NASA TECHNICAL MEMORANDUM

NASA TM X-74009

NASA TM X- 74009

(NASA-TM-X-74009) LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AERODYNAMIC CHARACTERISTICS OF AN UNPOWERED ESCAPE SYSTEM EXTRACTION ROCKET MODEL (NASA) 26 p HC A03/MF A01 CSCL 01A G3/02

N77-20025

Unclas 22834

LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AERODYNAMIC CHARACTERISTICS OF AN UNPOWERED ESCAPE SYSTEM EXTRACTION ROCKET MODEL

by

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March 1977

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER, HAMPTON, VIRGINIA 23665

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM X-74009		

4. Title and Subtitle	5. Report Date
LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AERODYNAMIC CHARACTERISTICS OF AN UNPOWERED ESCAPE SYSTEM EXTRACTION ROCKET MODEL	March 1977
	6. Performing Organization Code
7. Author(s) Jarrett K. Huffman, Charles H. Fox, Jr., and Robert E. Satterthwaite	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address NASA Langley Research Center Hampton, VA 23665	11. Contract or Grant No.
	13. Type of Report and Period Covered Technical Memorandum
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

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17. Key Words (Suggested by Author(s))	18. Distribution Statement
Longitudinal aerodynamics Lateral-directional aerodynamics High angle of attack data Subsonic Flow Rockets Missiles	Unclassified-Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	23	$3.50

* For sale by the National Technical Information Service, Springfield, Virginia 22161

ABSTRACT

An escape system extraction rocket proposed for use on the Rotor Systems Research Aircraft was tested at Mach numbers of 0.1 and 0.3 through an angle-of-attack range from -2° to 102° and an angle-of-sideslip range from 0° to 15° in the Langley 7- by 10-foot high speed tunnel. The data are presented without analysis in order to expedite publication.

INTRODUCTION

The Rotor Systems Research Aircraft is a combined effort of the U.S. Army and NASA. An emergency escape system for this aircraft was proposed using an extraction rocket for each personnel station. A hot gas launch system attached to the aircraft would initiate the separation of the extraction rocket from the aircraft. A wind tunnel test program was initiated to obtain static aerodynamic data for input to a digital computer simulation of the rocket and extracted crewman trajectory.

It is the purpose of this report to present, without analysis, the static aerodynamic characteristics of this proposed extraction rocket. The investigation was conducted in the Langley 7- by 10-foot high speed tunnel at Mach numbers of 0.1 and 0.3 which correspond to Reynolds numbers based on model reference diameter of 0.15×10^6 and 0.475×10^6, respectively. The angle-of-attack range was from -2° to 102° and the angle-of-sideslip range was from 0° to 15°.

SYMBOLS

The International System of Units, with the U.S. Customary Units presented in parentheses, is used for the physical quantities in this report. (See reference 1). Measurements and calculations were made in the U.S. Customary Units. The data presented in this report are referred to the body axis system as indicated in figure 1.

b model reference span, .0762 m (.25 ft)

C_A axial force coefficient, $\frac{\text{Axial Force}}{qS}$

C_l rolling moment coefficient, $\frac{\text{Rolling Moment}}{qSb}$

C_m pitching moment coefficient, $\frac{\text{Pitching Moment}}{qSd}$

C_N normal force coefficient, $\frac{\text{Normal Force}}{qS}$

C_n yawing moment coefficient, $\frac{\text{Yawing Moment}}{qSb}$

C_Y side force coefficient, $\frac{\text{Side Force}}{qS}$

d model reference diameter, .0762 m (.25 ft)

M free stream Mach number

q free stream dynamic pressure, Pa(lbs/ft^2)

S	model reference area, .00456 m^2 (.049087 ft^2)
α	angle of attack, degrees
β	angle of sideslip, degrees

DESCRIPTION OF MODEL

A full scale unpowered model was used in this study. A drawing of the model is shown in figure 1.

The model consisted of a nose, which incorporated the rocket nozzles, and a cylindrical center body, which was attached to a strain-gage balance.

The nose could be set at different roll angles relative to the centerbody. Since the centerbody was axisymmetric, the roll attitude of the nose was used to define the roll orientation of the model.

APPARATUS, TESTS, AND CORRECTIONS

This investigation was made in the Langley 7- by 10-foot high speed tunnel which is a continuous flow atmospheric tunnel. Forces and moments were measured by an internally mounted six-component strain-gage balance. The pitch attitude of the model was measured by an accelerometer mounted within the model. The pressure in the balance chamber was also recorded, however no corrections were made to the data for chamber pressure.

The test was conducted at Mach number of 0.1 and 0.3 which correspond to Reynolds numbers of 0.15×10^6 and 0.475×10^6 based on d. The angle-of-attack range was from -2° to 102° and the angle-of-sideslip range was from 0° to 15°.

Two major test setups were employed during the test. For the angle-of-attack range from -2° to 22°, the combined alpha and beta was obtained using combinations of sting pitch and sting yaw. The sting entered the model through the open base of the model.

The second test setup achieved combined alpha and beta using combinations of sting pitch and model roll. This setup divided the pitch angle into three overlapping ranges of 33° to 57°, 55.5° to 79.5°, and 78° to 102°. The model roll angle was chosen for the midpoint of each pitch range. Since the sideslip was achieved through a fixed model roll for each pitch range, the sideslip angle was not constant. The sting entered the model through an opening in the top of the centerbody.

The base of the model was plugged; however, no base pressures were measured. Note that the test technique employed for each pitch range was to start with the model at the midpoint of the range, then proceed to the lower limit of the range and take data as the pitch angle was increased to the upper limit of the range.

PRESENTATION OF RESULTS

The longitudinal characteristics are presented in figure 2. The lateral-directional characteristics are presented in figure 3. The chamber pressure characteristics are presented in figure 4.

