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UTC 4205-72-7

19 APRIL 1972

~~SECRET~~

A circular black and white stamp. The outer ring contains the number sequence "1234567890123456789012345678901234567890". In the center, there is an upward-pointing arrow above the date "APR 1972". Below the date, the word "RECEIVED" is printed in large, bold letters. Underneath "RECEIVED", the words "NSA STI FACILITY" are printed in smaller letters, followed by "INPUT SEARCH" at the bottom.



DIVISION OF UNITED AIRCRAFT CORPORATION



UNITED AIRCRAFT

N72-27821

(NASA-CR-127416) STUDY OF SOLID ROCKET
MOTORS FOR A SPACE SHUTTLE BOOSTER, VOLUME
2 Final Report (United Technology Center)
19 Apr. 1972 23 p CSCI 21H

Unclas
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INTRODUCTION

Additional technical data have been prepared by UTC to supplement the data supplied in the SRM Shuttle Booster Final Report, UTC 4205-72-7, 72 Mar 15. These data are supplied in response to NASA DR No. SE-01 of DPD 314.

1.0 PERFORMANCE CHARACTERISTICS

The ballistic data of subsection 2.4.1 of the final report utilized SRM motor efficiencies of 0.960 and 0.947 with nozzle divergence half-angles of 15° and 20° , respectively. This efficiency factor includes the effects of frictional flow, heat transfer, nozzle divergence, and two-phase flow; it is substantiated by static test data from 120-in.-diameter motors. This efficiency factor is applied to the momentum terms when calculating SRM thrust.

2.0 PROPELLANT CHARACTERISTICS

The UTC PBAN propellant formulation utilized in the SRM booster study has the following ballistic characteristics:

<u>Item</u>	<u>Value</u>
Standard specific impulse, lb-sec/lb	247
Characteristic velocity, ft/sec	5,170
Effective exhaust specific heat ratio	1.18
Burning rate exponent	0.25
Temperature coefficient of pressure, %/°F	0.13
Temperature coefficient of burning rate, %/°F	0.098

3.0 PARAMETRIC DATA

Limited parametric data are supplied in the final SRM shuttle booster report to extend the baseline designs to varying sizes of SRM's.

Specific data defining SRM case length and delivered specific impulse are shown in figures 1 and 2 as functions of motor propellant weight, maximum expected operating pressure, case diameter, and nozzle expansion ratio.

A limiting case length is reached with a case L/D ratio of 9 to 10 depending upon the attendant thrust or duration level. The effects of increased internal pressure drop and the restraints of internal Mach number upon cross sectional loading density tend to reduce the efficiency of the SRM design beyond this L/D ratio. Definition of a specific limit is dependent upon the specific ballistic requirements and the extent of risk acceptable during development.

Figure I
 Effects of Motor Design Parameters
 on Motor Case Length

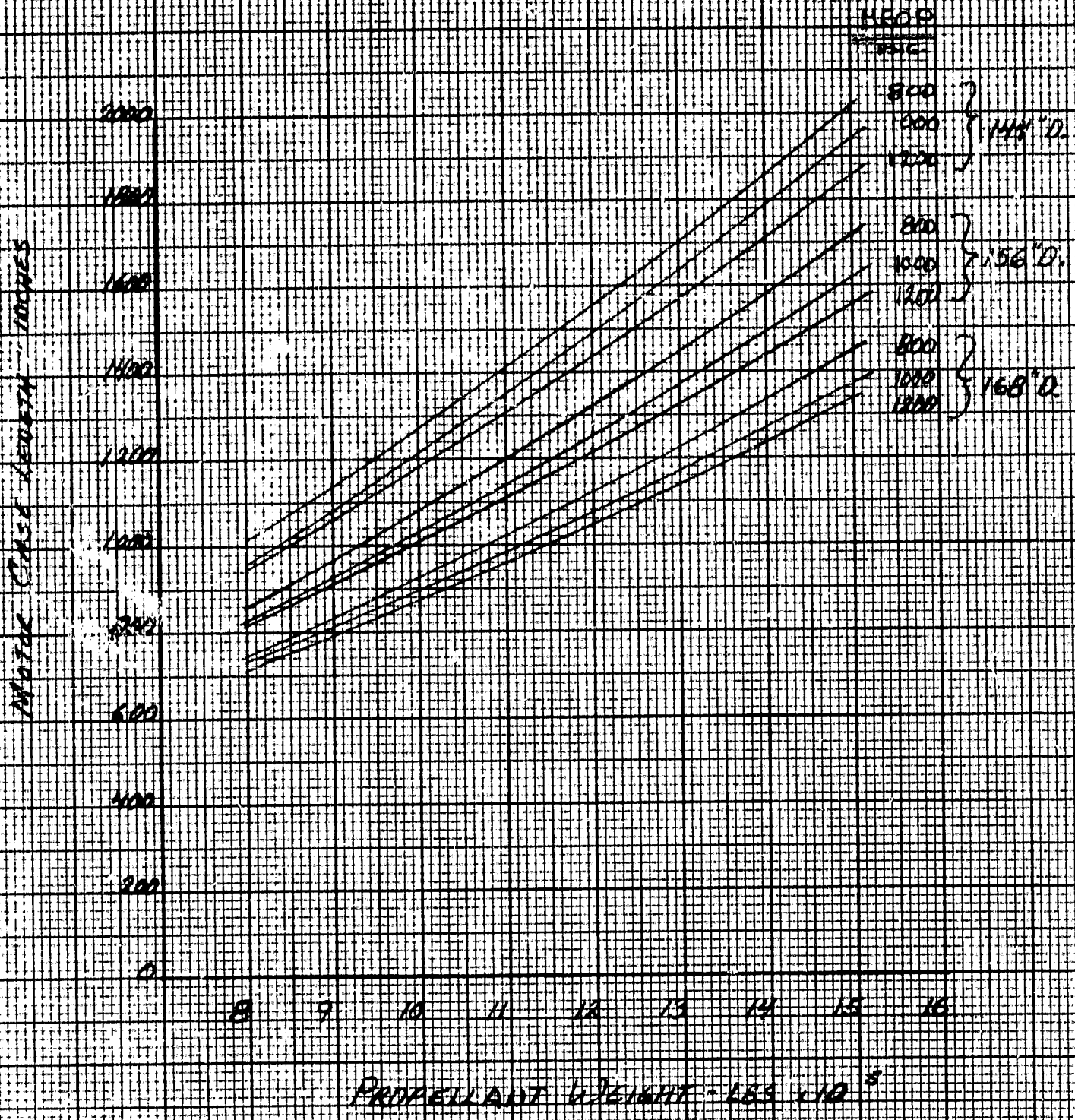
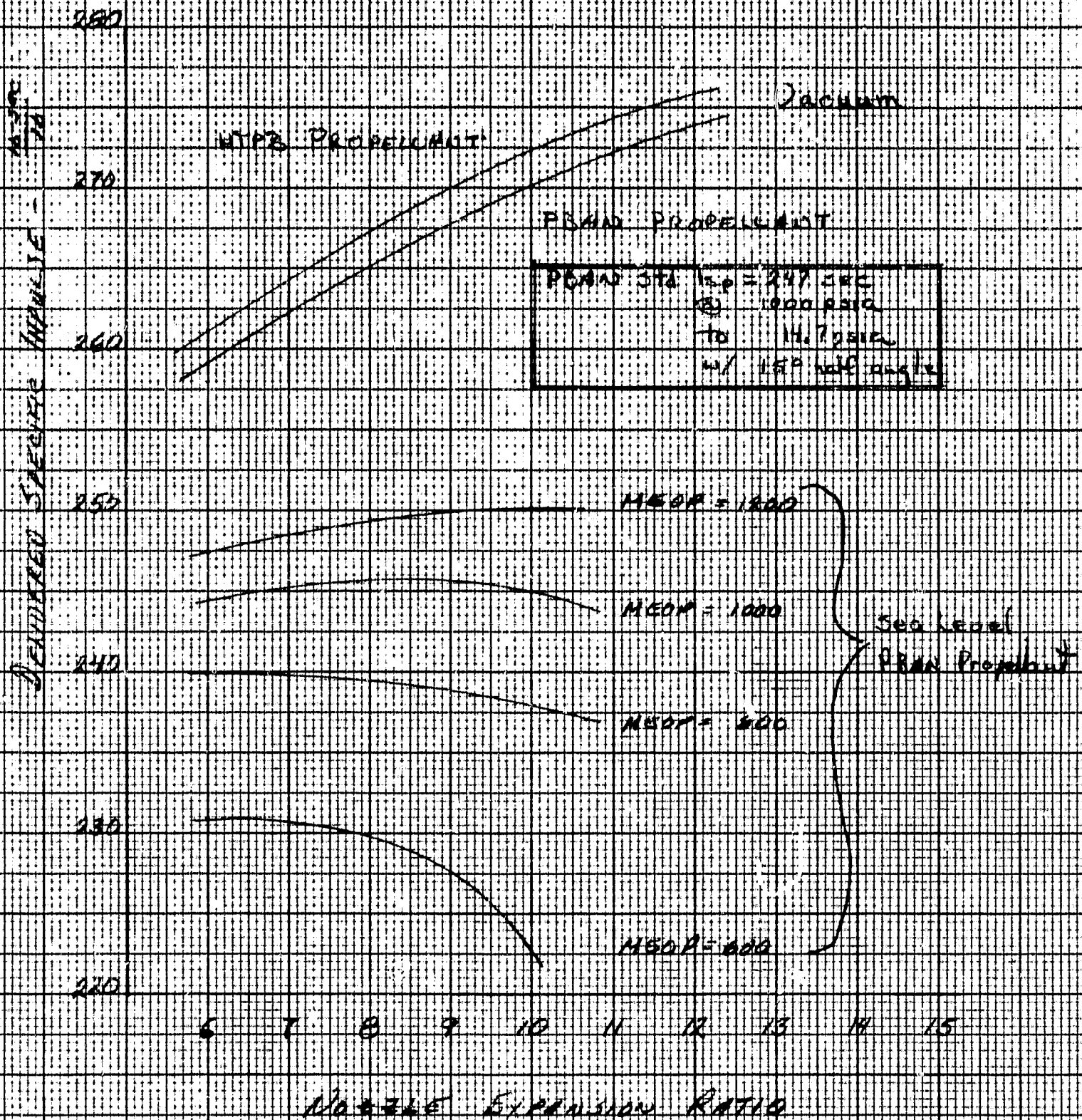


