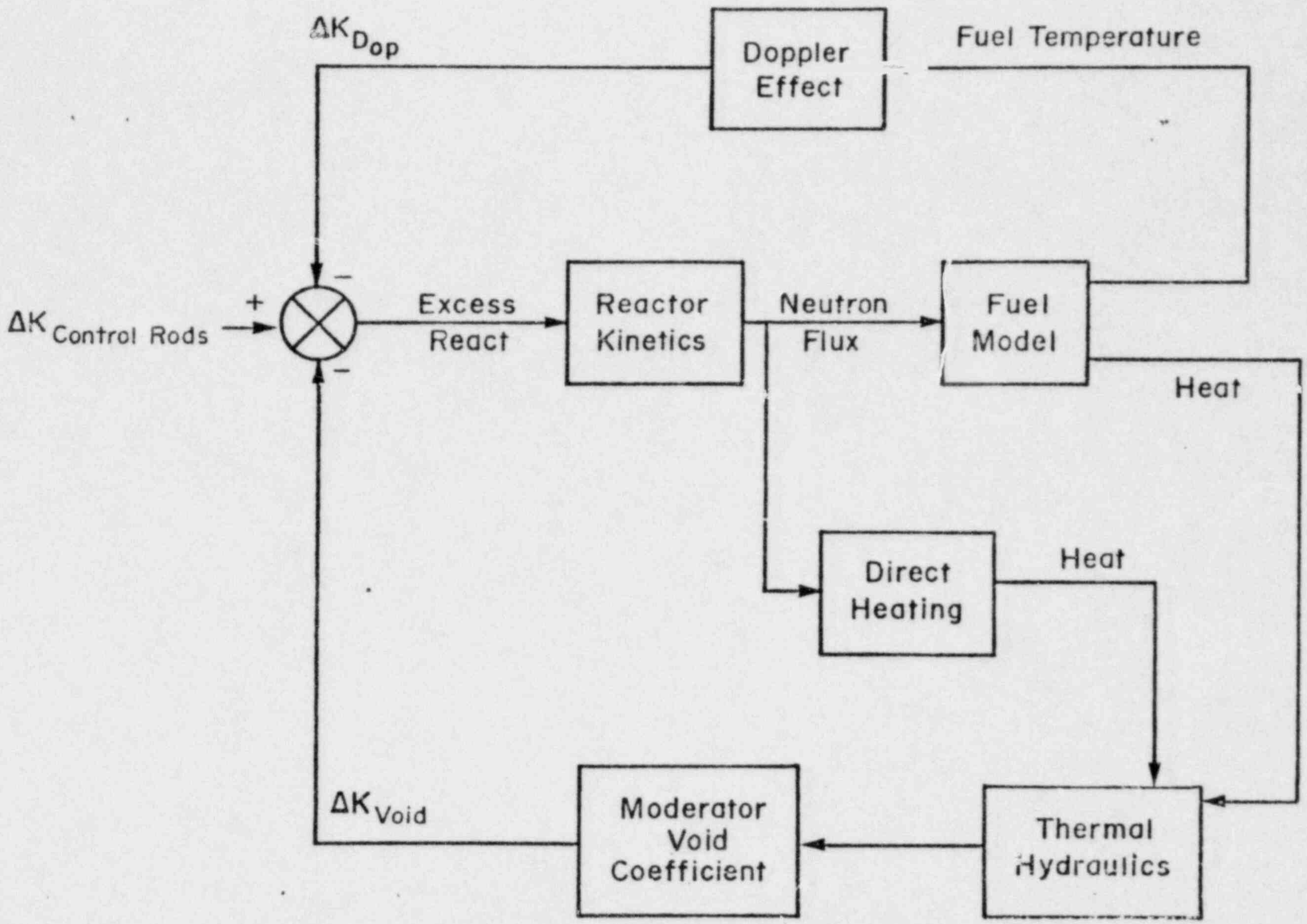
OF

DECAY RATIO AND PEAK FREQUENCY

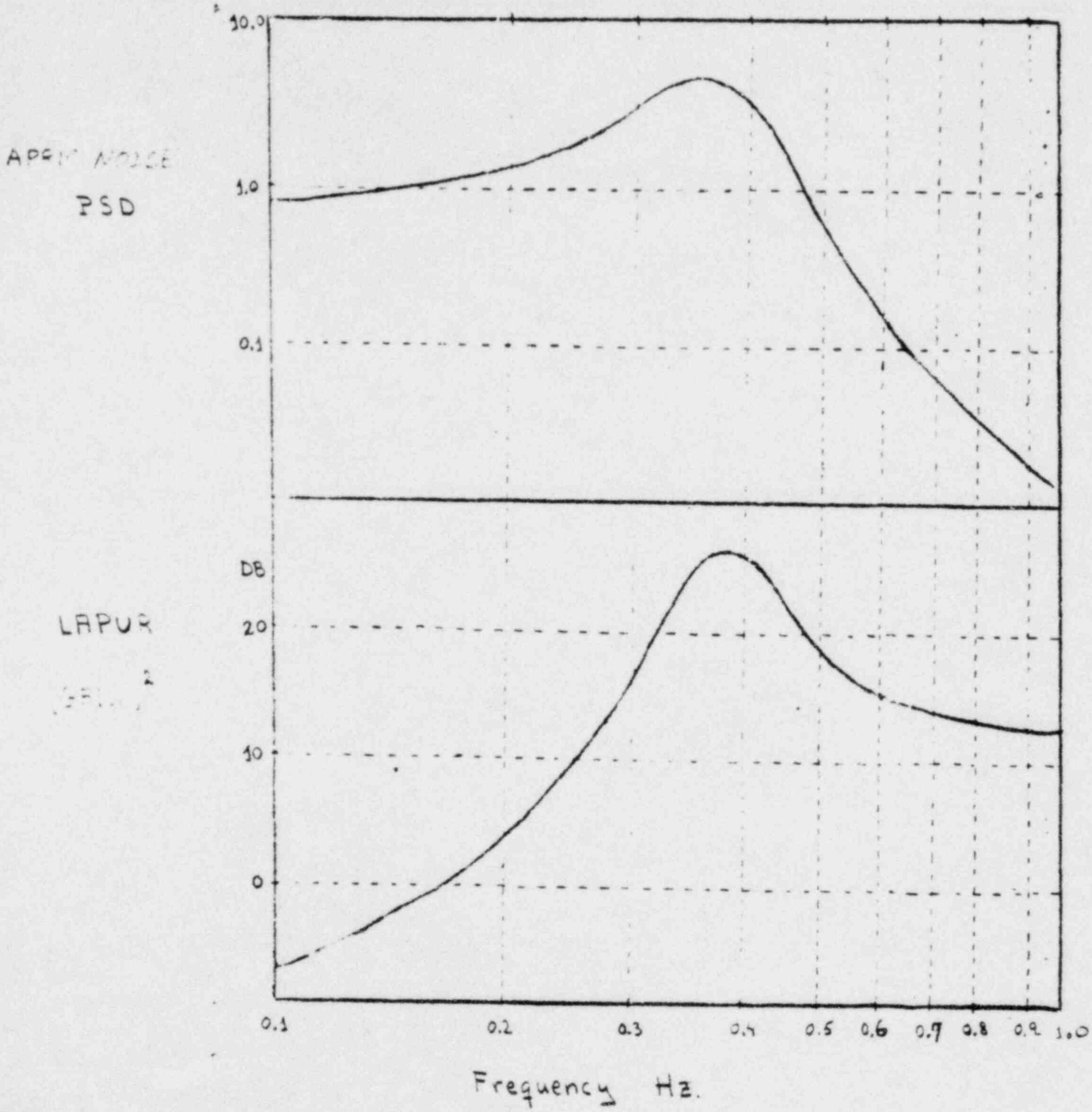
WERE OBTAINED USING LAPUR

- COUPLES THERMAL HYDRAULIC AND NEUTRONIC EQUATIONS

LAPUR COUPLES THERMAL HYDRAULIC AND NEUTRONIC EQUATIONS