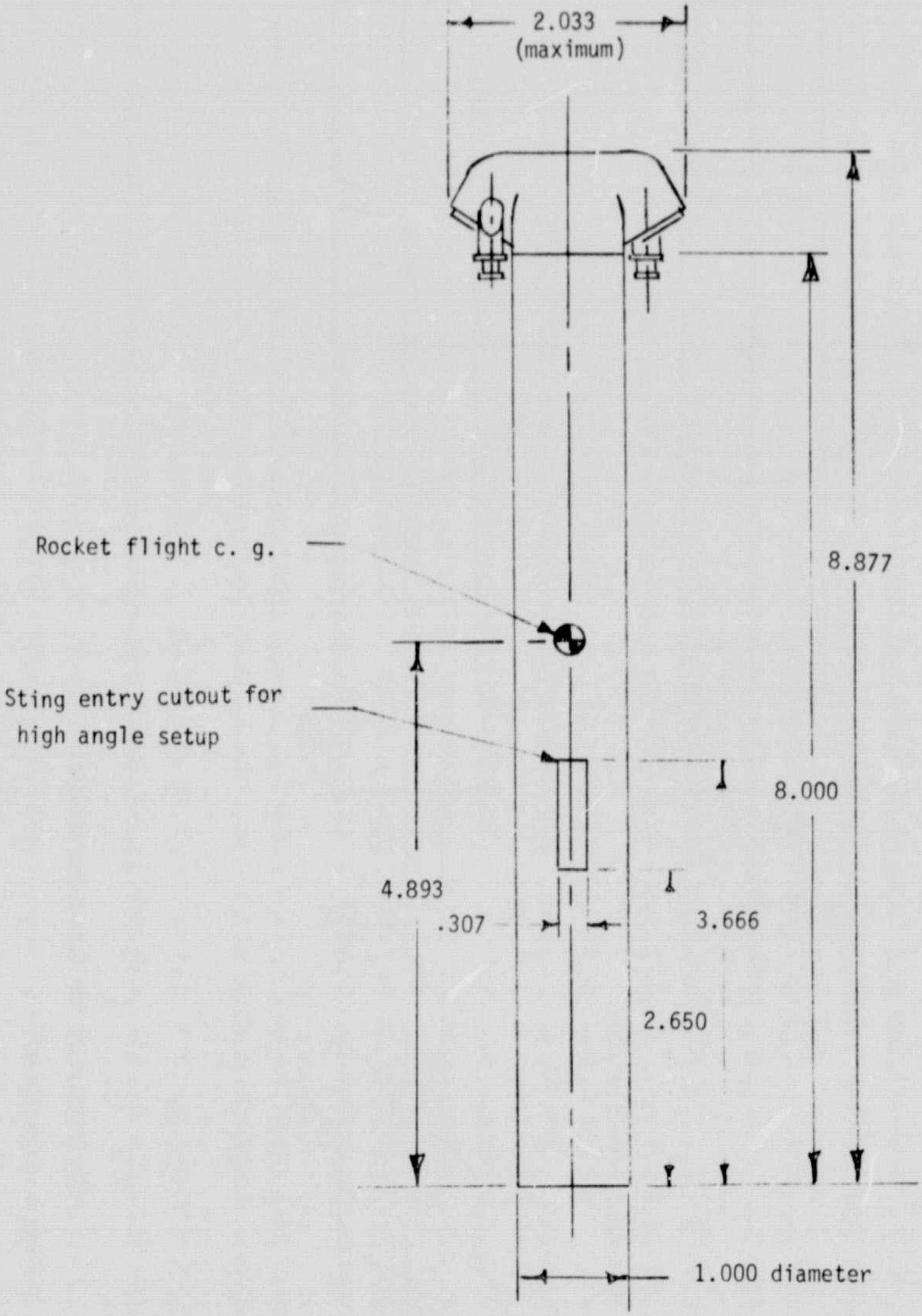
Note that, due to the test technique employed, there may be anomalies between the data in the overlapped pitch range. These anomalies are real and result from the fact that, in one case the overlap region was presumably approached with attached flow on the model, whereas in the other case, the overlap region was presumably approached with separated flow on the model.

The differences between the data at a Mach number of 0.1 and at a Mach number of 0.3 are attributable primarily to Reynolds number effects. (See reference 2.)

REFERENCES

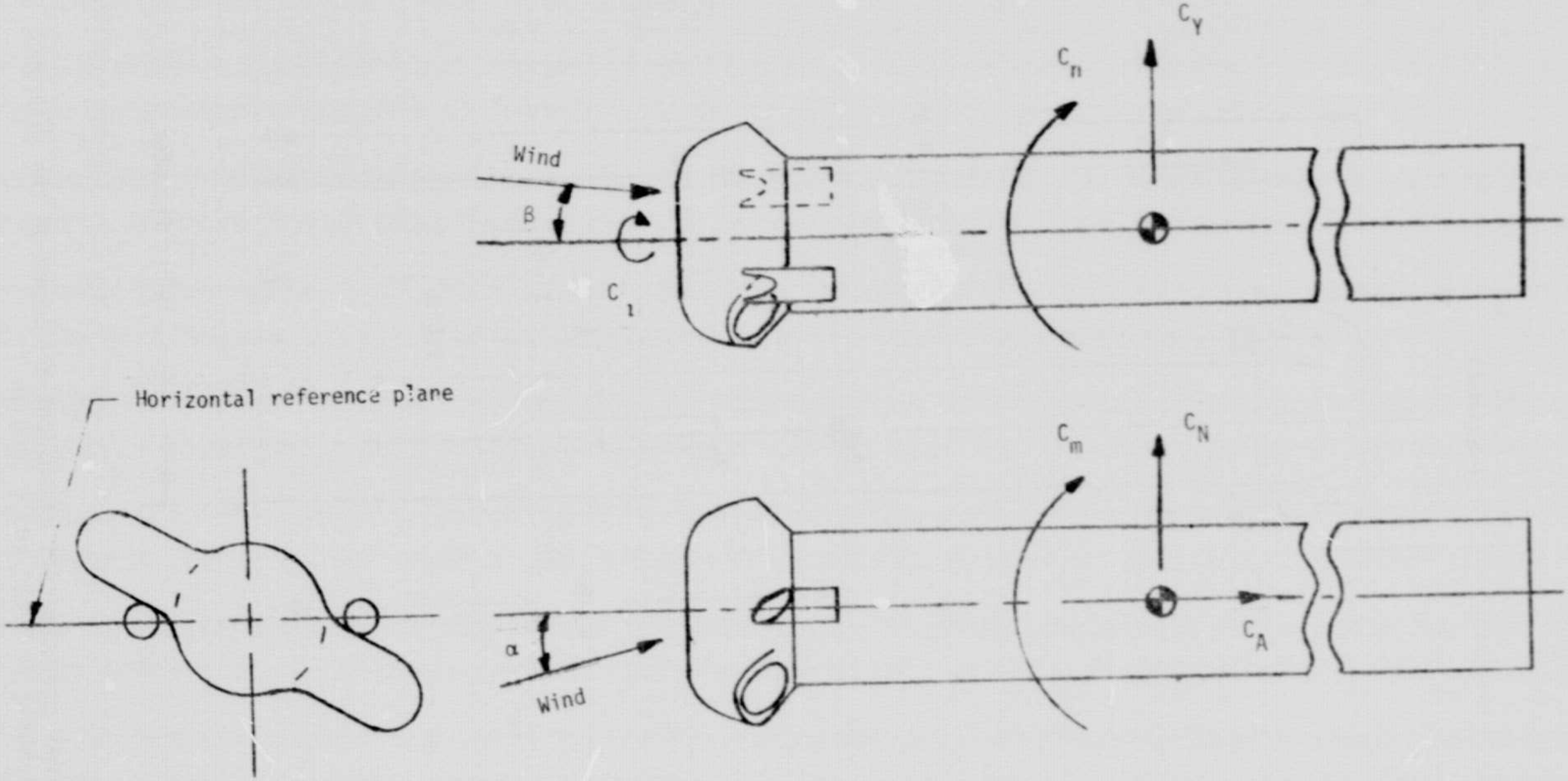
1. Mechtly, E. A.; The International System of Units NASA SP-7012, 1964.

2. Polhamus, Edward C.; Effect of Flow Incidence and Reynolds Number on Low-Speed Aerodynamic Characteristics of Several Noncircular Cylinders with Applications to Directional Stability and Spinning NASA TR R-29, 1959.