Figure 2
Effect of Motor Design Parameters
on Delivered Specific Impulse



4.0 SRM MASS PROPERTIES

Complete SRM mass properties data in summary, sequential, and time varying formats were supplied for each of the baseline boosters of the shuttle booster study. These data may be found on pages 2-225 through 2-251 of UTC 4205-72-7, 72 Mar 15.

5.0 PLUME CHARACTERISTICS

SRM exhaust plume profiles are shown in figures 3 through 9 for SRM nozzles with the following characteristics:

<u>Item</u>	<u>Value</u>
Flame temperature, °R	6,160
Exhaust gas ratio of specific heats	1.18
Nozzle expansion ratio	9.2
Nozzle half-angle, degree	15

The data are provided for ambient altitudes of sea level, 40,000-, 60,000-, 80,000-, 100,000-, 120,000-, and 136,000-ft altitudes. Plume data required for SRMs of varying characteristics require specific request and implementation.

Figure 3
Jet Wake-Flow Characteristics
UA 1207 at Sea Level

M	T/T_0
3.42	0.488
3.65	0.453
3.90	0.421

Conditions: $\gamma = 1.18$
 $\epsilon = 9.2/1$
 $R_0 = 63''$
 $P_0 = 700 \text{ psia}$
 $T_0 = 6160^\circ \text{R}$
Exit Angle = 15°

