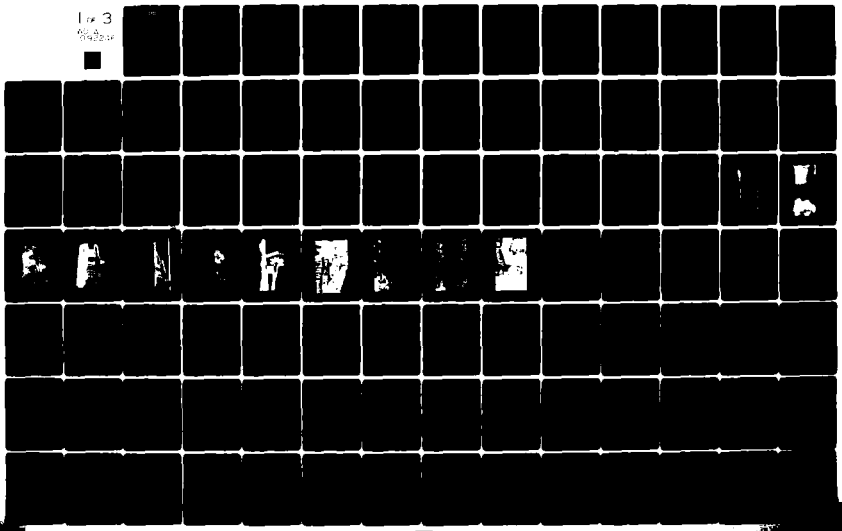
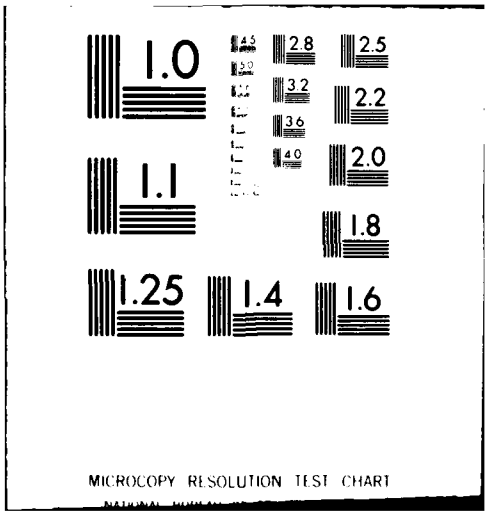
AD-A092 246 DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC F/G 20/4
ANALYSIS OF WAKE SURVEY EXPERIMENTAL DATA FOR MODEL 5365 REPRES--ETC(U)
OCT 80 R B HURWITZ, L B CROOK
UNCLASSIFIED DTNSRDC/SPD-0833-04 NL