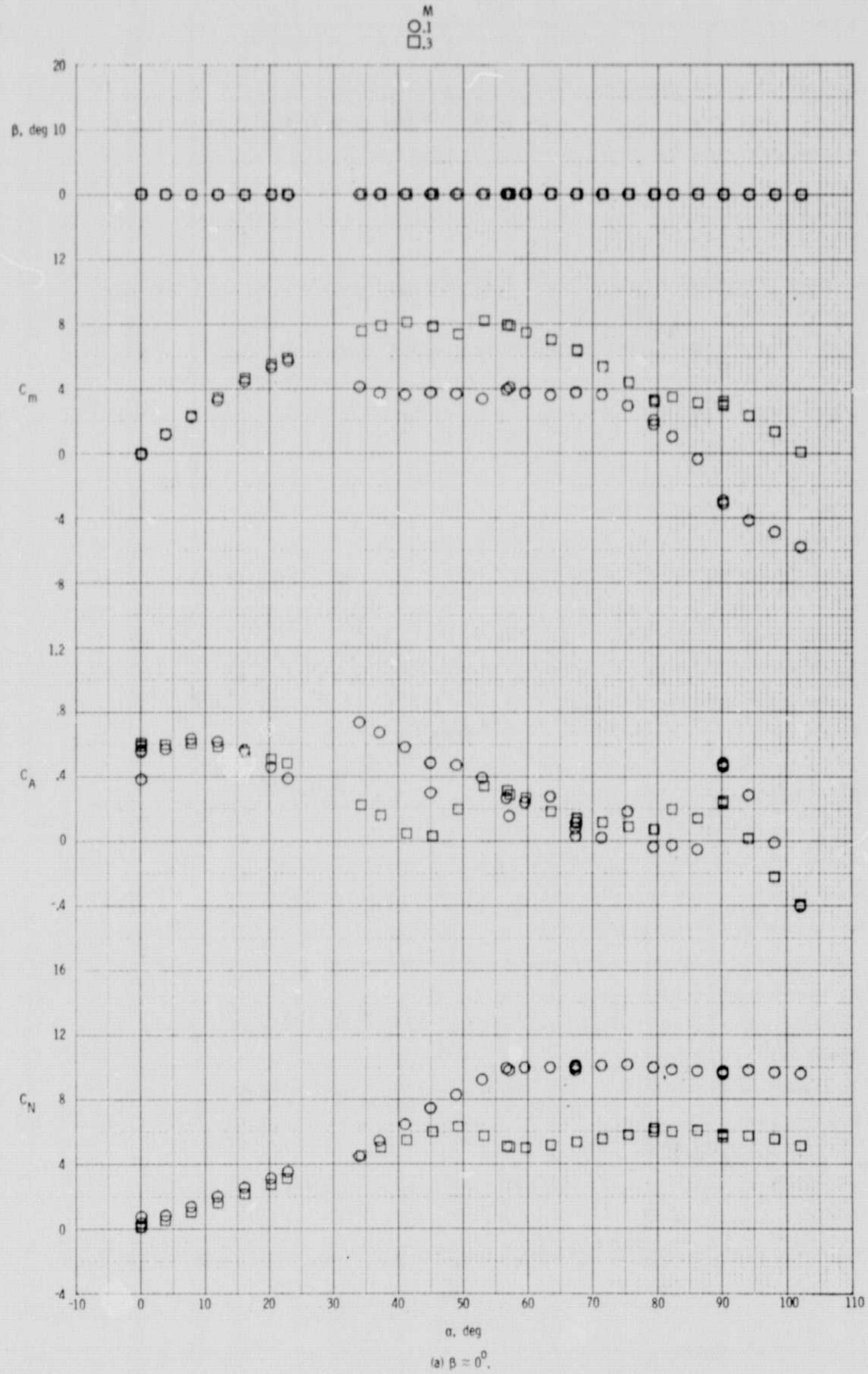
(a) Model geometry. All dimensions are based on the reference diameter of 7.620 cm. (3.000 in.)

Figure 1. Drawings of the model tested.



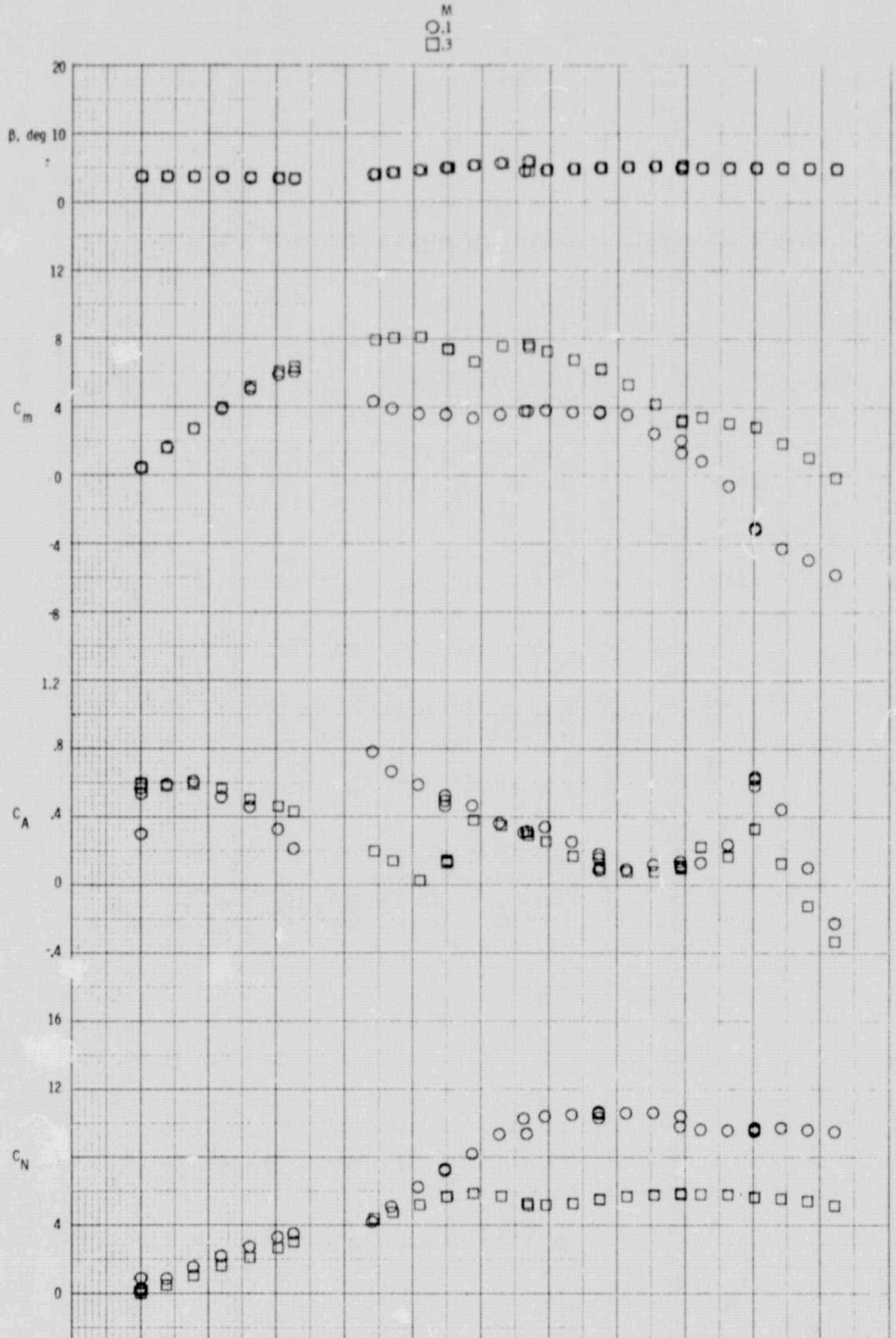
(b) Axis system for forces and moments.

Figure 1. Concluded.