NEUTRON NOISE (APRM) SPECTRUM HAS A RESONANT FREQUENCY SIMILAR TO LAPUR CALCULATED GAIN



UNFORTUNATELY, WE HAVE NOT BEEN ABLE TO MAKE A DIRECT COMPARISON BETWEEN LAPUR CALCULATIONS AND NOISE ANALYSIS BECAUSE

- AVAILABLE PEACH BOTTOM 2 NOISE DATA IS FROM END OF CYCLE 3

BUT

- WE DON'T HAVE INPUT DATA FOR LAPUR CORRESPONDING TO THIS TEST CONDITION

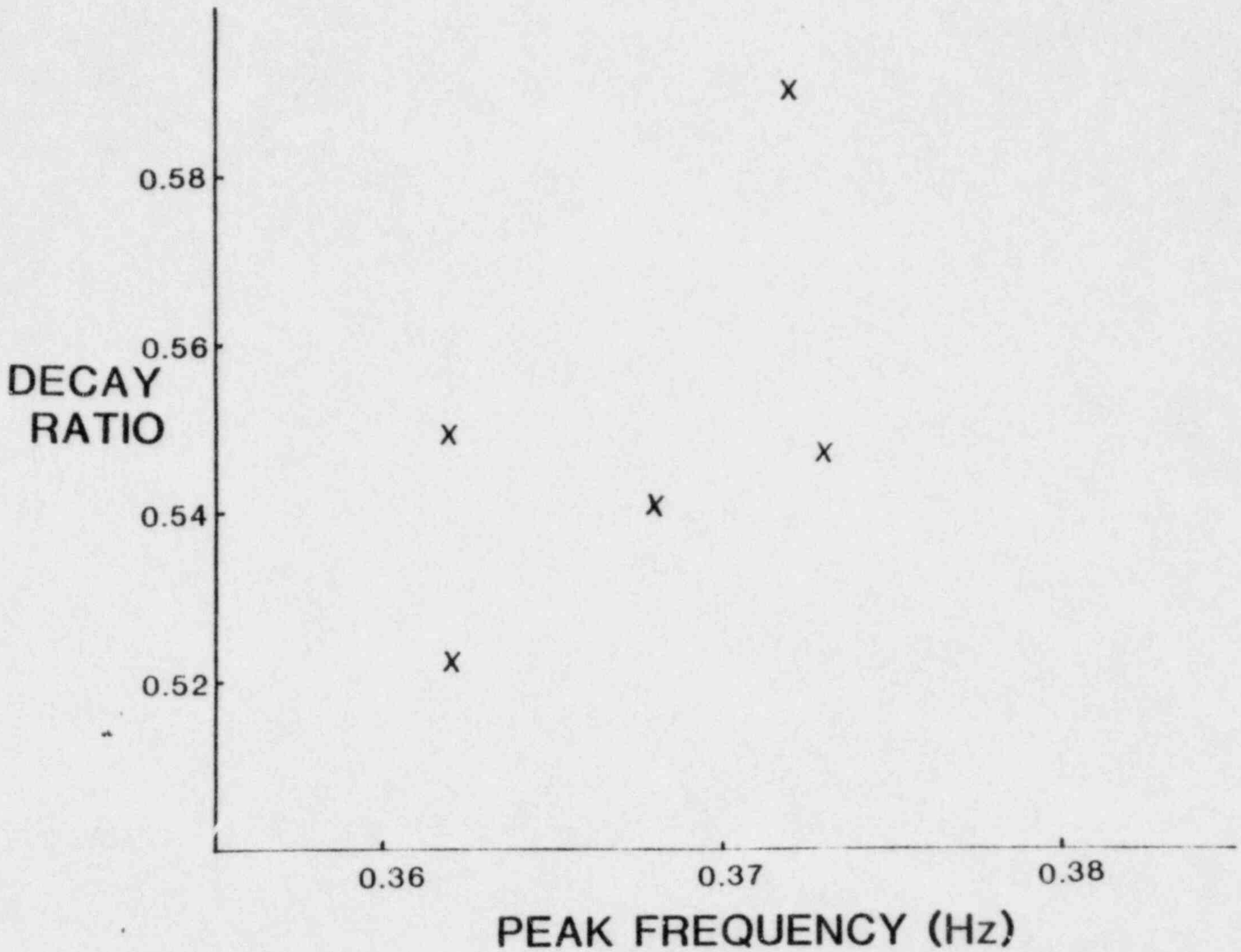
HOWEVER, WE HAVE USED LAPUR TO STUDY THE RELATIONSHIP BETWEEN DECAY RATIO AND

