MMTO Conversion Internal Technical Memorandum #00-2

Smithsonian Institution &
The University of Arizona

MMT f/9 Secondary,

Fan Balancing Requirement

B. Cuerden

February 21, 2000

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February 21, 2000

MEMORANDUM

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To: S. West cc: R. Allen

FROM: Brian Cuerden
Technical Services

SUBJECT: MMT f/9 Secondary, Fan Balancing Requirement

Summary:

It is proposed to use a Kanalflackt K6 fan coupled to a Lytron 6310-G3-AN heat exchanger for the thermal control system of the f/9. The fan must be balanced to a disturbance force of less than 0.075 lbs to limit the wavefront distortion to less than 0.2 μ-inch verses an allowable tilt of 1.3 μ-inch/39" = 0.033 μ-rad or 0.007 arc seconds.

Discussion:

The fan-heat exchanger unit consists of a Kanalflackt K6 fan coupled to a Lytron 6310-G3-AN heat exchanger. This assembly is similar to that used in the 6.5 m polishing cell and is expected to weigh approximately 18 lbs (the measured weight of a 6.5 m unit is 18.9 lbs using a Kanalflackt K8/10 fan). The unit will be mounted on three wire rope isolators (McMaster Carr P/N 62225K5) which have axial and lateral stiffness of 208 and 67 lb/in. Accounting for the rocking effect of the cantilevered assembly, the expected lateral resonance occurs at 8 Hz. The static deflection due to 1 g lateral is 0.18".

A spring mass model of the fan assembly was added to a model of the f/9 shroud assembly. This model includes stiffness representing the headring and stiffness and mass representing the hexapod and secondary assemblies. A unit lateral disturbance was applied at the fan CG over the frequencies from 1 to 200 Hz. Trnslational and rotational responses of the secondary assembly are plotted in figures 1 and 2. The response of the fan assembly is plotted in figure 3.

Results:

The fan speed is 2680 rpm (45 hz). Translational and rotational responses of the mirror at this frequency are entered in Table 1, converted to wavefront tilt equivalents, and compared to 10% of the structure function allowable at zenith. The amplitude of the fan input is set at a level that drives the net response to the allowable level. This amplitude becomes the fan balance requirement.

Table 1 Wavefront Vibrational Response Verses Allowable Vibration

Response Directior	Resp to Unit Input	Resp to 0.075# Input	Equiv P-V Height Diff	Allowable Ht Diff	Fraction of Allowable
Translational	4.00E-07	3.00E-08	2.12E-08	1.40E-07	0.15
Rotational	2.00E-08	1.50E-09	1.17E-07	1.40E-07	0.84
			Net Response =		0.99

Allowable vibration is taken to be 10% of the zenith pointing structure function allowable (1.4E-6 inches across the mirror). This converts to a mirror tilt of 0.7 μ- inch/39" = 0.018 μ-rad or 0.0036 arc-sec.

Table 2 Wavefront Vibrational Response Verses Allowable Vibration

Using softer M/C 62225K4 Isolators (Kshear = 33.3 lb/in, Kax = 100 lb/in)

Response Directior	Resp to Unit Input	Resp to 0.15# Input	Equiv P-V Height Diff	Allowable Ht Diff	Fraction of Allowable
Translational	2.00E-07	3.00E-08	2.12E-08	1.40E-07	0.15
Rotational	1.00E-08	1.50E-09	1.17E-07	1.40E-07	0.84
			Net Response =		0.99