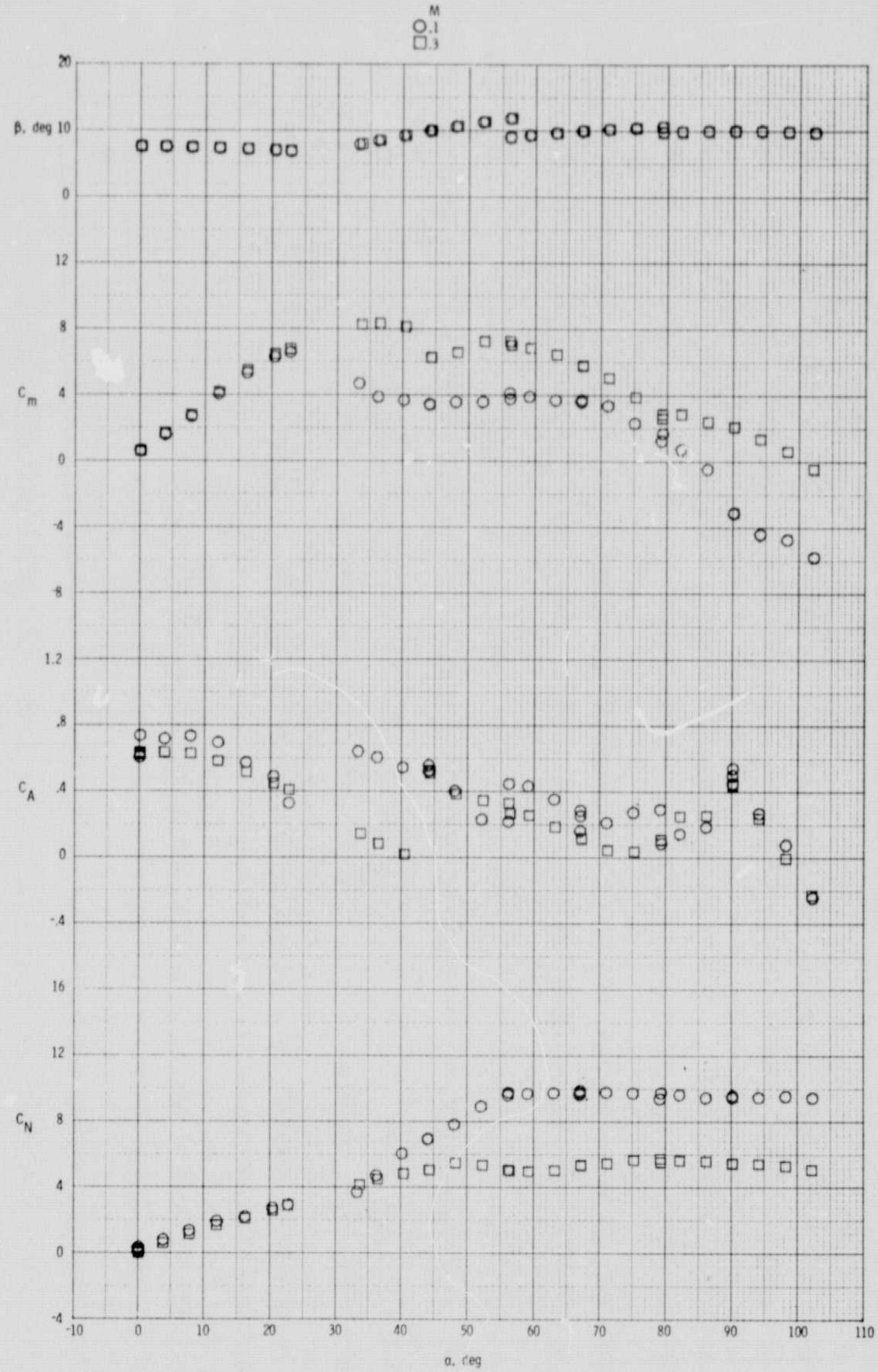
(a) $\beta = 0^0$.

Figure 2- Longitudinal aerodynamic characteristics.



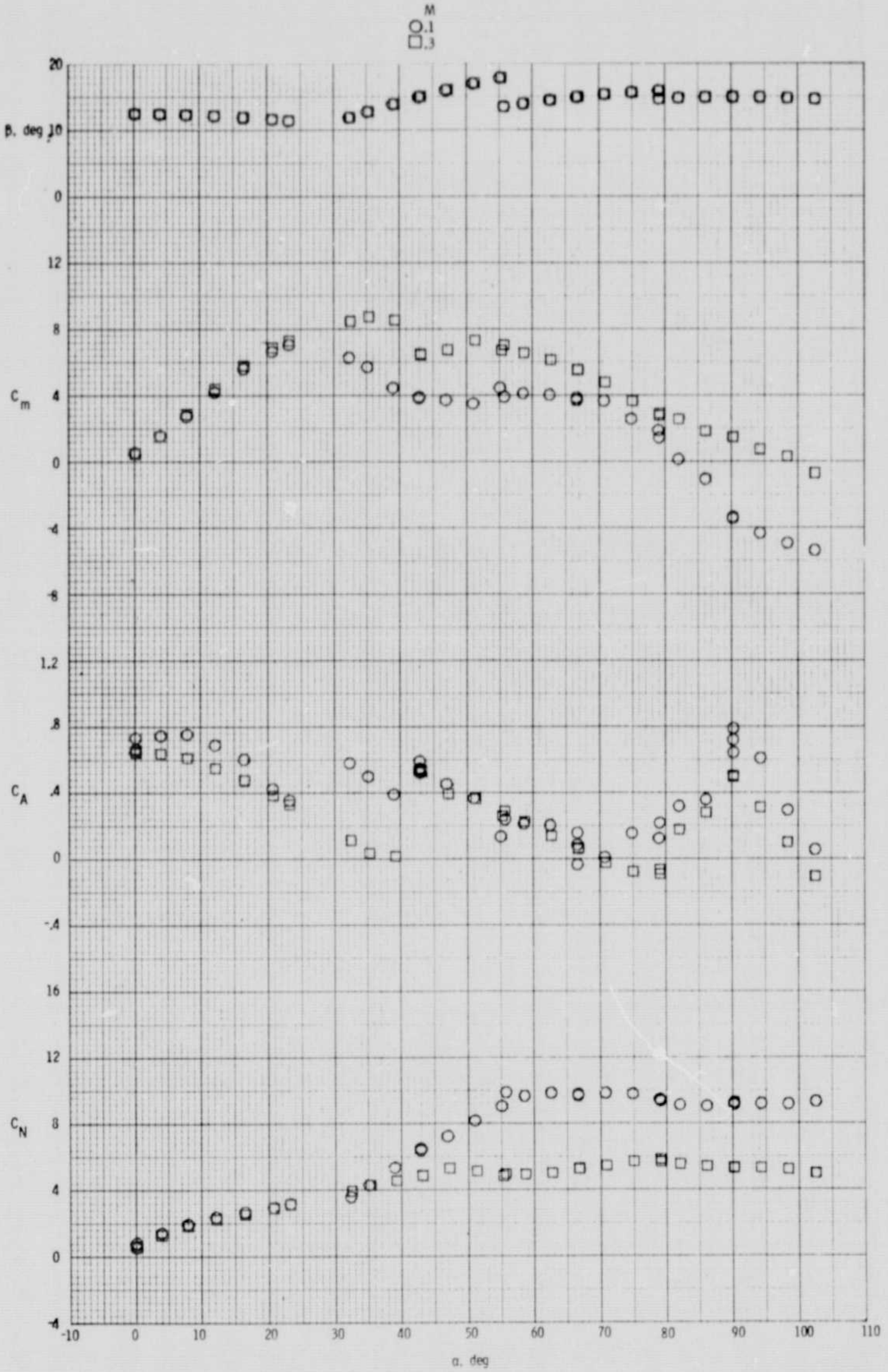
(b) $\beta = 5^0$.

Figure 2- Continued.