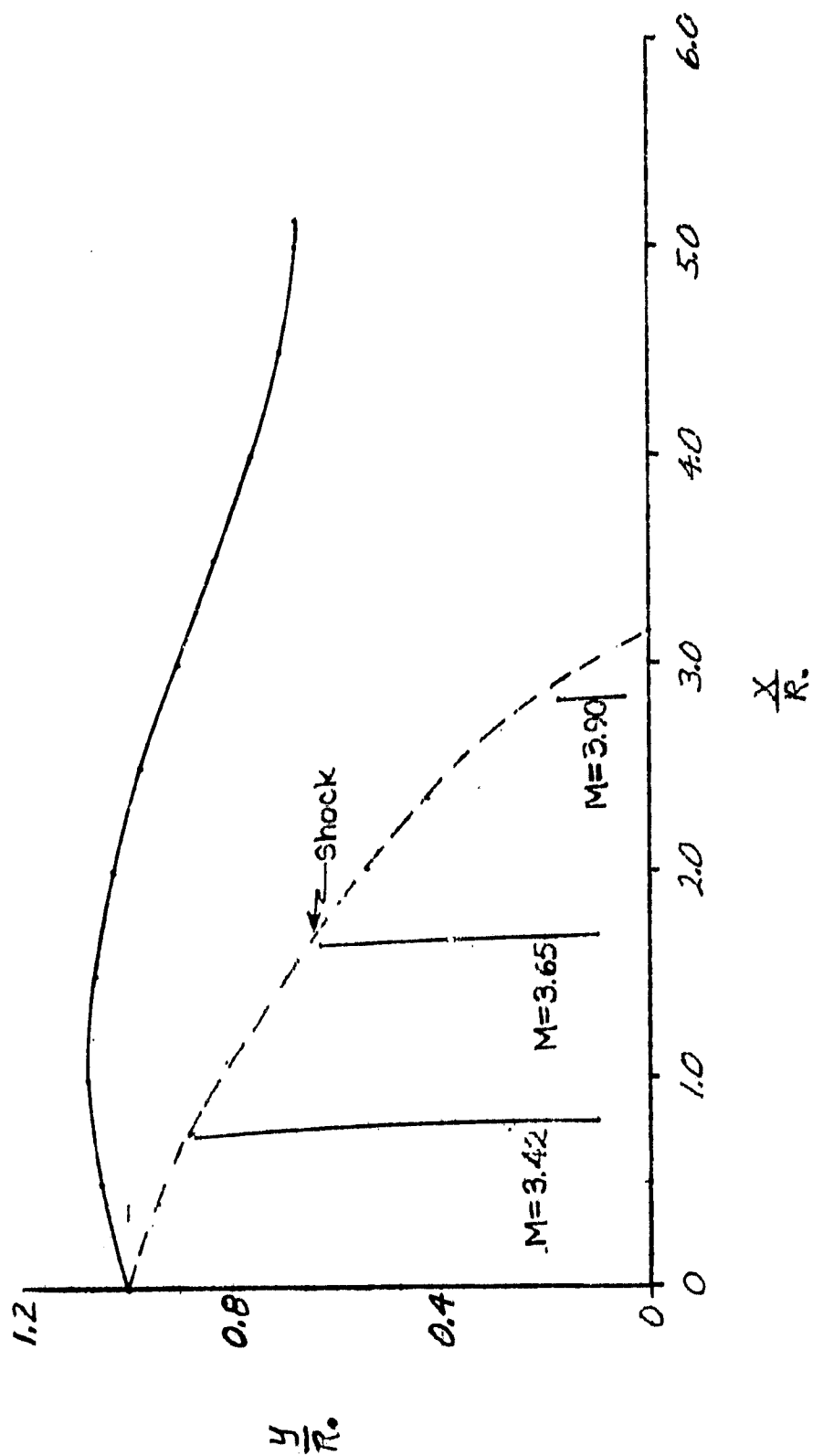
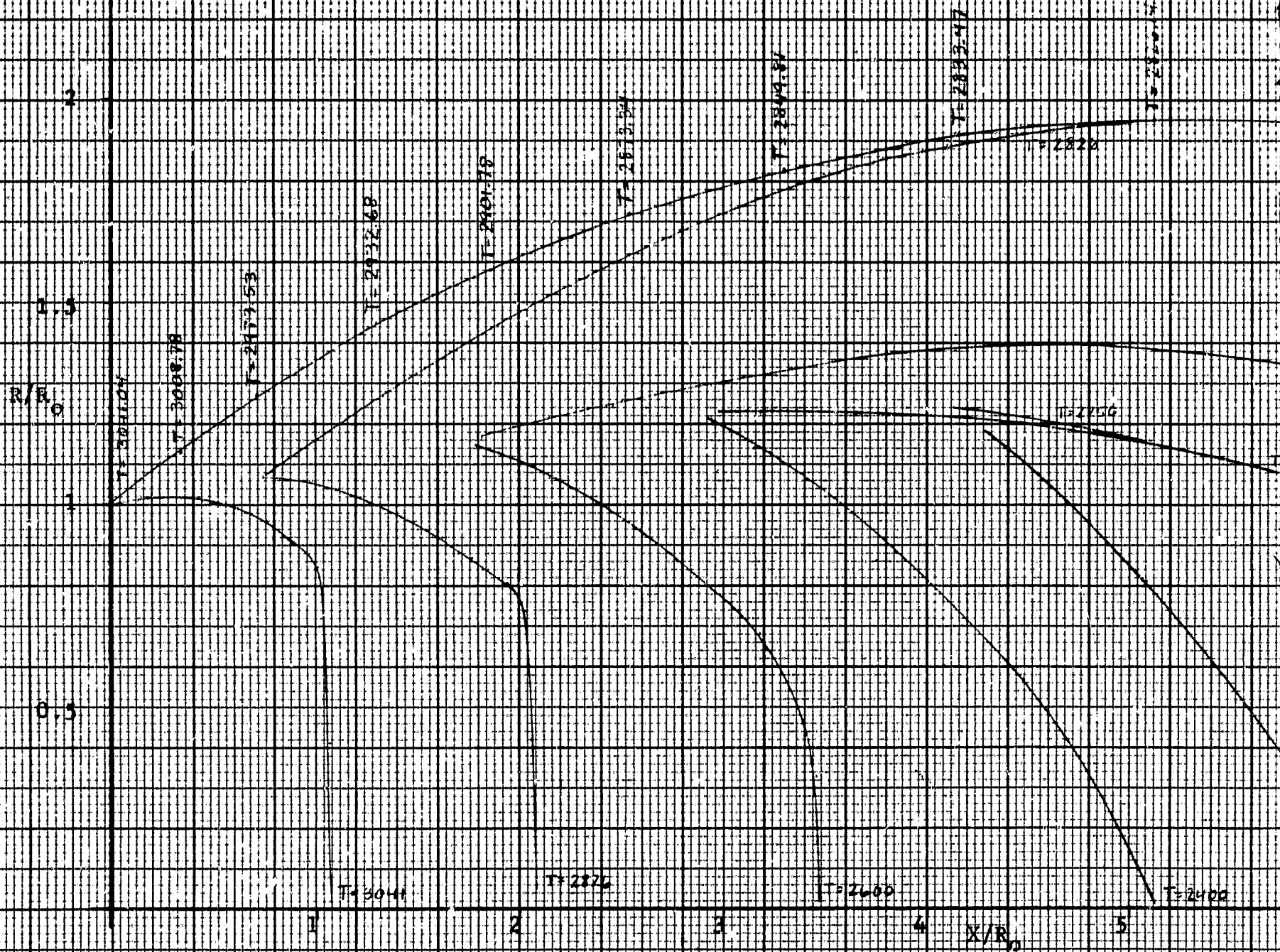


