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SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
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SANDIA SYSTEMATIC DECLASSIFICATION REVIEW

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SOME COMPUTATIONS ON PITCH-OFF ANGLES OF UNSTABLE RETARDED TX-28 SHAPES PRIOR TO PARACHUTE DEPLOYMENT

James F. Reed

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ABSTRACT

Calculations are presented to show that the Retarded TX-28 store will have unsatisfactory release characteristics prior to parachute deployment unless a reasonably stable shape is employed. Even if a satisfactory release can be achieved an angle of attack of 30° at parachute snatch load is more realistic than the 15° formerly employed.

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SOME COMPUTATIONS ON PITCH-OFF ANGLES OF UNSTABLE RETARDED TX-28 SHAPES PRIOR TO PARACHUTE DEPLOYMENT

INTRODUCTION

The retarded version of the TX-28 bomb must, by necessity of ground clearance on the carrier airplane, be equipped with much less fin area than the conventional weapon. The fins to be used will depend on aircraft compatibility, ground clearance, and stability requirements prior to parachute deployment. This paper is an attempt to clarify these stability requirements in the light of present knowledge. A wind tunnel program scheduled for late November 1956, will yield stability derivatives of various stub fin configurations on the Retarded 28 and another program in February 1957, is designed to obtain actual drop information using scale model F-105 airplane and bombs. A program in April 1957, using a scale model F-100C airplane should give separation data from external drops.

DISCUSSION

To obtain a feeling for the angle of pitch achieved by an unstable store, such as the retarded TX-28 with no fins or with inadequate fins, a series of computations have been made and are presented as Figure 1. In lieu of stability information on the retarded TX-28 shape, some stability derivatives were chosen from wind tunnel tests of the external TX-28 with no fins. The static stability parameter, $\frac{\partial C_m}{\partial \alpha}$ referred to in Figure 1, is defined as the slope of the pitching moment curve C_m, versus angle of attack, α.

C_m can be described as

$$C_m = \frac{M}{q\,s\,\ell}$$

where M = restoring or pitching moment

q = $1/2\rho v^2$ dynamic pressure

s = characteristic area of the store

ℓ = characteristic length of the store

It can be seen that, if $\frac{\partial C_m}{\partial \alpha}$ is positive, an increase in angle of attack yields an increase in destabilizing moment and the store is thus statically unstable. Such will be the case of the retarded TX-28 unless enough fin area with a large enough moment arm from the store center of gravity can be used.

Figure 1 shows the effect of the pitching moment curve slope, $\frac{\partial C_m}{\partial \alpha}$, on on the time required for an unstable store to pitch to any given angle. The curves designated by $\frac{\partial C_m}{\partial \alpha}$ = .10 are considered most representative of the Retarded 28 with no fins. Pertinent assumptions were: store moment of inertia, 367 slug-ft^2, release Mach number 0.95, release altitude, 1000 ft. giving a dynamic pressure, q, of 1287 psf. In addition for the three solid curves an initial angle of attack of one degree was assumed because, theoretically, any store at 0° would never pitch away from that angle unless disturbed. This angle was chosen small, which is optimistic. In actual flight such a small initial angle may be difficult to achieve. The fourth curve on the graph is predicated on the same $\frac{\partial C_m}{\partial \alpha}$ as the center curve

of the other three, but, instead of the initial static pitch assumed an initial pitching velocity of one-half radian per second. Such a rate might be imparted by an ejector pushing off the center of gravity or a curved flow field near the airplane. As can be seen, even this very low initial pitching rate has an appreciable effect on the time required to reach a given angle.

Figure 1 therefore shows that the Retarded 28 with no fins will achieve pitch angles of approximately 45° in the first 0.5 second after release. It should be noted from this study that if the store is significantly unstable at low angles, it achieves a large pitching velocity which then cannot be adequately changed by a less destabilizing moment characteristic of the store at large angles of attack. This can be seen from Figures 2 and 3. These figures show the effect of a reduced instability as extrapolated from wind tunnel data on the TX-28 with no fins. As can be seen, the greatly decreased instability evidenced by the TX-28 store at large angles produced no appreciable delay in time to reach a given angle.