ANSYS

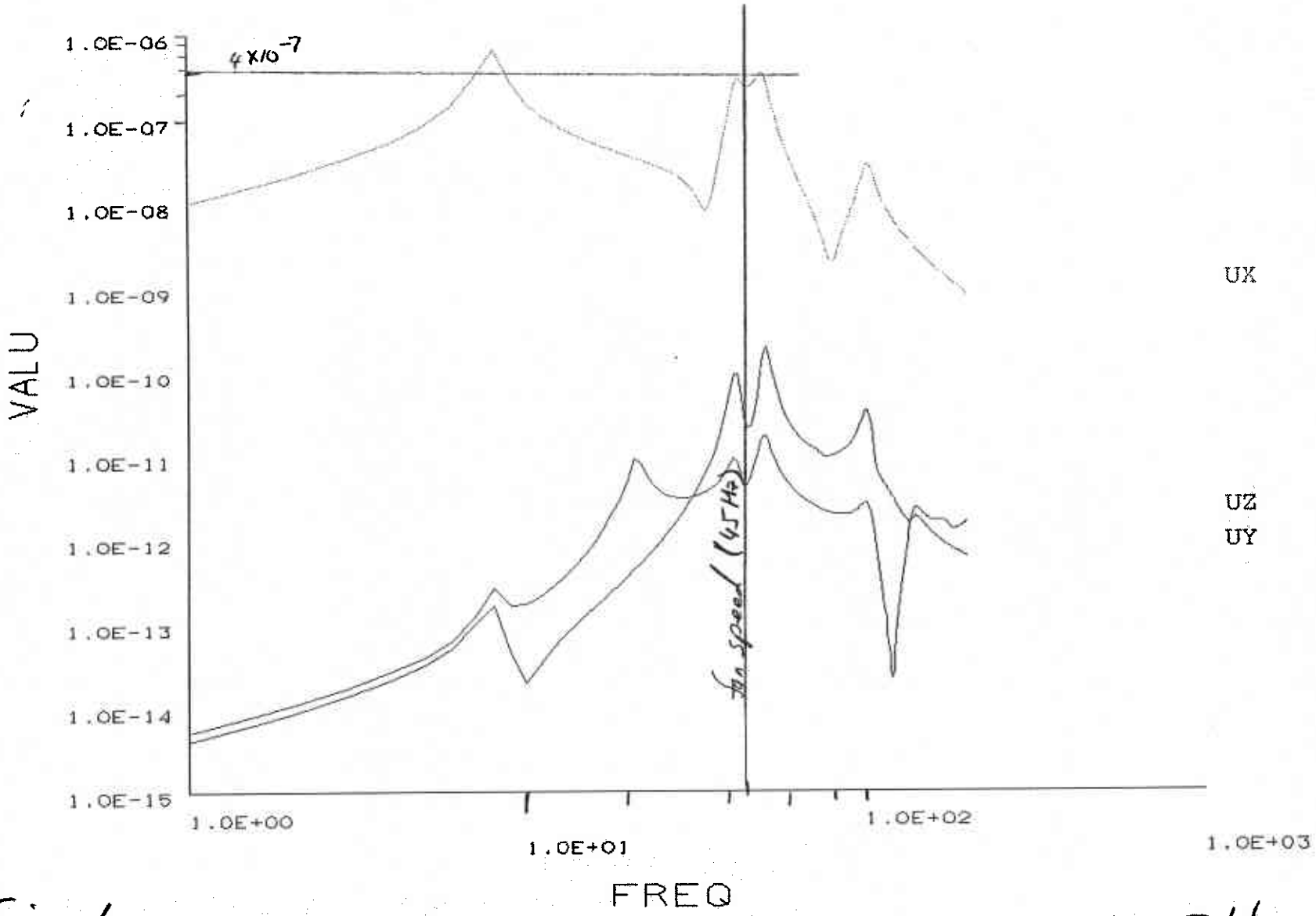

Figure 1
Translational Response to unit Fx Disturbance

K5 Isolators

ANSYS