Figure 4
Jet Wake - Flow Characteristics
Alt. = 40,000 ft.
 $T = R$



1 FOLDOUT FRAME 2

UIC 4205-72-7
Addendum 1

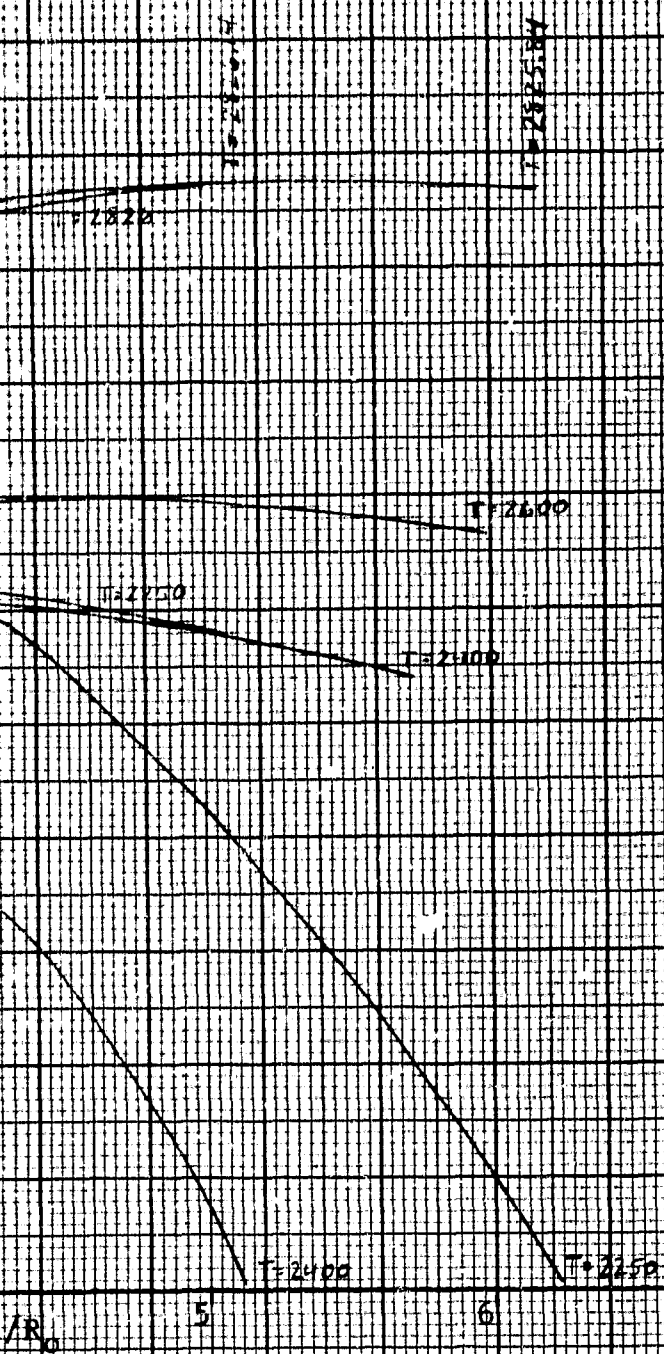