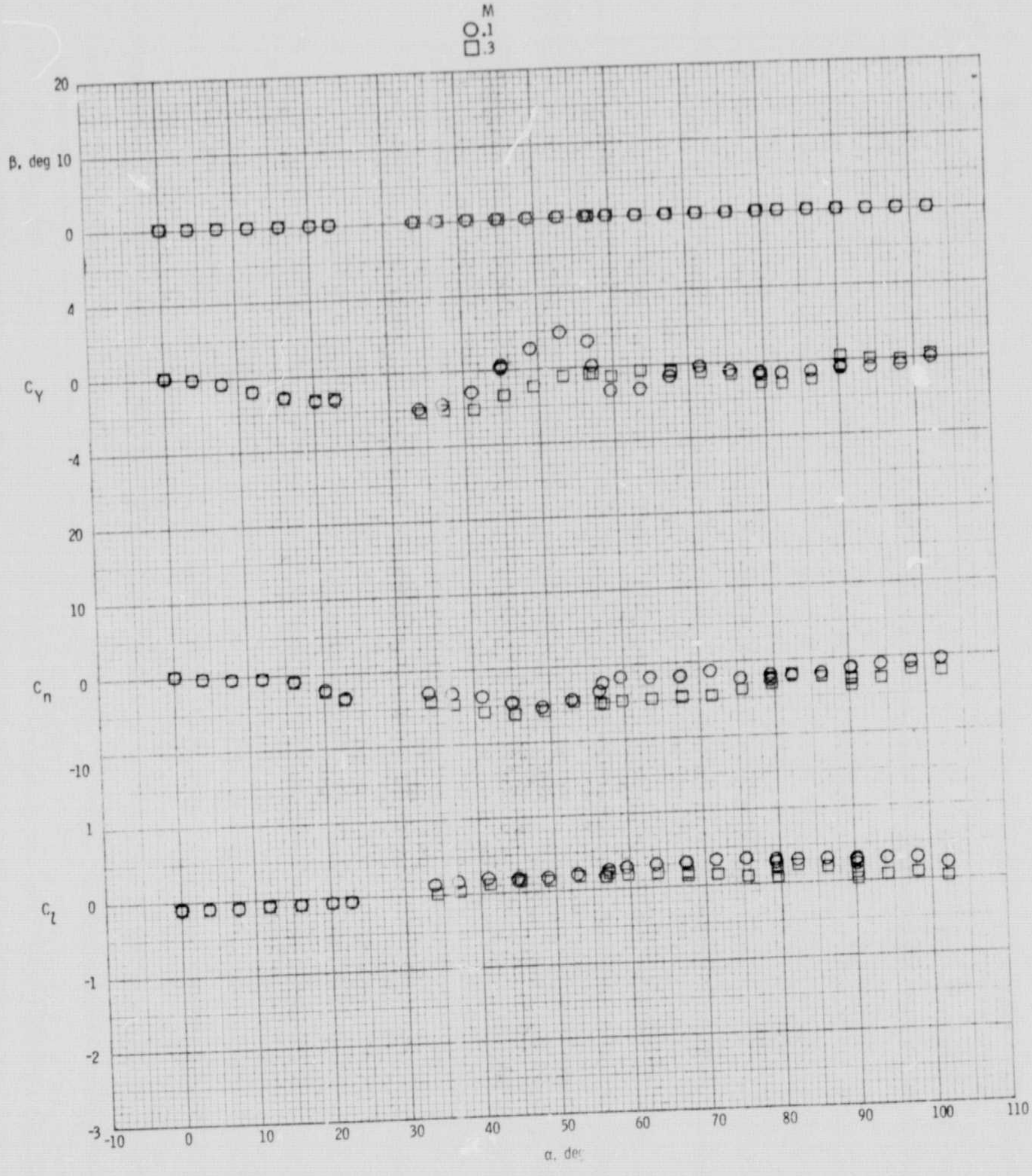
(c) β ≈ 10°.

Figure 2- Continued.



(d) β = 15°.

Figure 2 - Concluded.



(a) β ≈ 0°.

Figure 3- Lateral-directional aerodynamic characteristics.

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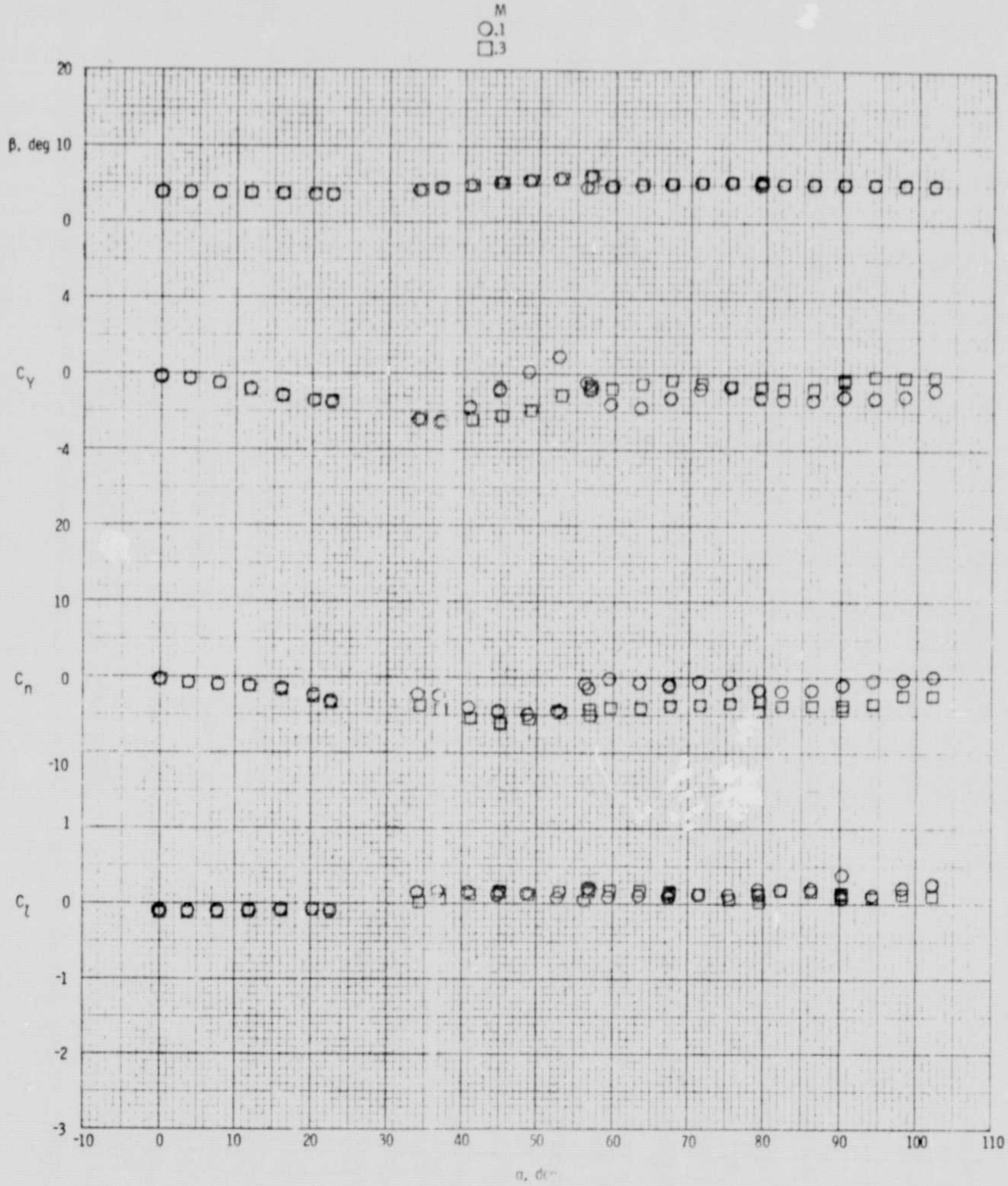
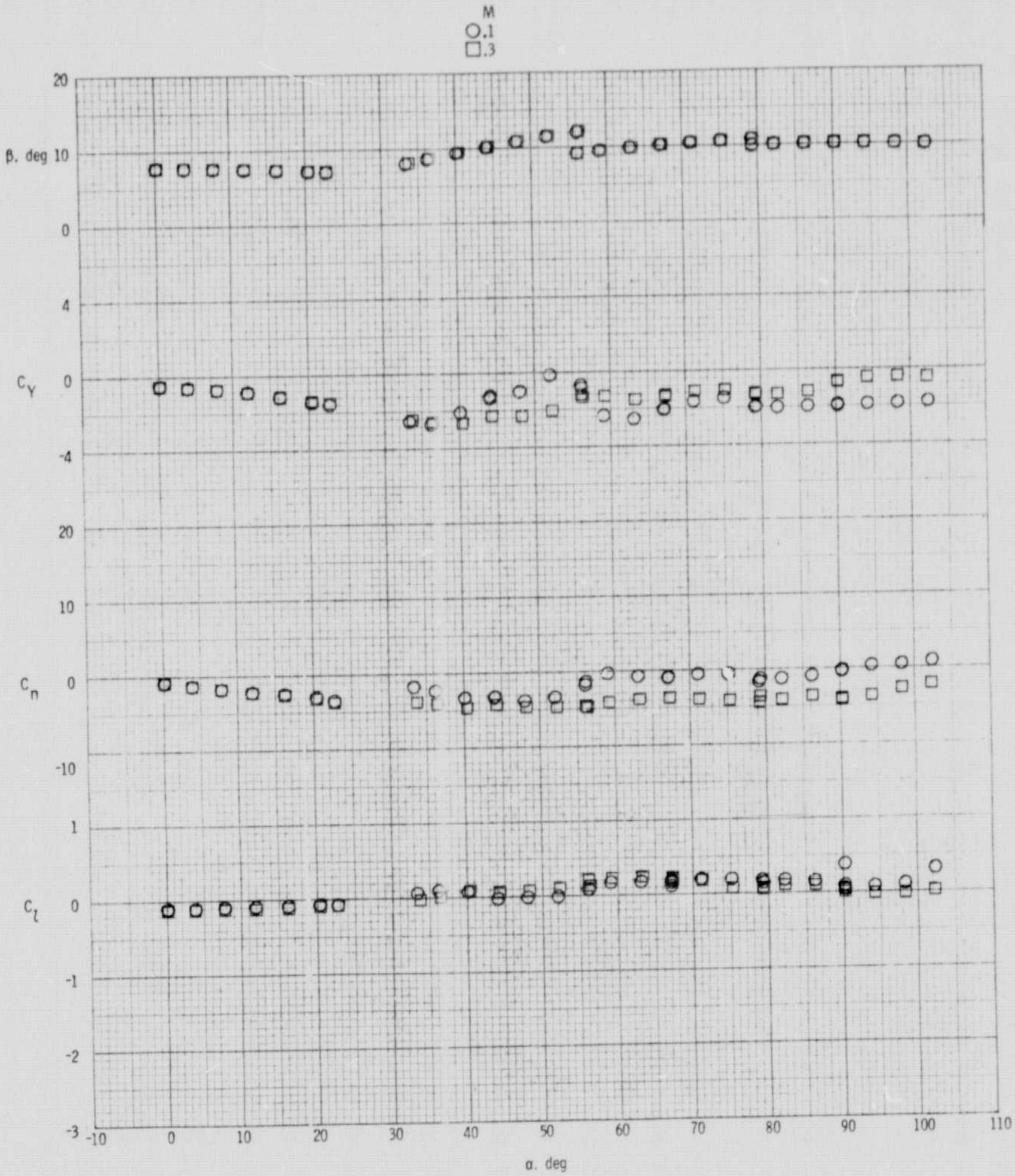