Figure 4 presents some corroborating data obtained from the Parachute Test Vehicle developed by Division 5141. These drops were made from the F7U aircraft under the conditions indicated on the graph. The Mach number, dynamic pressure and store moment of inertia should be noted in particular. All three of these items on the indicated drops would tend to markedly decrease pitching rates from those achieved in the same time under the conditions assumed for Retarded 28 release. An important point to note

is that the store continues to pitch after initiation of deployment until the main parachute load is realized. This may mean times as great as one second after release from aircraft before any stabilizing action manifests itself.

CONCLUSIONS

The conclusions which can be reached on the basis of the above computations are the following:

1) The Retarded TX-28 without fins will experience angles in excess of 45° at 0.5 seconds after release.
2) Marginally stable stores may yield satisfactory release characteristics. Further work is being conducted to clarify this point.
3) In view of the fin limitations on the Retarded TX-28, it is felt that an angle of attack of 30° at time of parachute snatch load (0.4 to 0.5 seconds after initiation of parachute deployment) is a more realistic design criterion than the 15° formerly considered.

J. F. REED - 5144

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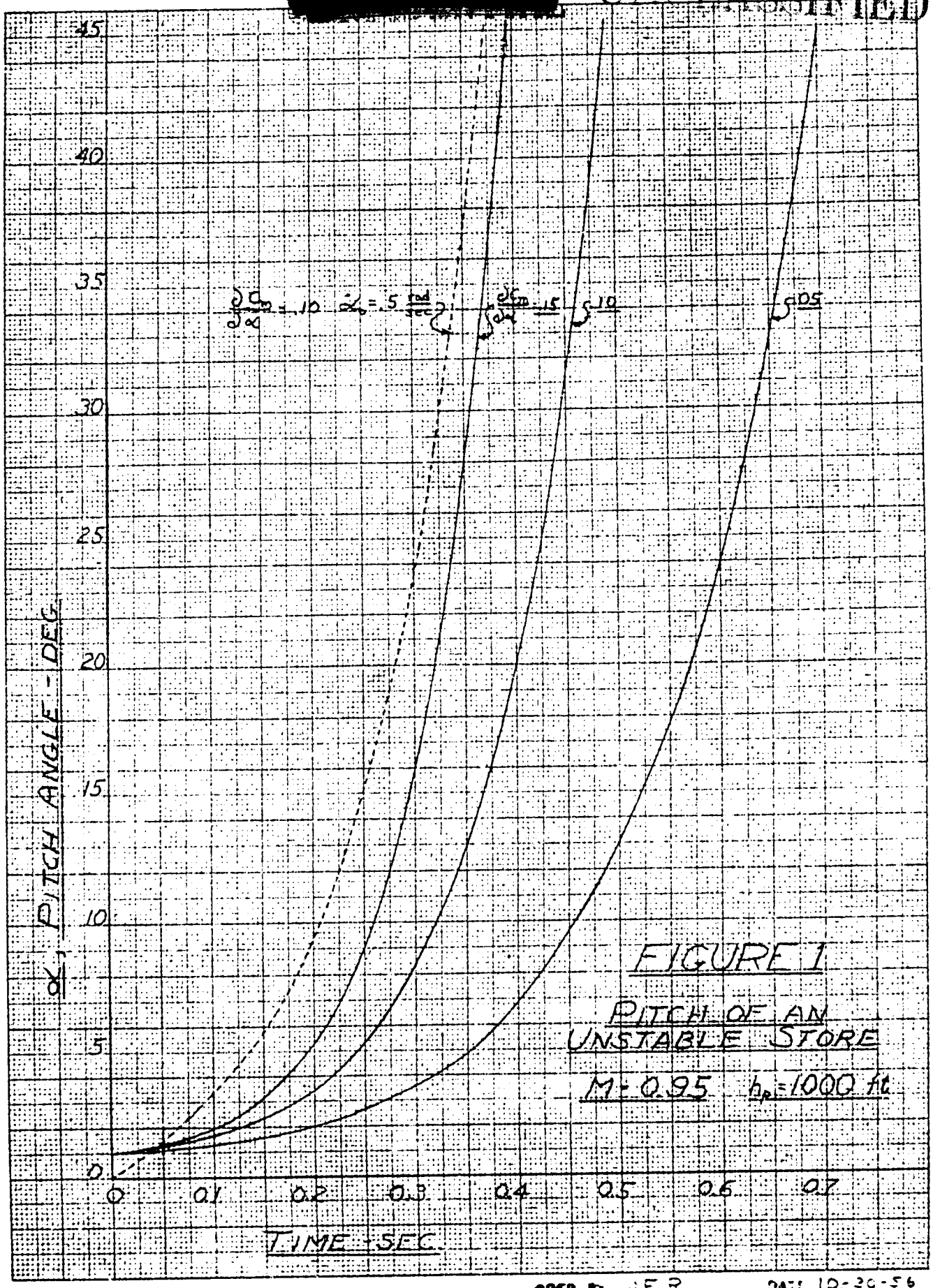