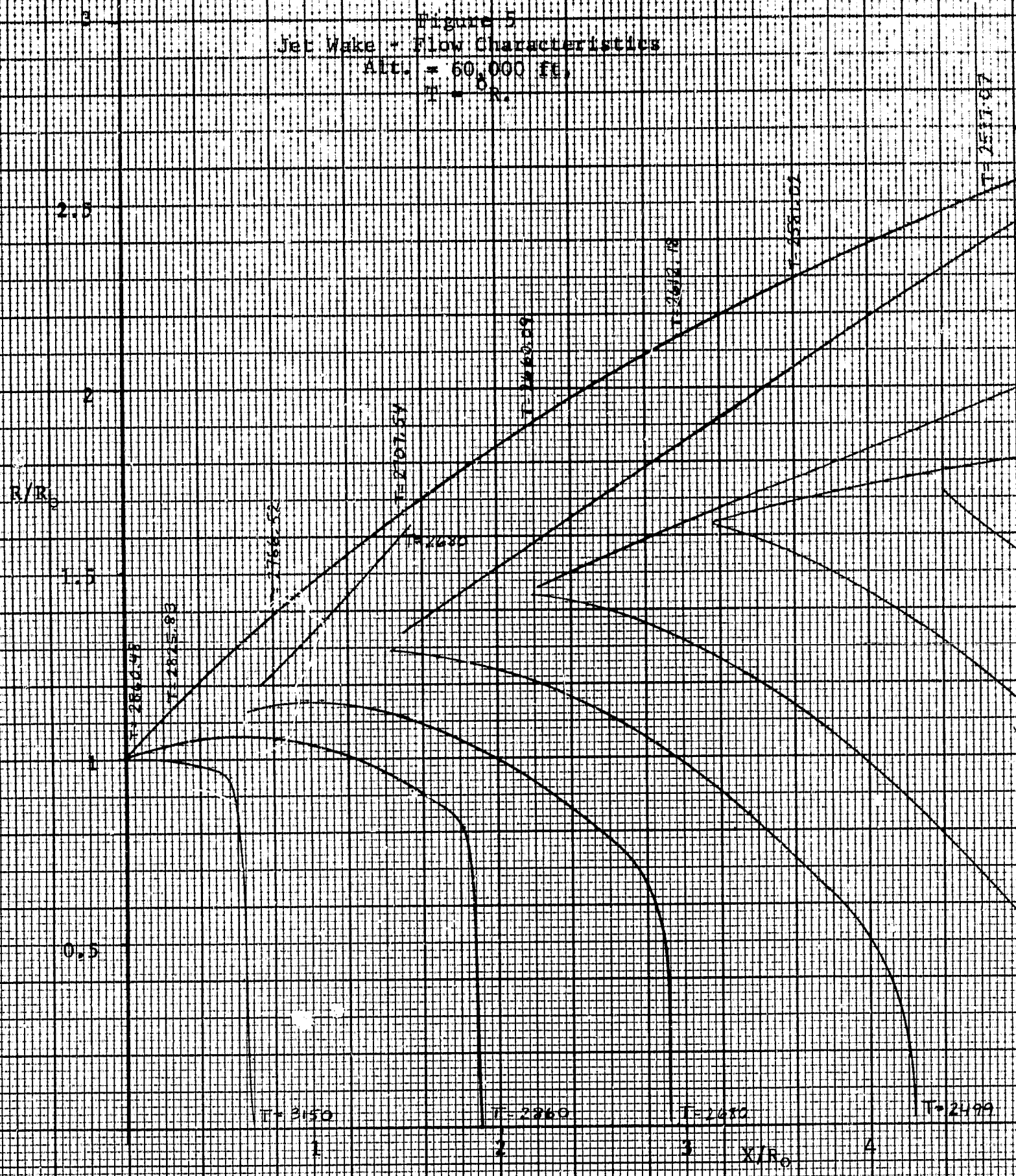
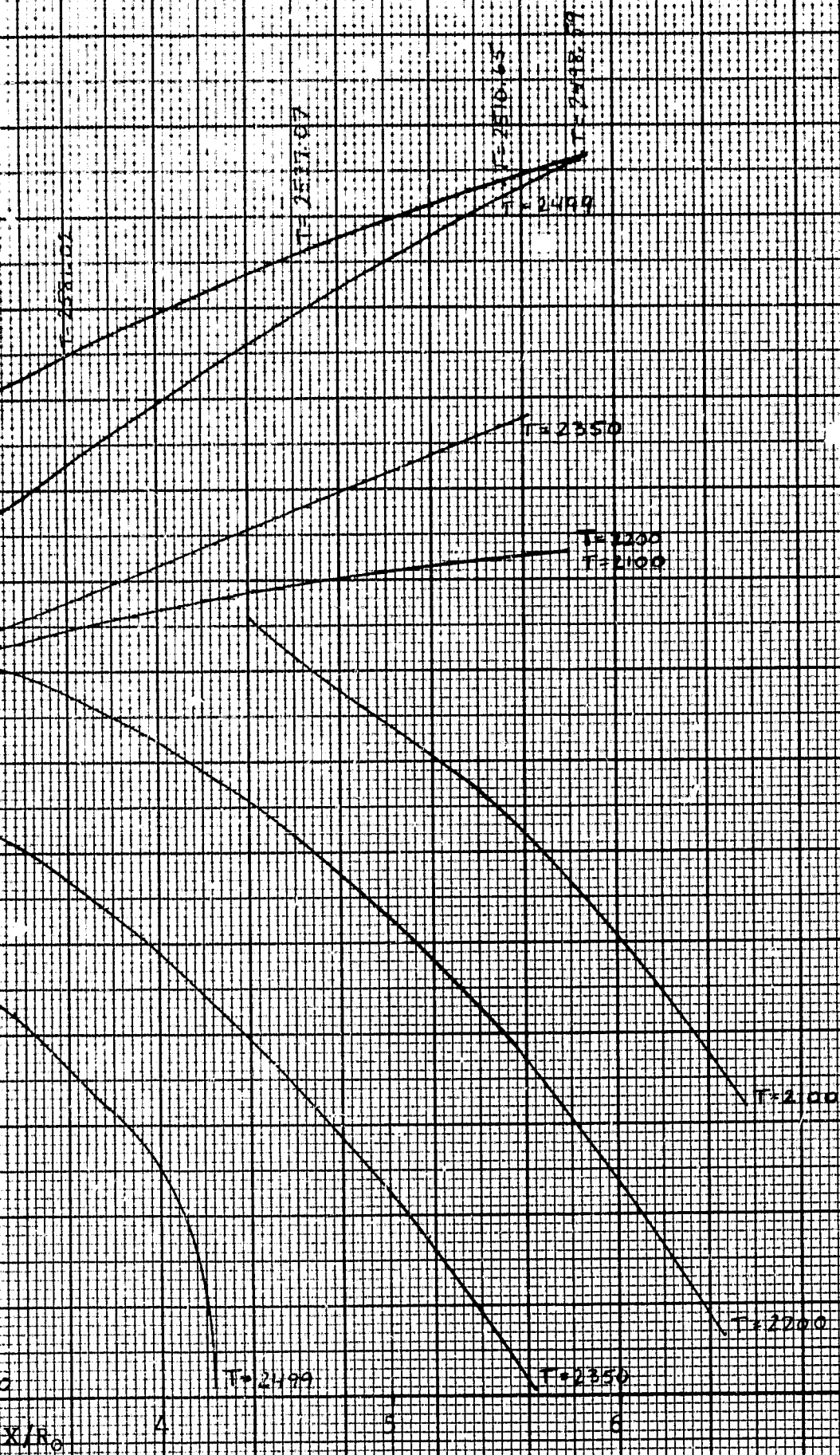
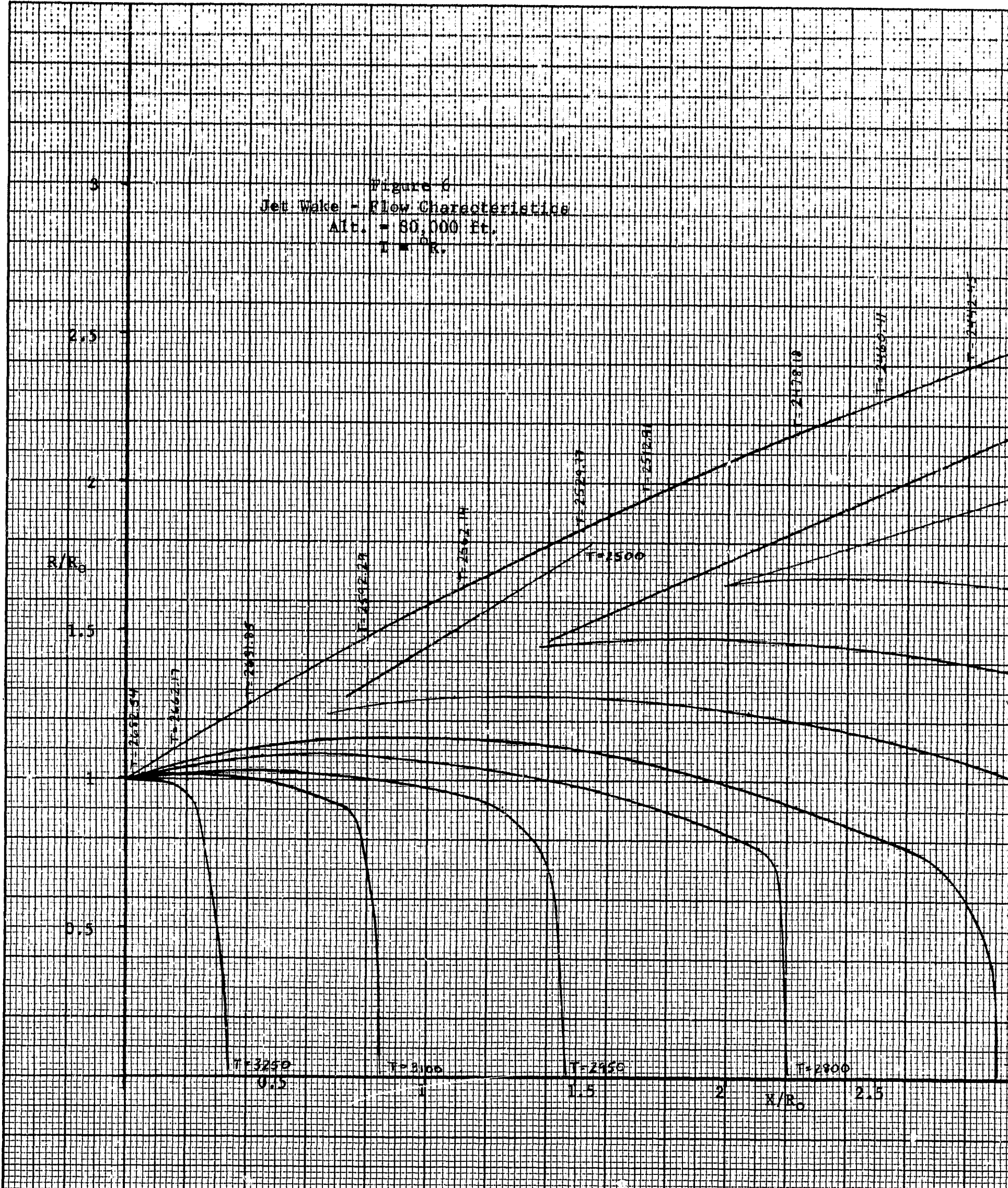