1 of 3
AD A
092246




1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

LEVEL II

DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

DTNSRDC/SPD-0833-04

AD A092246

ANALYSIS OF WAKE SURVEY EXPERIMENTAL DATA FOR MODEL 5365 REPRESENTING THE R/V ATHENA IN THE DTNSRDC TOWING TANK

by

Rae B. Hurwitz

and

L. Bruce Crook

DTIC ELECTE DEC 1 1980 S C D

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

DDC FILE COPY

SHIP PERFORMANCE DEPARTMENT REPORT

October 1980

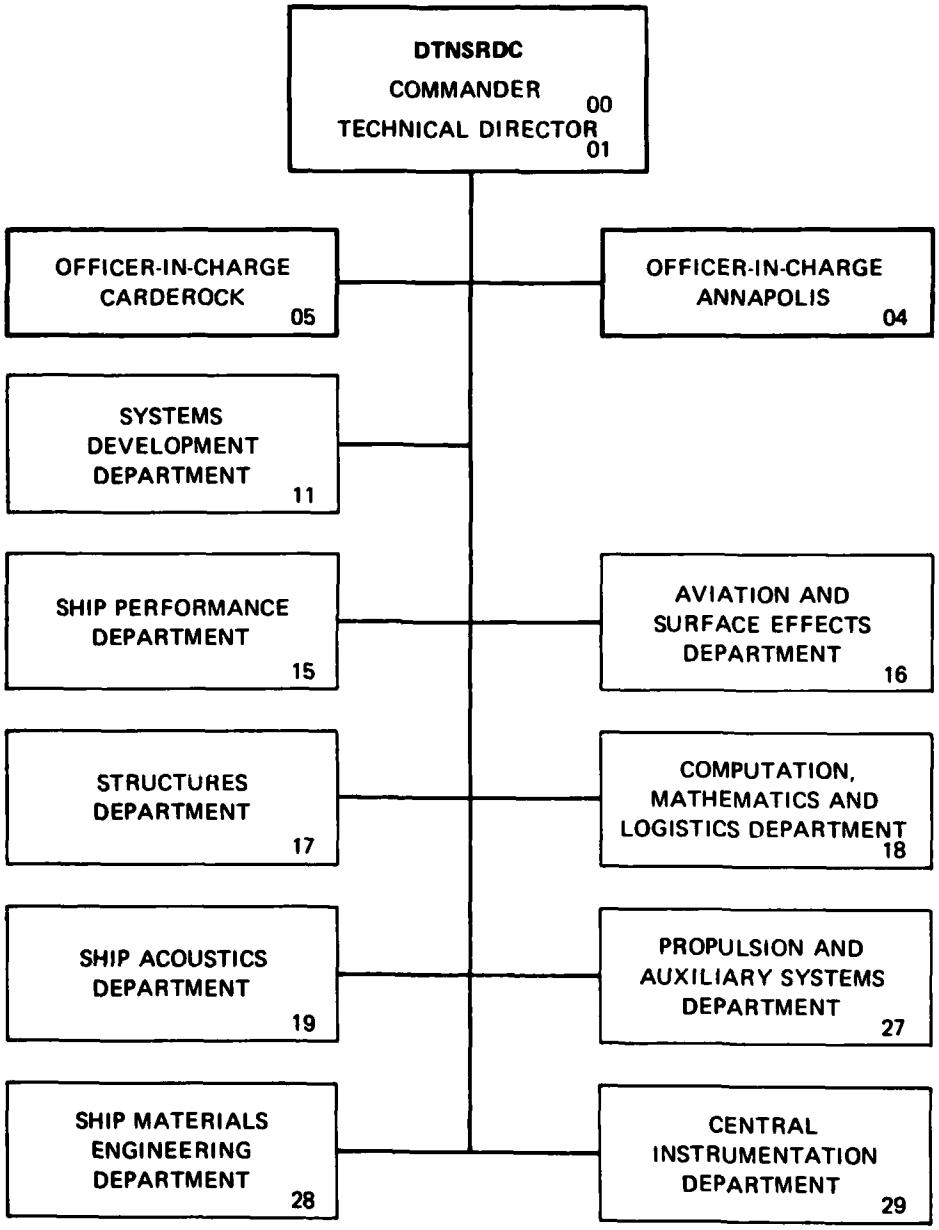
DTNSRDC/SPD-0833-04

ANALYSIS OF WAKE SURVEY EXPERIMENTAL DATA FOR MODEL 5365 REPRESENTING THE R/V ATHENA IN THE DTNSRDC TOWING TANK

80 1201 055

(DTNSRDC 5602/30 (2-80)
(supersedes 3960/46)

MAJOR DTNSRDC ORGANIZATIONAL COMPONENTS



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: DTNSRDC/SPD-0833-04 (14)

2. GOVT ACCESSION NO.: AD-A093 246

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): (6) ANALYSIS OF WAKE SURVEY EXPERIMENTAL DATA FOR MODEL 5365 REPRESENTING THE R/V ATHENA IN THE DTNSRDC TOWING TANK

5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL Rept.

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): (10) Rae B. Hurwitz ~~and~~ L. Bruce Crook

8. CONTRACT OR GRANT NUMBER(s): (15)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
David W. Taylor Naval Ship R&D Center
Ship Performance Department
Bethesda, MD 20084

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (17) ~~Task Area~~ S0379001
Work Unit 1524-641
1524-684

11. CONTROLLING OFFICE NAME AND ADDRESS
Naval Sea Systems Command (NAVSEA 05R) (11)
Washington DC 20362

12. REPORT DATE: October 1980

13. NUMBER OF PAGES: 212 + XX

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (16) SØ379

15. SECURITY CLASS. (of this report): UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMTED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Wake survey
Shallow Water
R/V Athena
Model 5365

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A series of wake survey experiments were conducted on Model 5365 representing the R/V ATHENA in the DTNSRDC towing tank. Longitudinal, tangential, and radial velocity components for experiments at model speeds of 2.87 knots (1.48 m/s), 5.22 knots (2.68 m/s), 6.96 knots (3.58 m/s), and 13.5 knots (6.94 m/s) are presented. Several comparisons are made between wake surveys with different water depths, trims, and speeds. A comparison of full-scale and model-scale towing tank wake survey measurements is also presented. Harmonic analyses of the circumferential distribution of the velocity component ratios

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

389611

were performed on the model experimental data and the results are reported herein.