(b) β ≈ [illegible]

Figure 3- Continued.



(c) β ≈ 10°.

Figure 3- Continued.

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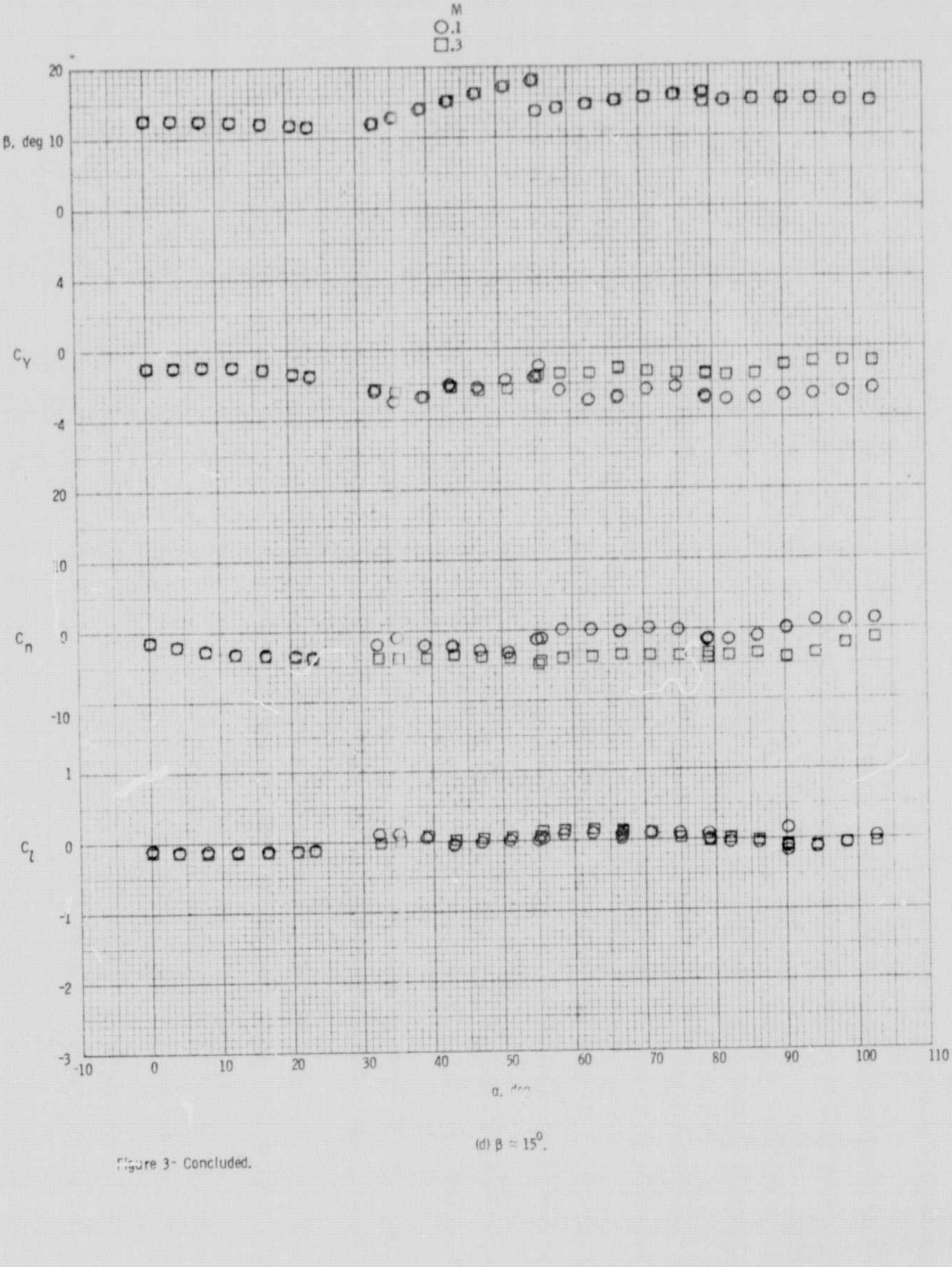
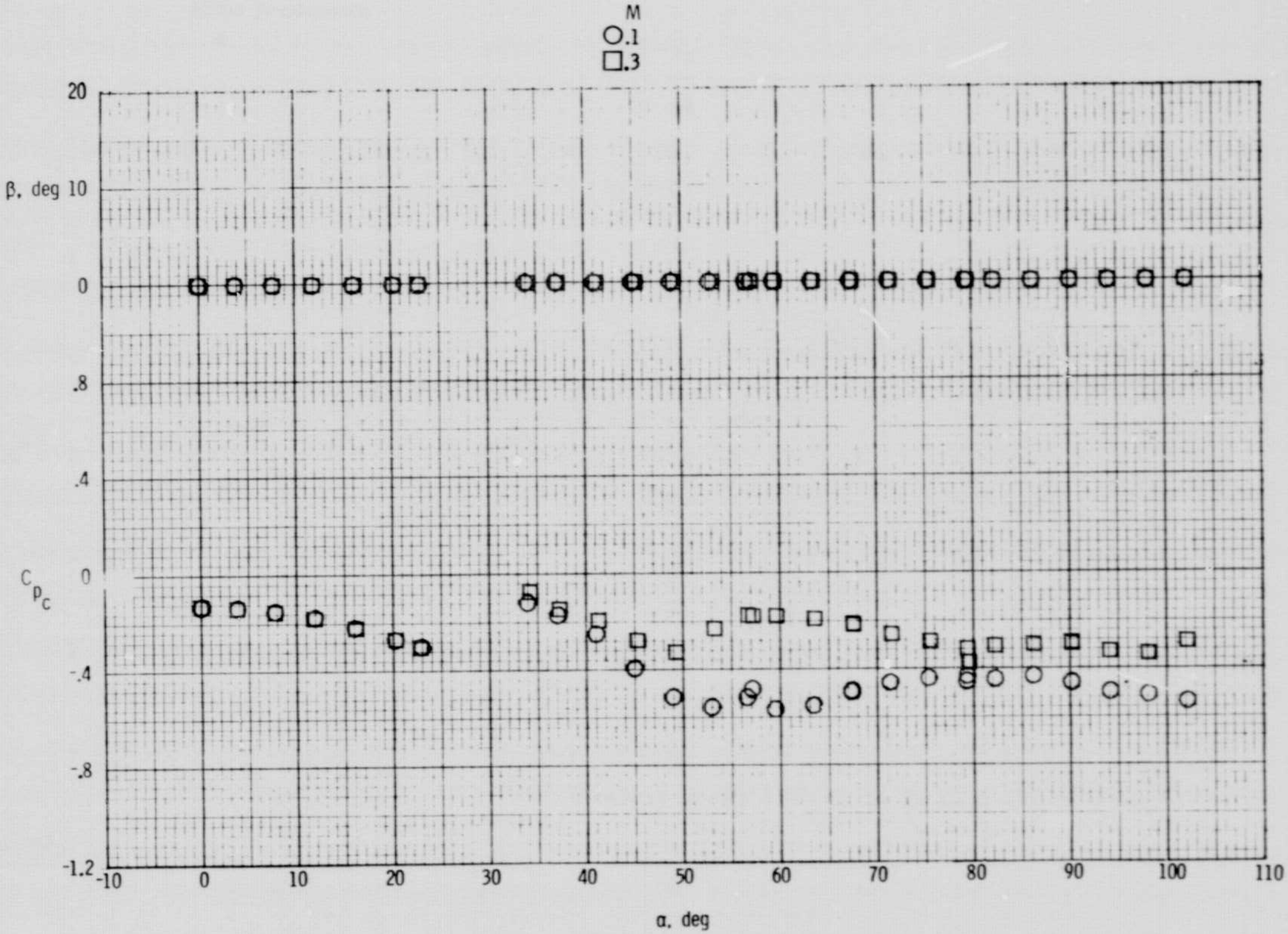