- PEAK FREQUENCY

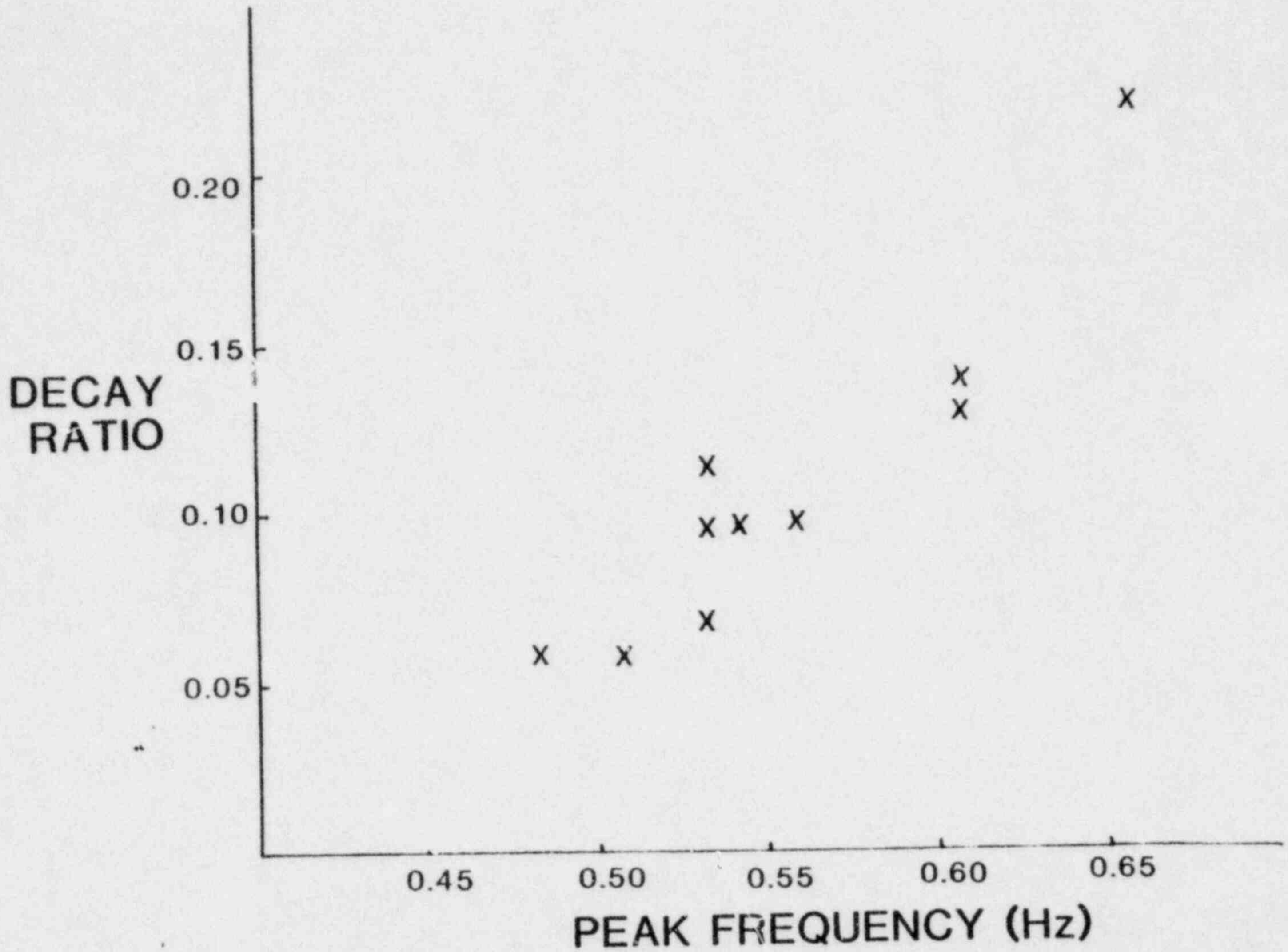
AND

- STEAM VELOCITY

LAPUR PREDICTS THAT THE PEAK FREQUENCY WILL INCREASE WHEN THE DECAY RATIO INCREASES



NOISE ANALYSIS OF LPRM SIGNAL SHOWS AN