FIGURE 1

PITCH OF AN UNSTABLE STORE

M = 0.95 h_p = 1000 ft

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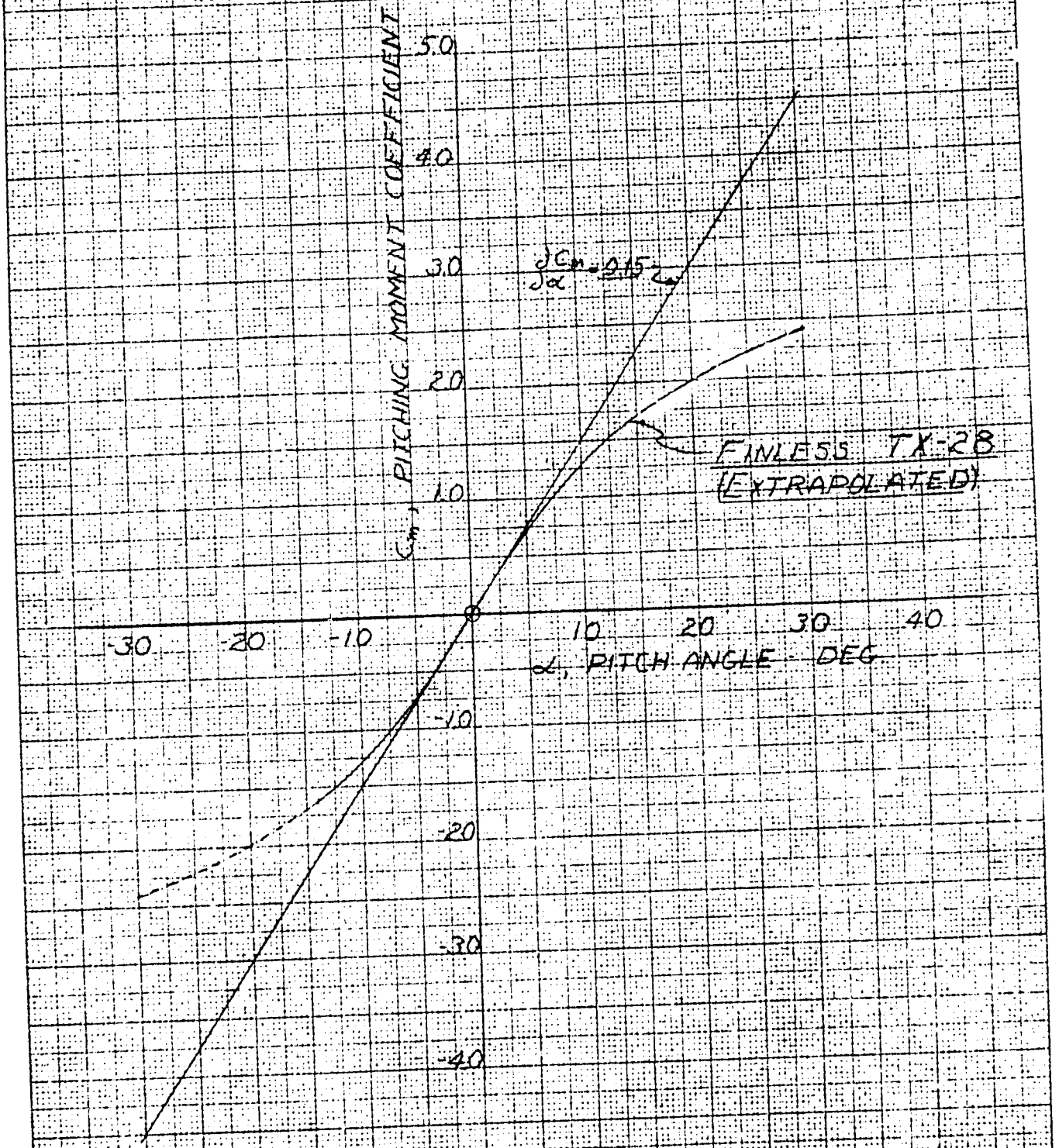