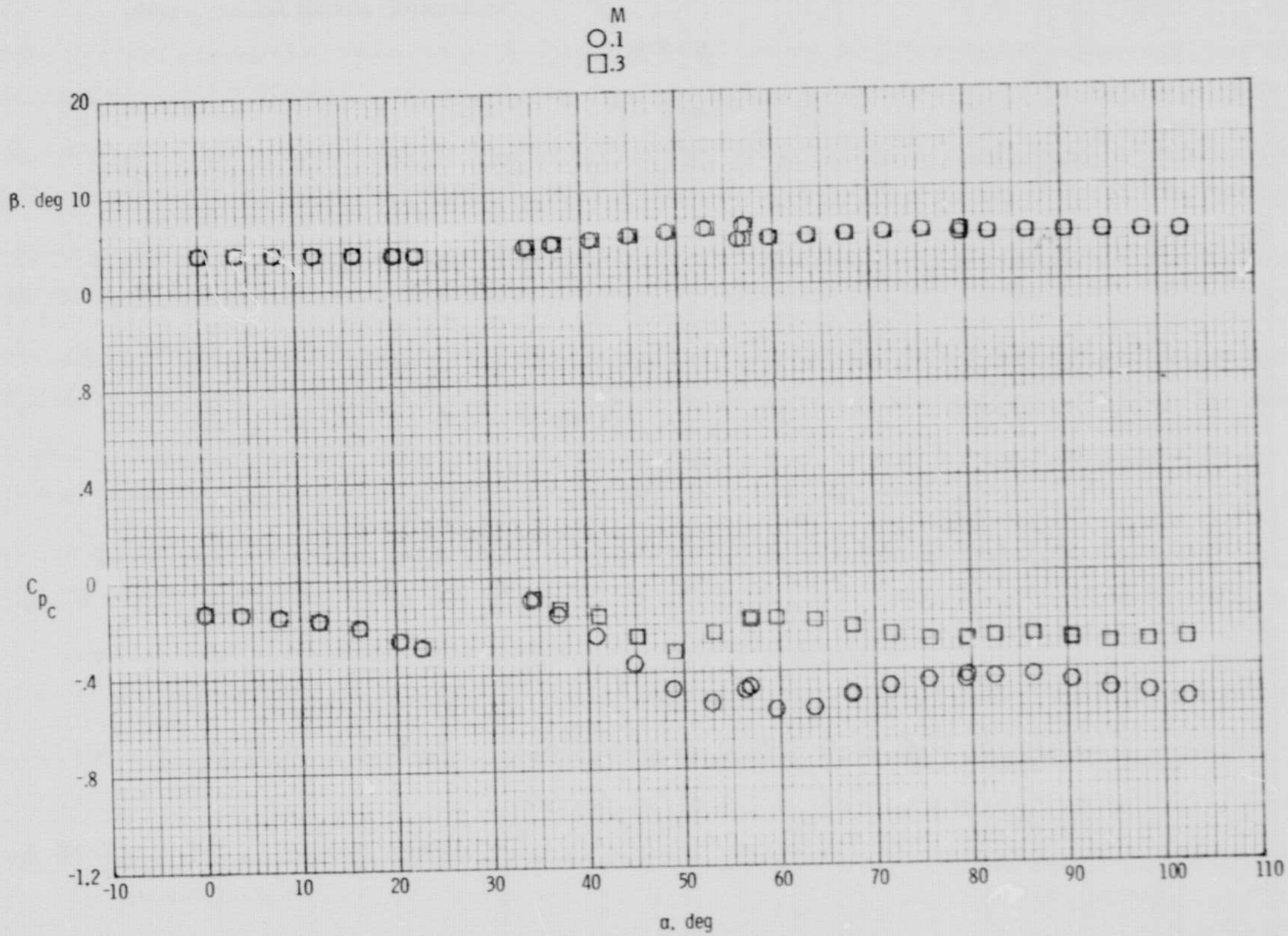
(d) β ≈ 15°.

Figure 3- Concluded.