INCREASE IN PEAK FREQUENCY WHEN DECAY RATIO INCREASES

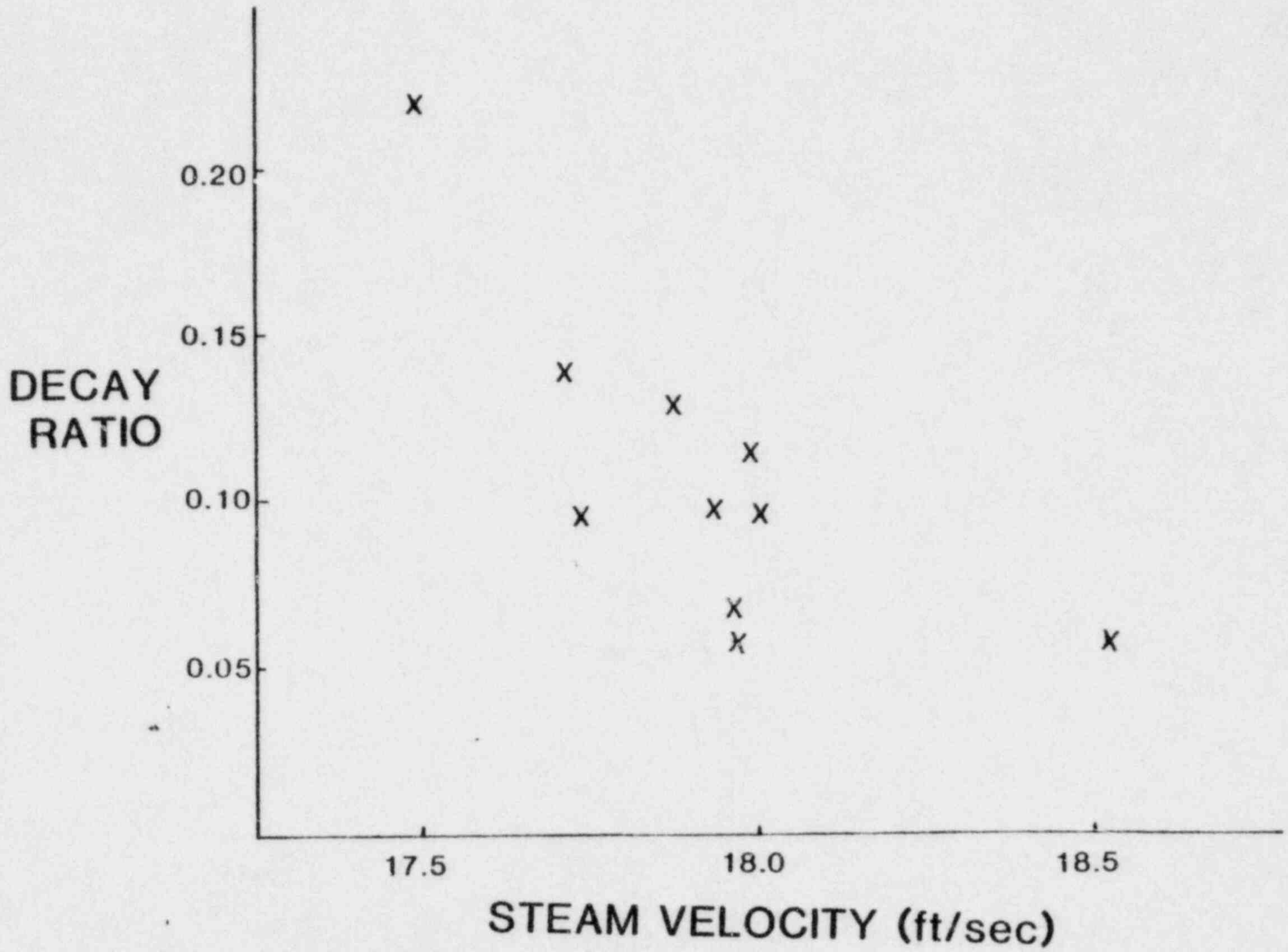


PARAMETRIC STUDIES WITH LAPUR SHOW THAT INCREASED VOID PASSAGE RATE (STEAM VELOCITY) ACTS AS A STABILIZING FORCE ON BWR CORE DYNAMICS