Figure 5
Jet Wake - Flow Characteristics
Alt. = 60,000 ft.
 $M = 8$



UTC 4205-72-7
Addendum 1





UIC 4205-7.2-7.
Addendum I

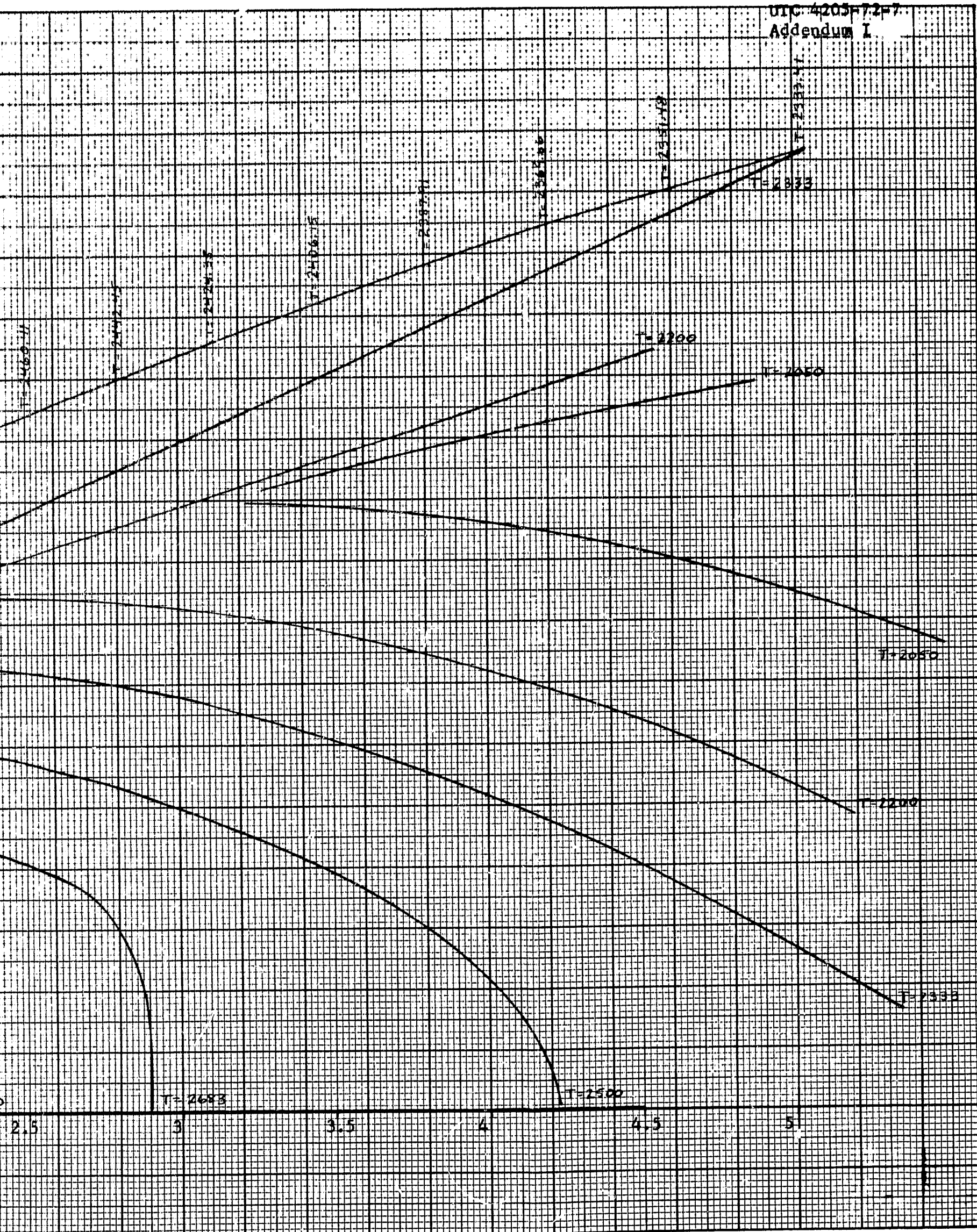
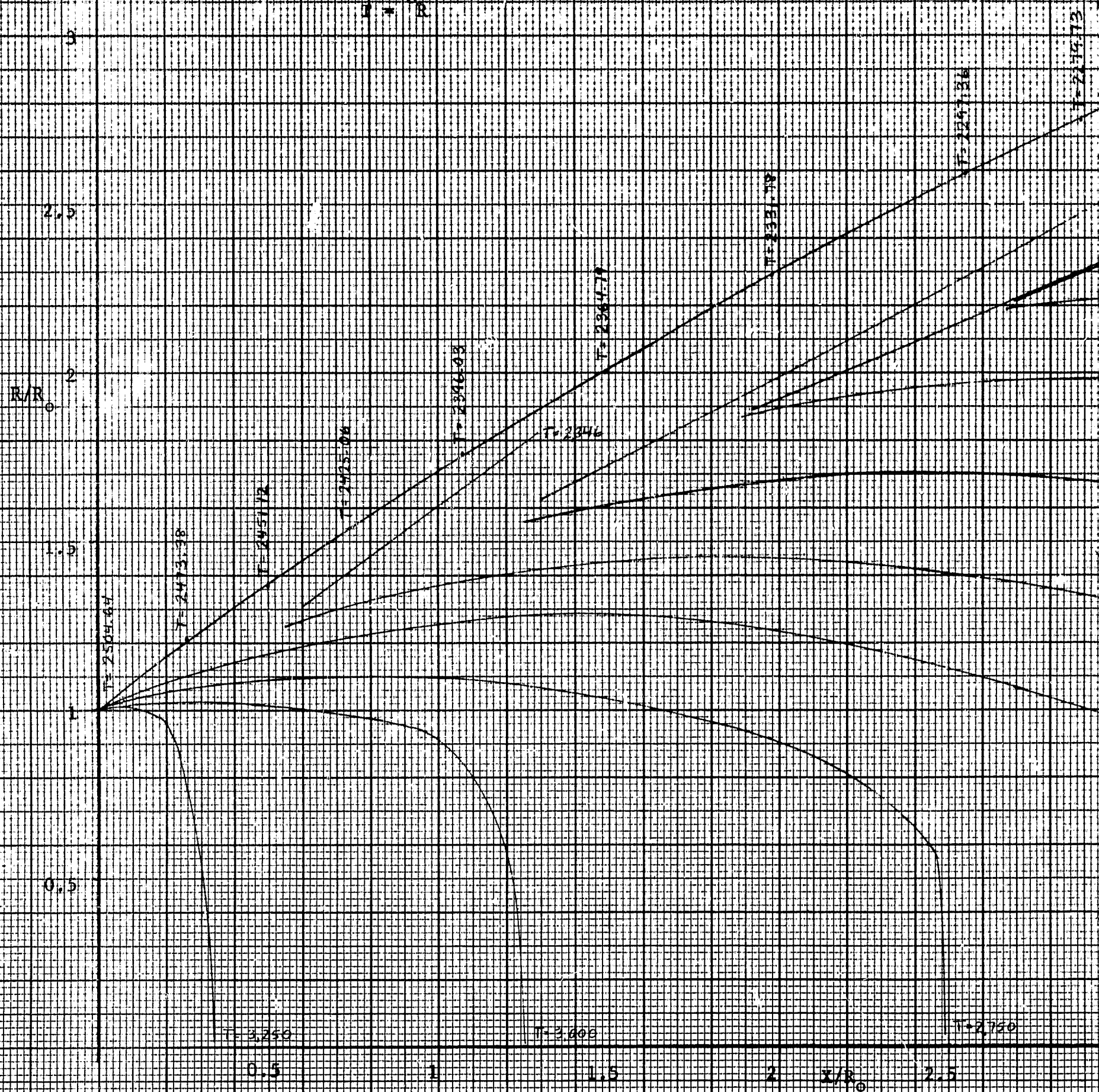