FIGURE 2

COMPARISON OF LINEAR PITCHING MOMENT SLOPE WITH FINLESS TX-28 (EXTRAPOLATED)

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EFFECT OF PITCHING MOMENT CURVE LINEARITY ON PITCH ANGLE

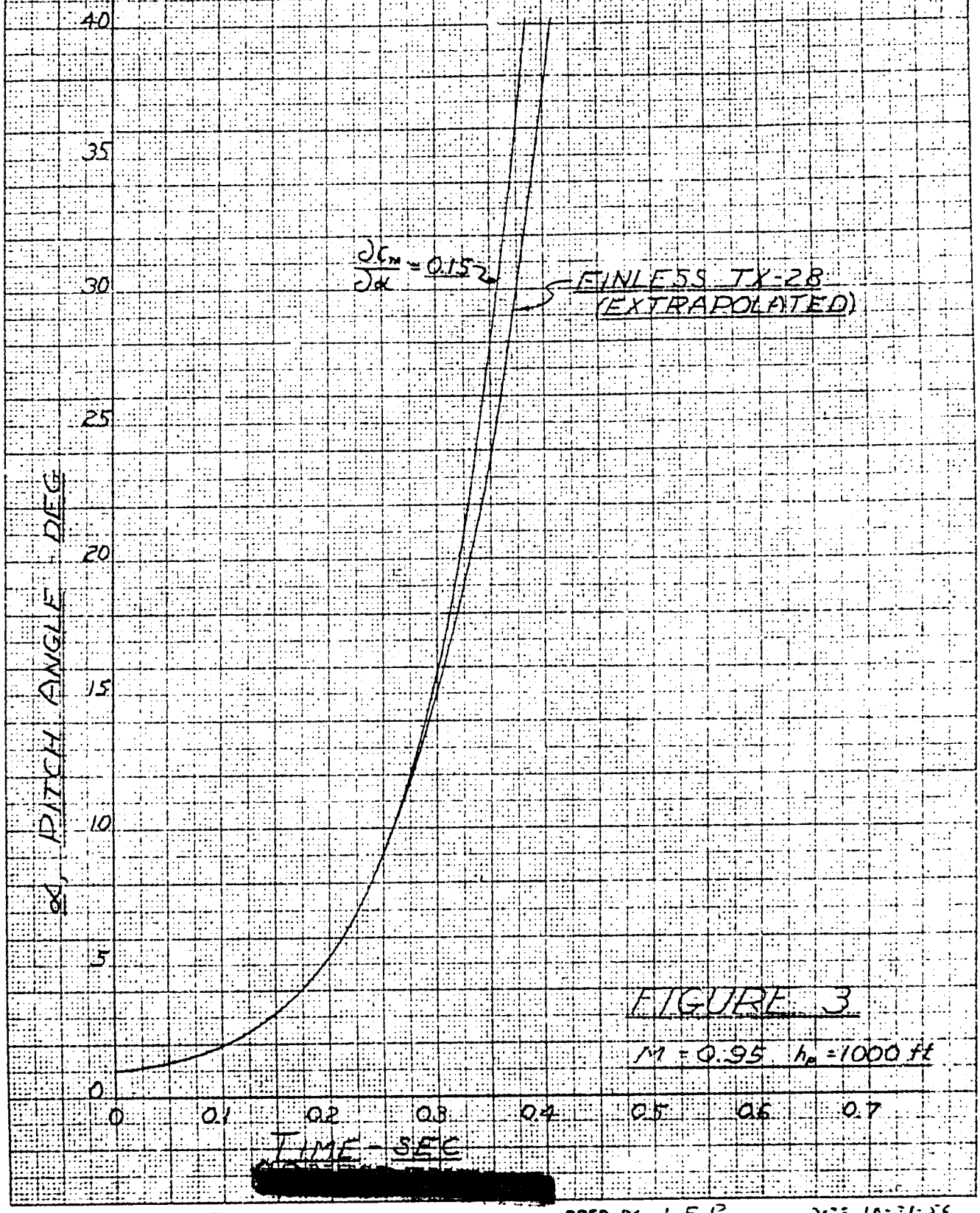

FIGURE 3

$M = 0.95$ $h_p = 1000$ ft

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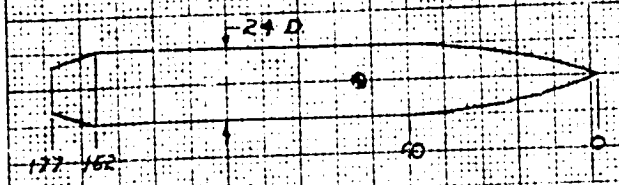
ANGLE vs. TIME FOR UNFINNED PARACHUTE TEST VEHICLE. MACH .727 q = 745 psf