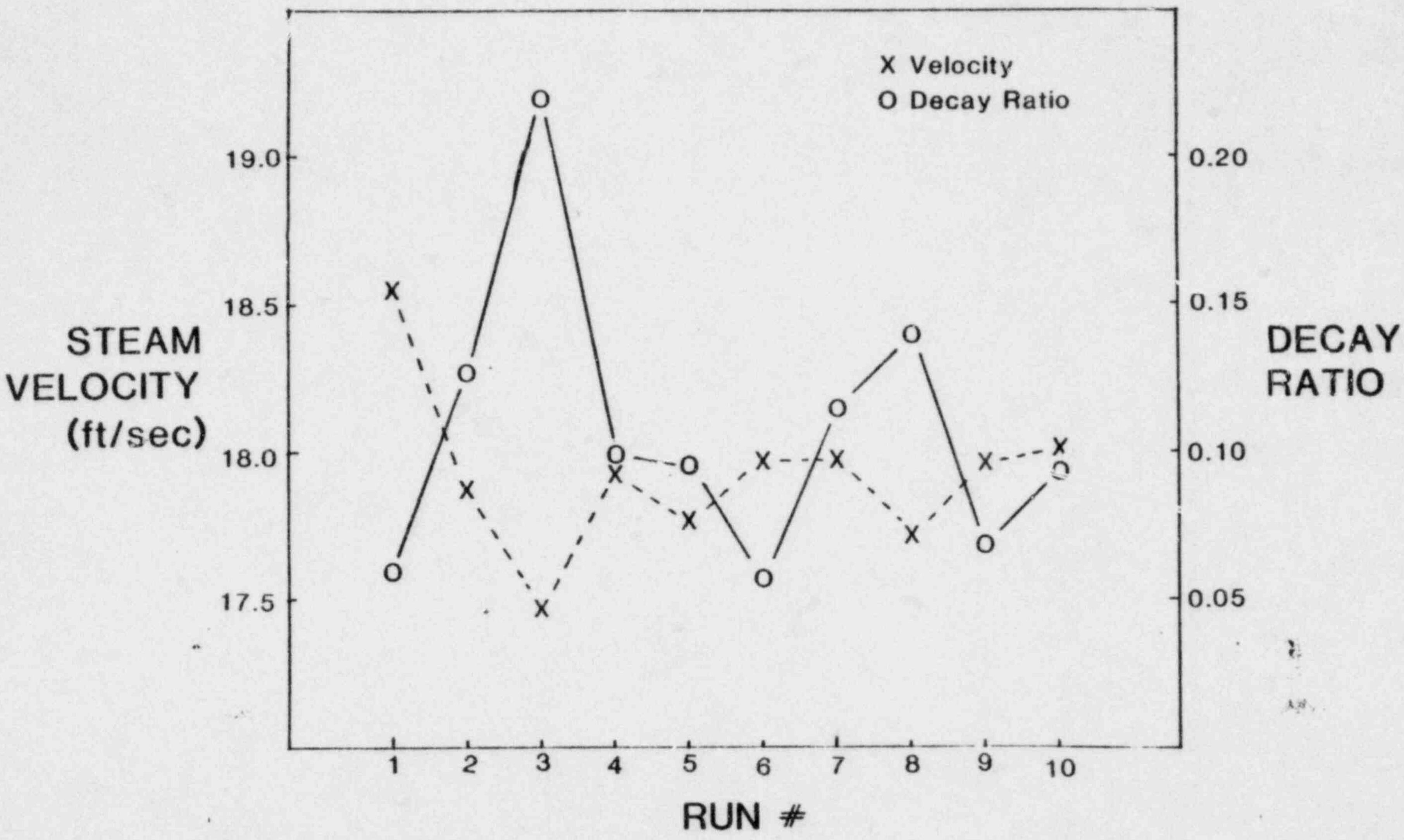
THEREFORE,

DECAY RATIO SHOULD DECREASE AS STEAM VELOCITY INCREASES

THE DECAY RATIO OBTAINED FROM NOISE ANALYSIS IS INVERSELY PROPORTIONAL TO STEAM VELOCITY



WE ALSO OBSERVE THAT THE DECAY RATIO OBTAINED FROM NOISE ANALYSIS IS OUT-OF-PHASE WITH THE STEAM VELOCITY



FROM THESE STUDIES, WE CONCLUDE THAT

- NOISE ANALYSIS CAN BE EFFECTIVE FOR DETECTING TRENDS IN STABILITY

AND

- THAT UNIVARIATE TIME-SERIES ANALYSIS OF THE NOISE SIGNAL IS FEASIBLE FOR ON-LINE MONITORING

FURTHERMORE

IT IS POSSIBLE THAT FURTHER TESTING MAY SHOW THAT THIS METHOD MAY BE A VIABLE ALTERNATIVE TO PERTURBATION TESTS FOR QUANTITATIVE MEASUREMENT OF STABILIT