Figure 1
Jet Wake - Flow Characterization
Alt. = 100,000 Ft.
 $T = R$



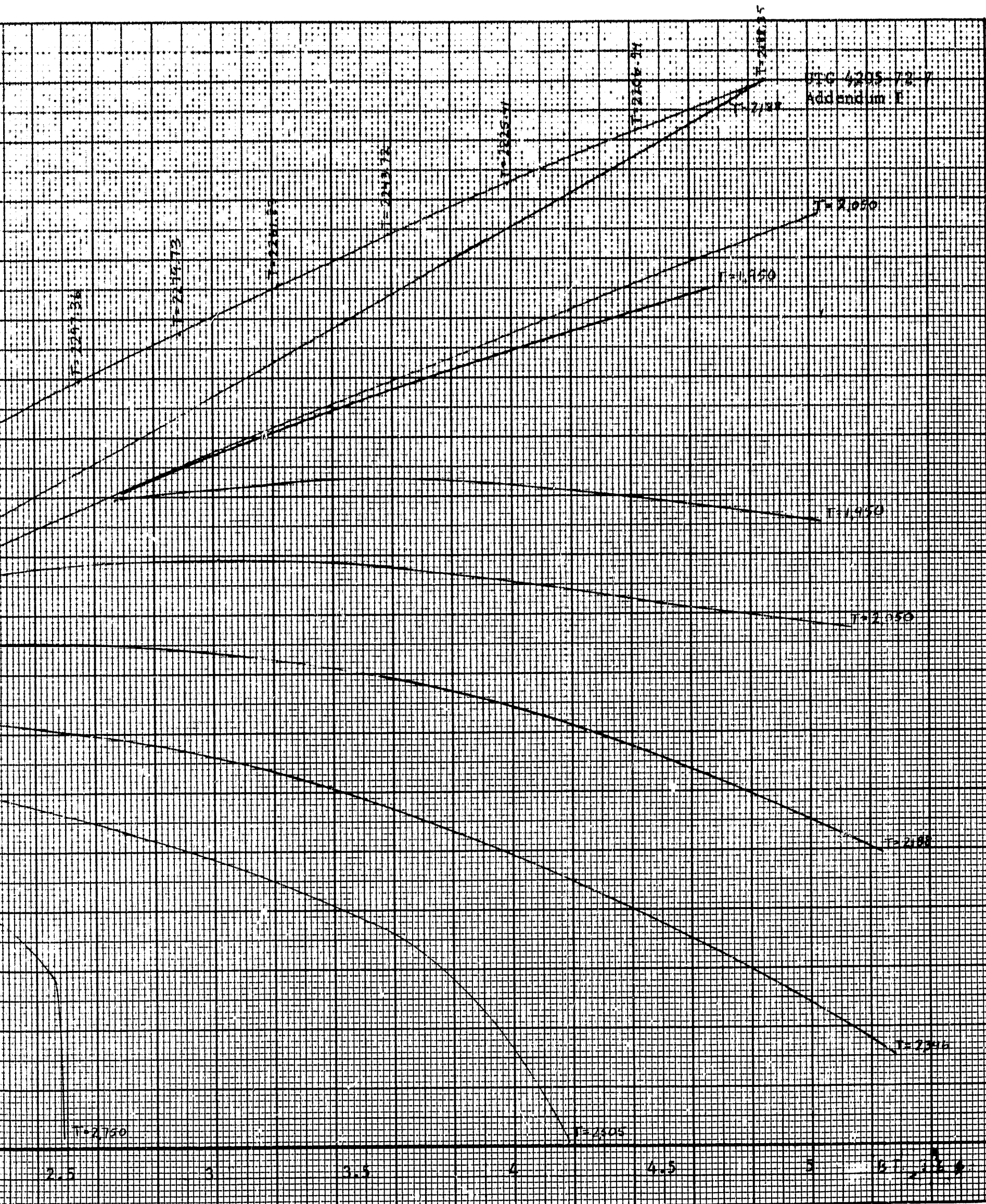
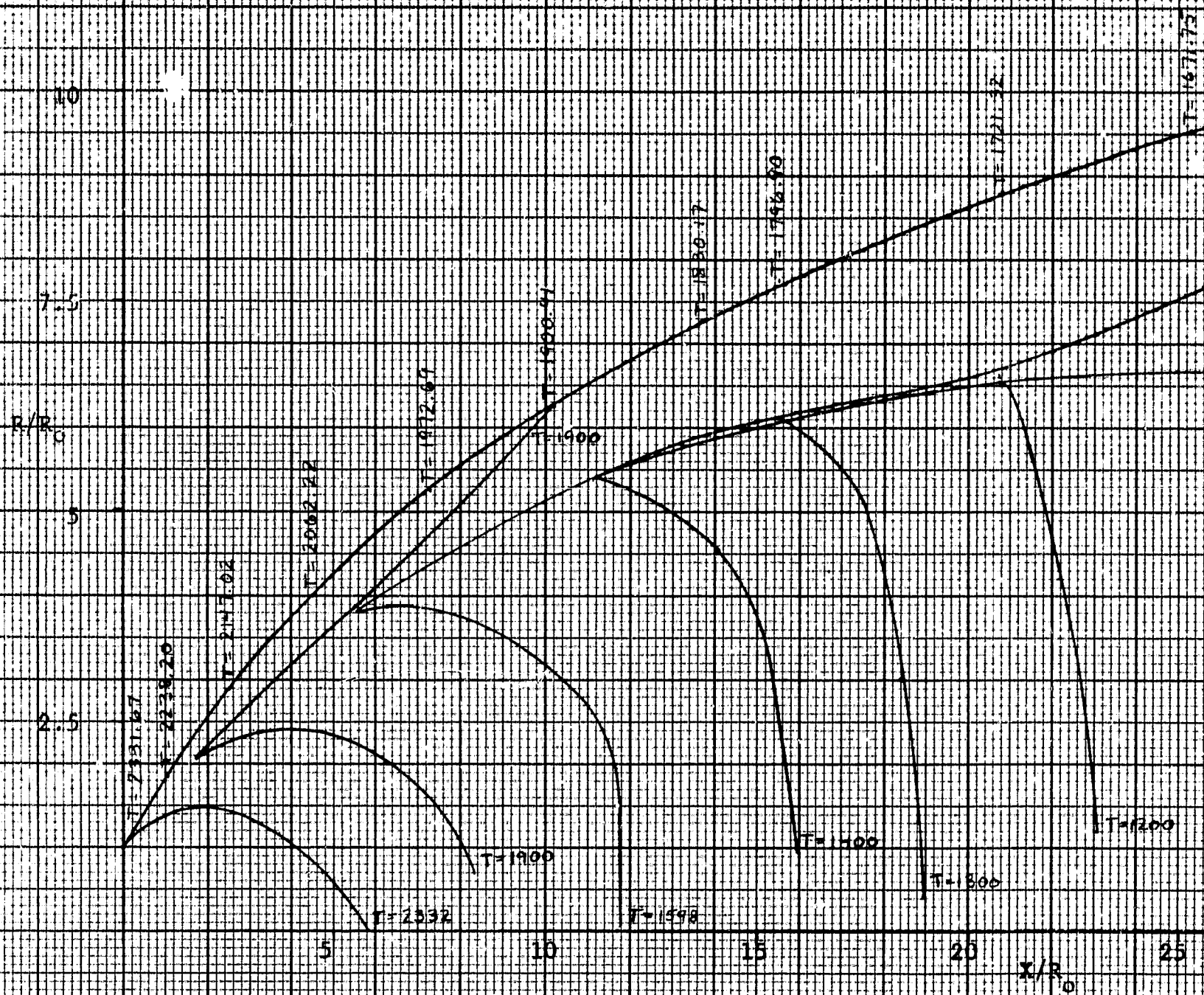