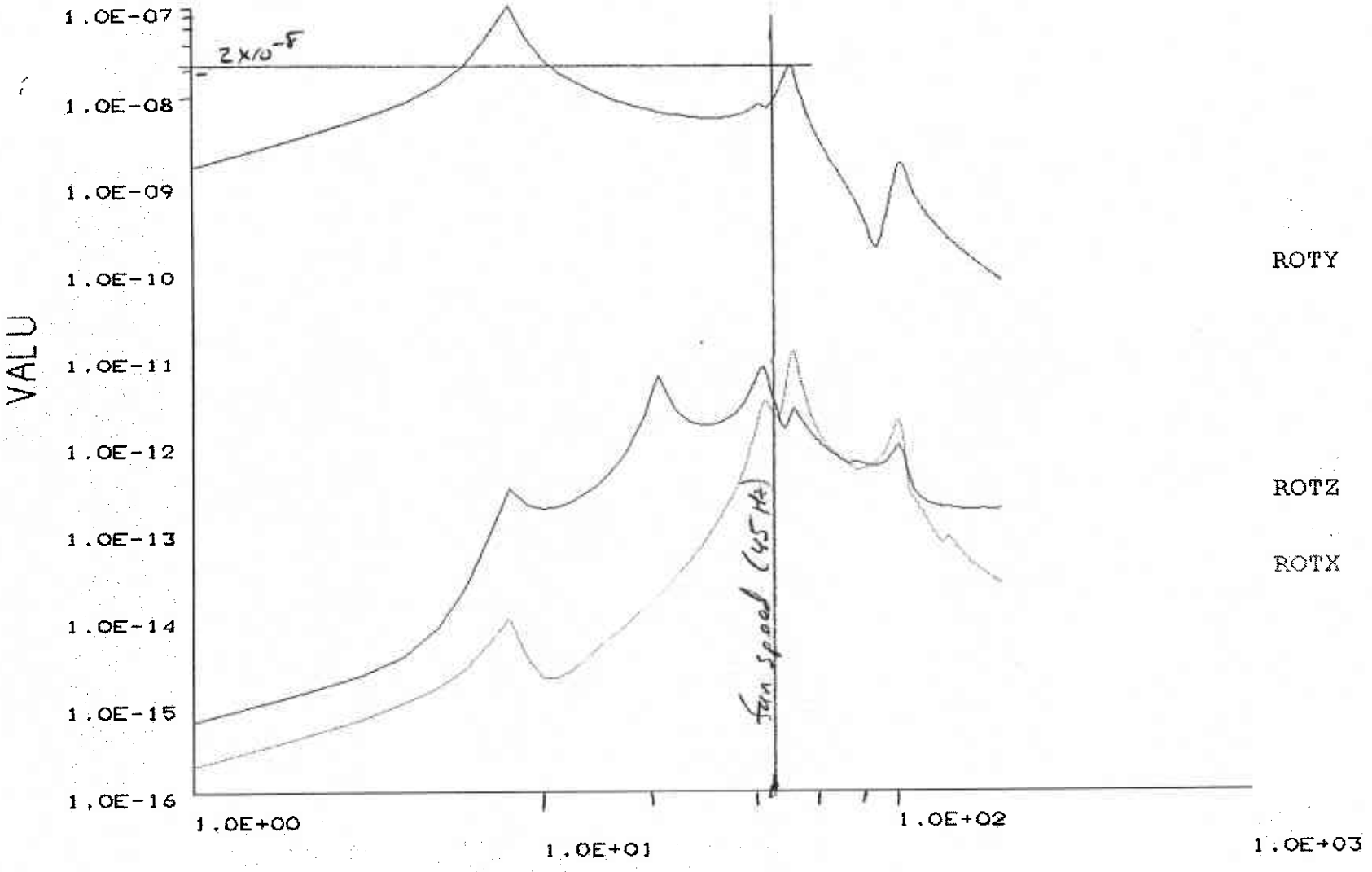

Figure 2
Rotational Response to unit Fx Disturbance

(K5 isolators
Kchar = 67 lb/in
Kax = 205 lb/in)