DROP	MI	c.g.
RP-31	993 - slug-ft²	77.8"
RP-146	971 - slug-ft²	76.9"

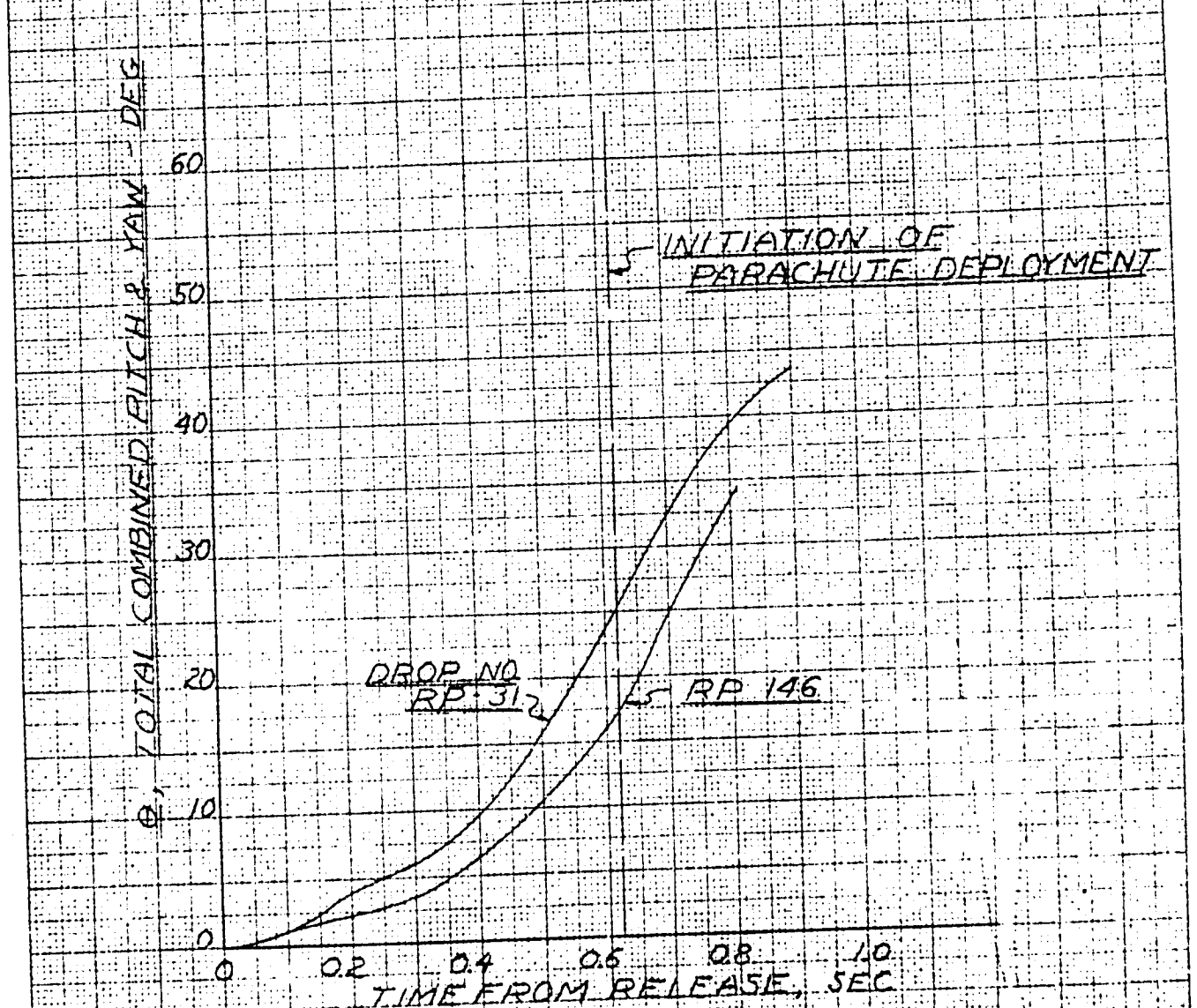


FIGURE 4

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