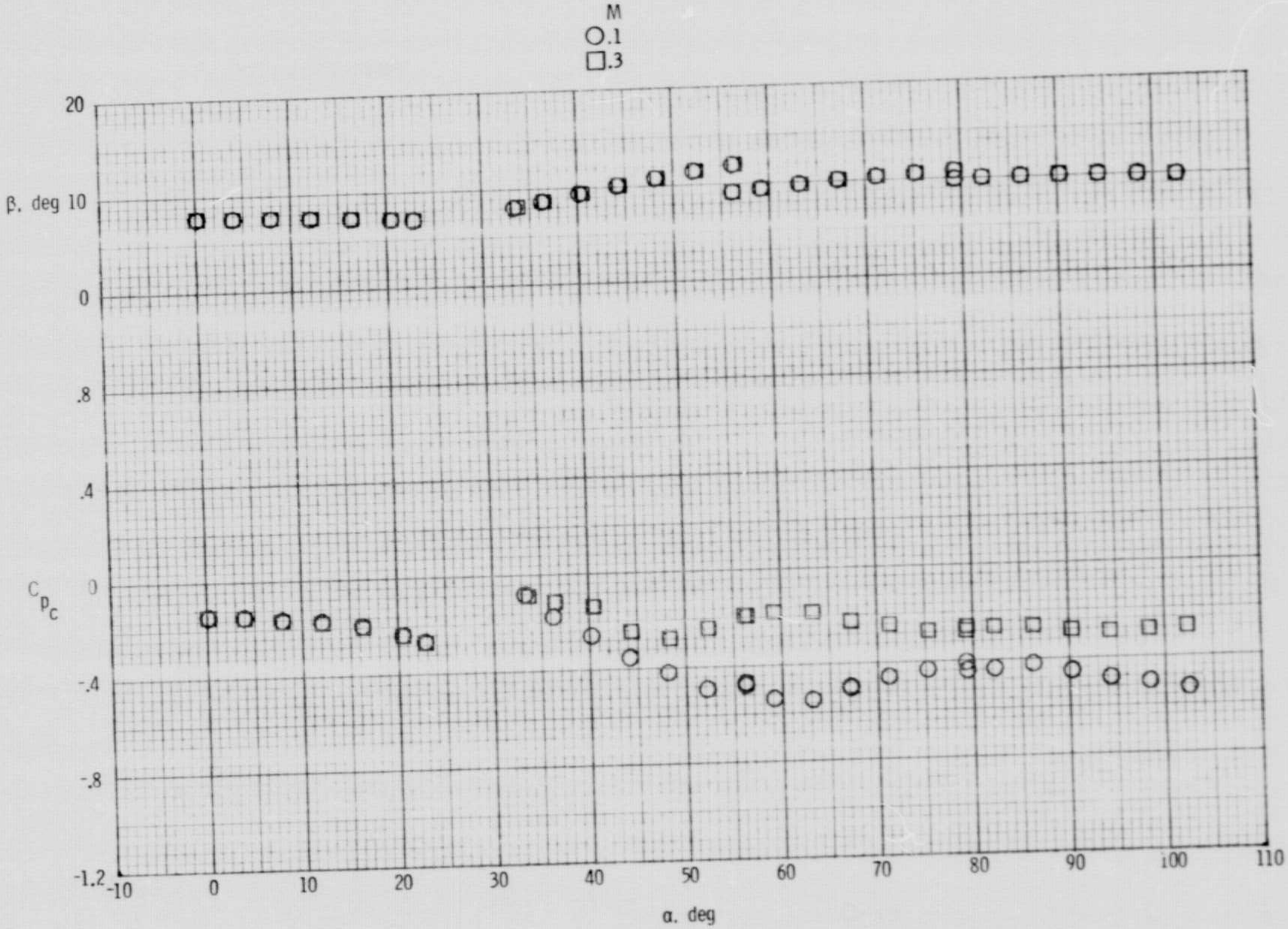
(a) $\beta \approx 0^0$.

Figure 4- Chamber pressure characteristics.



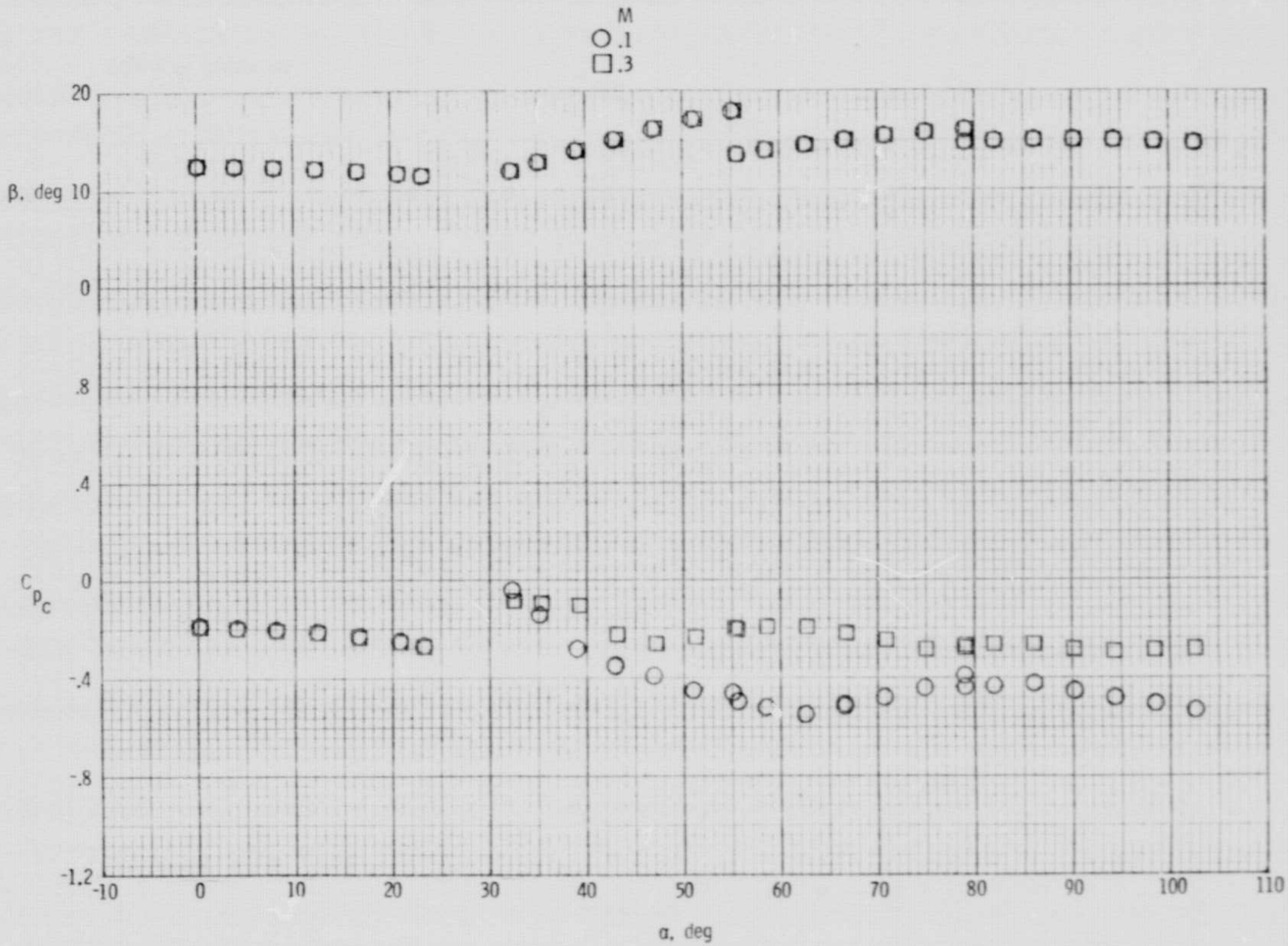
(b) $\beta \approx 5^0$.

Figure 4- Continued.



(c) $\beta \approx 10^0$.

Figure 4- Continued.



(d) $\beta \approx 15^0$.

Figure 4 - Concluded.