ANSYS

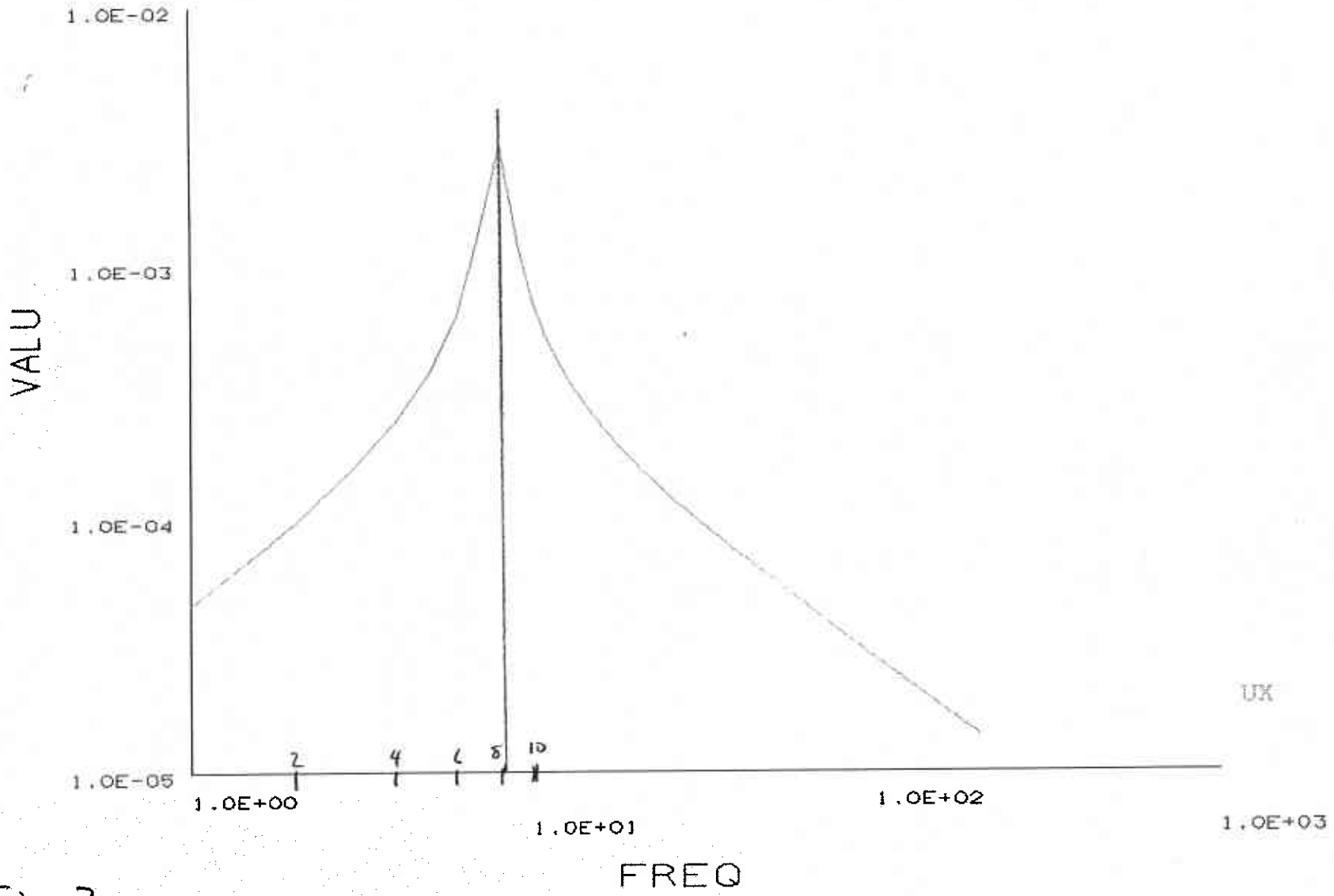

Figure 7
Translational Response at input point

K5 Isolators

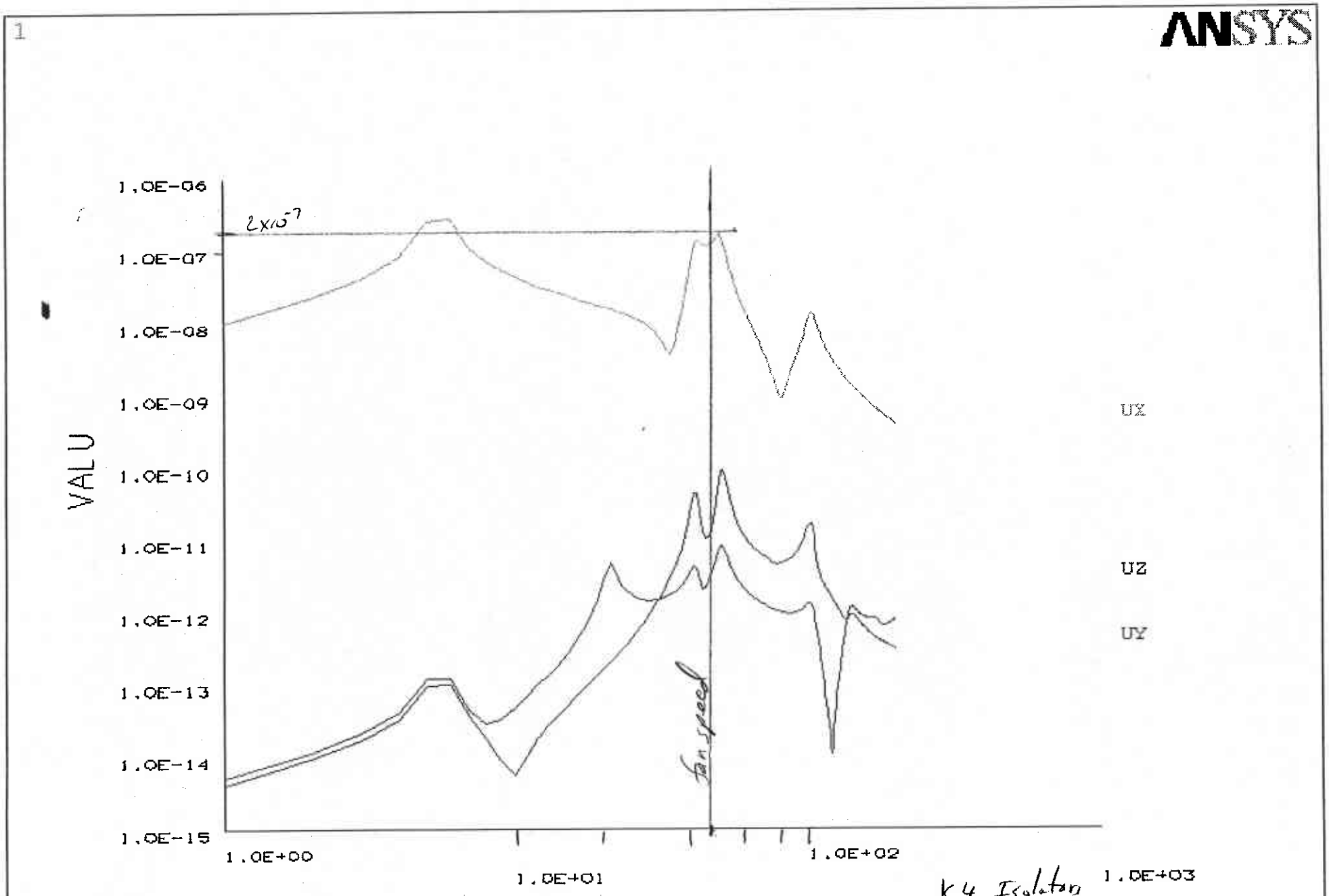

Figure 4
Translational Response to unit Fx Disturbance

ANSYS