Figure 8
Jet Wake - Flow Characteristics
Alt. 120,000 ft.
 $T = 0^\circ R$



UML 4205-72-7
Anderson T

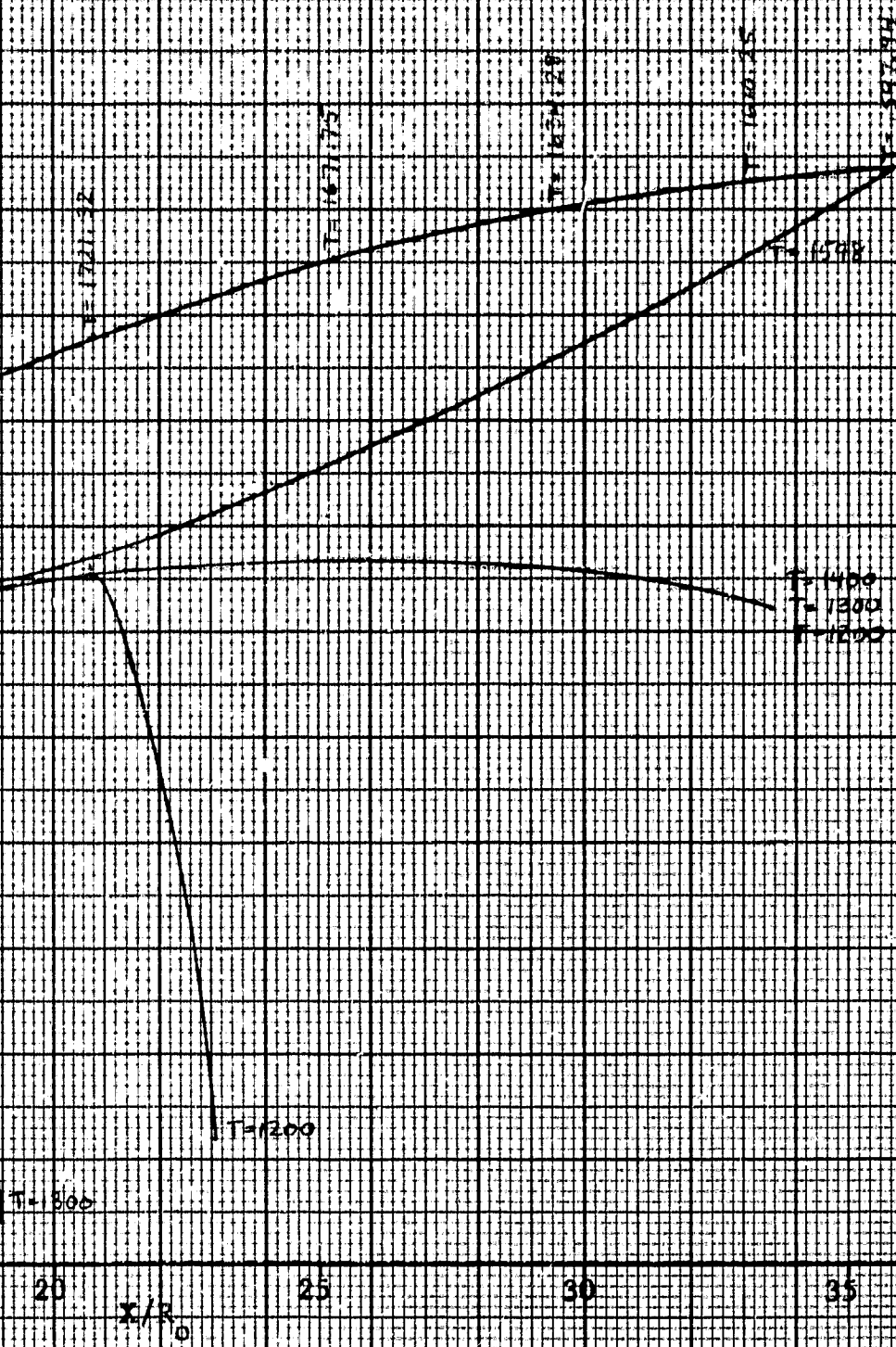
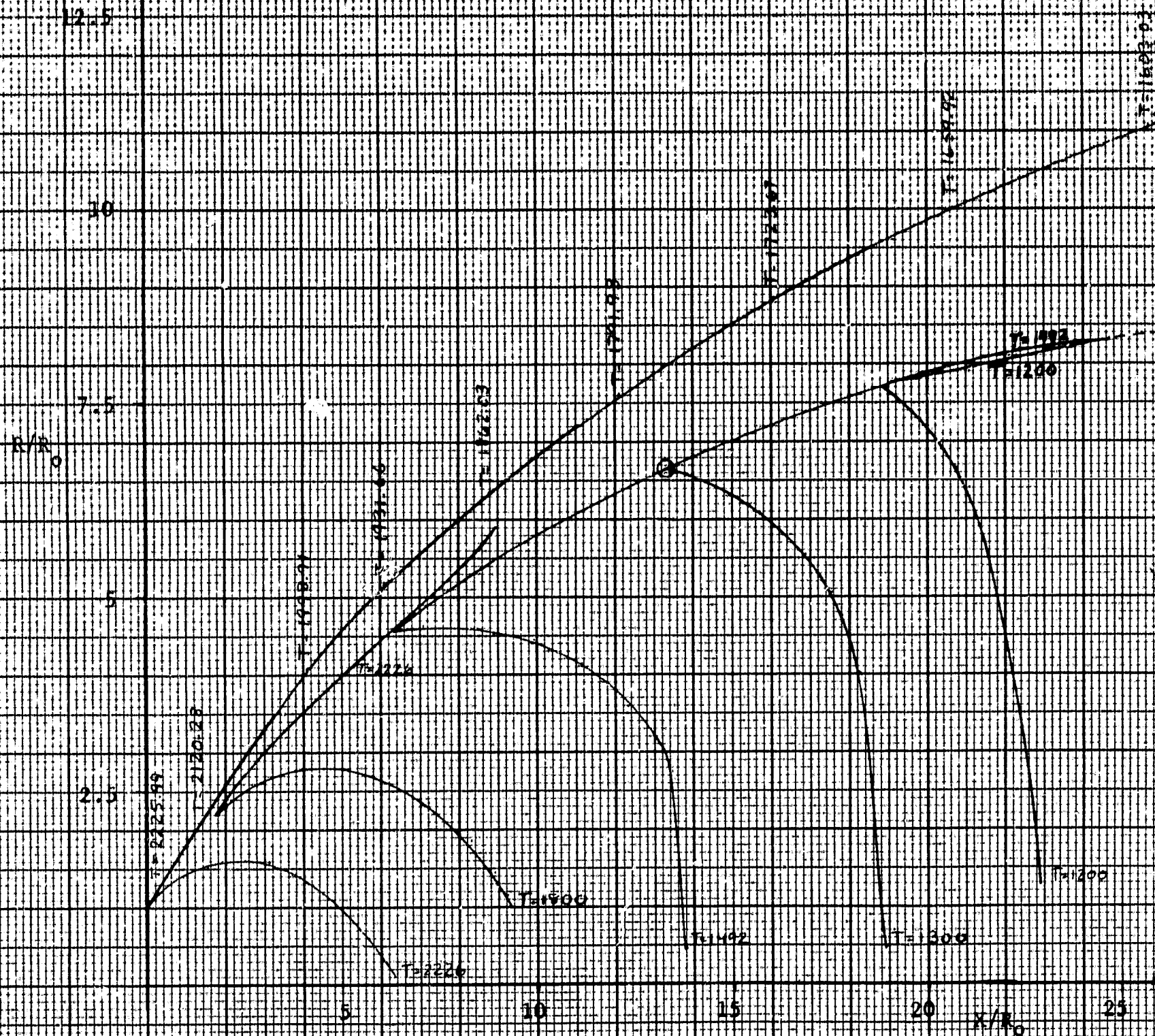


Figure 9
Jet Wake Flow Characteristics
 $A/c = 136,000 \text{ ft}^2$
 $T = 10^\circ \text{R}$



UTC 4205-72-7
Addendum I