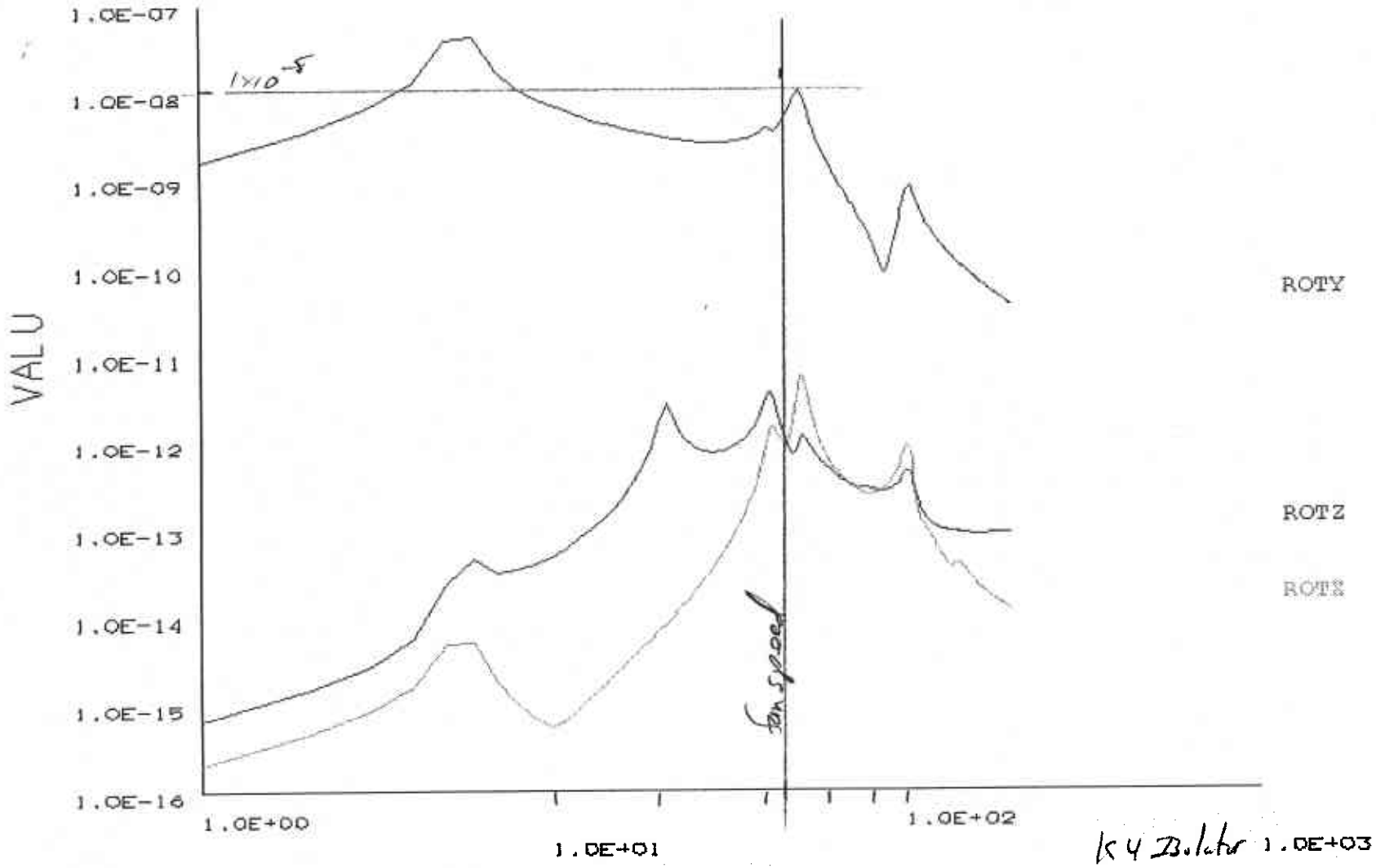

Figure 5

Rotational Response to unit Fx Disturbance

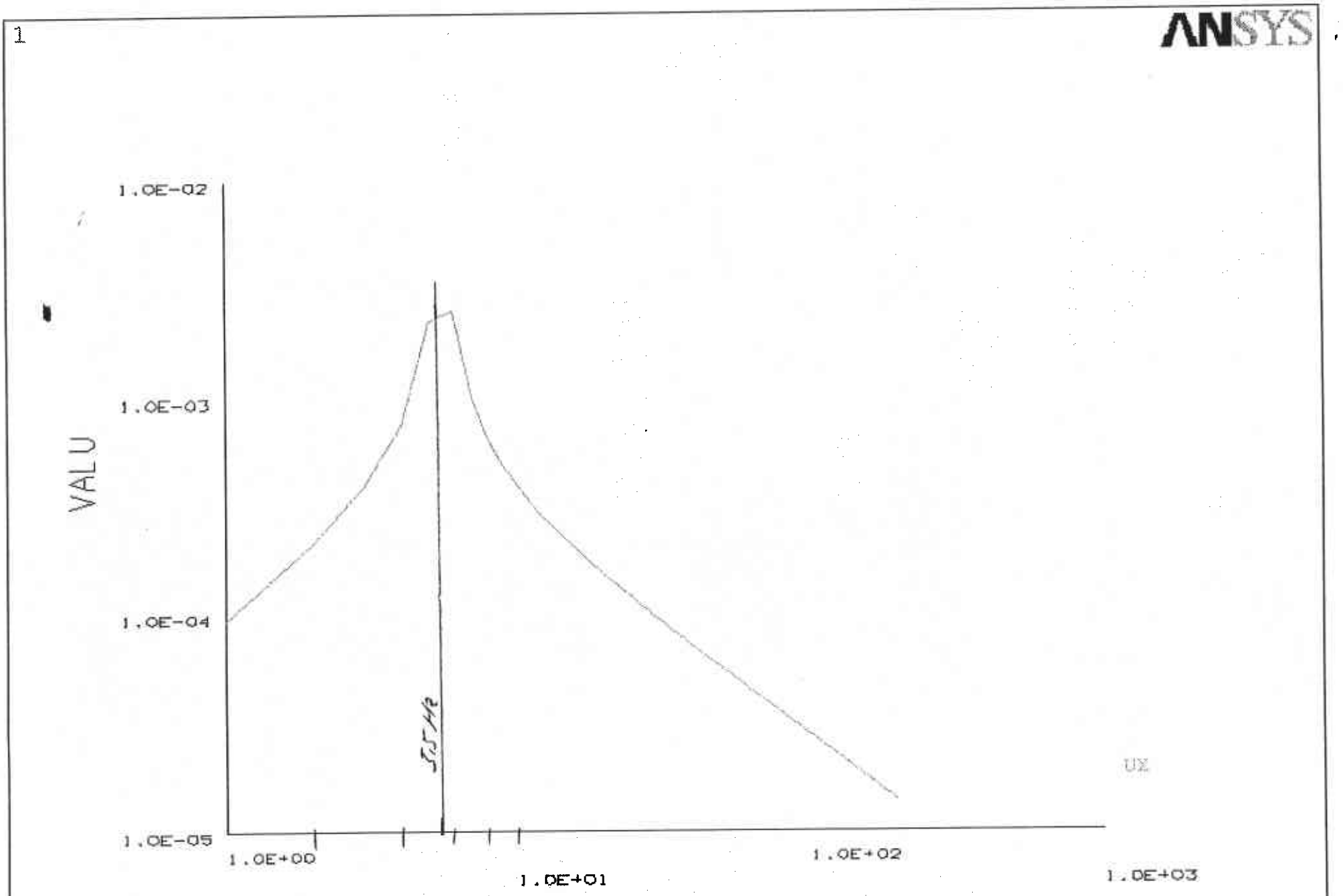

Figure
K4 Isolators

Translational Response at input point

Addendum: Fan Balancing

Heinz Balancing Systems Inc
9620 Topanga Cyn Pl Unit E
Chatsworth, CA 91311

~~818-341-3313~~
No longer listed

Per S. West, feasible balance level is 7.6 gm-mm = 0.000659 lb-in

$$F=(.000659/g)*(44.67*2*\pi)^2 = 0.134 \text{ lbs}$$

Foster Electric Motor Service
490 E Frye Road
Chandler, AZ 85225

Tim (outside sales)
Marty – ship attn: of

$55/hr for fan balancing, est ¾ to 2 hrs to balance each of two fans.