TABLE OF CONTENTS

	Page
LIST OF FIGURES	iv
LIST OF TABLES	xi
NOTATION	xvi
ABSTRACT	1
ADMINISTRATIVE INFORMATION	1
INTRODUCTION	1
DESCRIPTION OF MODEL AND INSTRUMENTATION	3
EXPERIMENTS	4
PRESENTATION OF RESULTS OF VELOCITY SURVEYS	5
PHASE ONE - EXPERIMENTS 2, 3, 4, 5, 6, 7, 8, AND 9	5
PHASE TWO - EXPERIMENTS 19 AND 21	7
DISCUSSION OF RESULTS	7
ACCURACY OF INSTRUMENTATION	7
EFFECT OF HIGHER MODEL SPEED - EXPERIMENTS 2 AND 4	8
EFFECT OF OPERATING PORT PROPELLER - EXPERIMENTS 2 AND 8	8
EFFECT OF SHALLOW WATER AND STRUT BARREL - EXPERIMENTS 8, 19, AND 21	8
DIFFERENCES IN VELOCITY COMPONENT RATIOS BETWEEN EXPERIMENTS	9
COMPARISON OF MODEL- AND FULL-SCALE DATA	10
CONCLUSIONS	11
REFERENCES	13
APPENDIX A - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENTS 2 AND 7	51
APPENDIX B - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENTS 3 AND 9	81
APPENDIX C - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 4	111

Accession For
By
Distribution/
Availability
Avail and
Dist Special
A

Page

APPENDIX D - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 5 127

APPENDIX E - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 6 154

APPENDIX F - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 8 159

APPENDIX G - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 19 175

APPENDIX H - VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 21 191

APPENDIX I - VELOCITY COMPONENT RATIOS FOR R/V ATHENA AND MODEL EXPERIMENTS 8 AND 21 207

LIST OF FIGURES

1 - Profile Lines and Body Plan for the R/V ATHENA Represented by Model 5365 15

2 - Controllable Pitch Propeller Geometry 16

3 - Afterbody of Hull Showing Radii of Wake Survey Measurements .. 17

4 - Fitting Room Photographs of DTNSRDC Model 5365 Representing the R/V ATHENA 18

5 - After End View of DTNSRDC Model 5365 Fitted with a Rake of Five-Hole Pitot Tubes on the Starboard Shaft 19

6 - Afterbody Quarter View of DTNSRDC Model 5365 Fitted with a Rake of Five-Hole Pitot Tubes on the Starboard Shaft .. 20

7 - Afterbody Profile View of DTNSRDC Model 5365 Fitted with a Rake of Five-Hole Pitot Tubes on the Starboard Shaft .. 21

8 - Starboard Afterbody Profile View of DTNSRDC Model 5365 Showing Strut Barrel Extension 22

9 - Starboard Quarter View of DTNSRDC Model 5365 Showing Strut Barrel Extension 23

10 - Port Afterbody Profile View of DTNSRDC Model 5365 Showing Propeller and Rudder 24

LIST OF FIGURES (Continued)

Page

11 - Bow Wave Profile of DTNSRDC Model 5365 in Shallow Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 Knots, Full-Scale 25

12 - Stern Wave Profile of DTNSRDC Model 5365 in Shallow Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 Knots, Full-Scale 26

13 - Bow Wave Profile of DTNSRDC Model 5365 in Deep Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 Knots, Full-Scale 27

14 - Stern Wave Profile of DTNSRDC Model 5365 in Deep Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 Knots, Full-Scale 28

15 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.456 Radius..... 29

16 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.633 Radius..... 30

17 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.781 Radius..... 31

18 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.963 Radius..... 32

19 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake from R/V ATHENA and Experiments 2 and 8..... 33

20 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle from R/V ATHENA and Experiments 2 and 8..... 34

21 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.456 Radius..... 35

22 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.633 Radius 36

23 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.781 Radius 37

24 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.963 Radius 38

25 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake of Experiments 2 and 4 39

26 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle of Experiments 2 and 4 40

LIST OF FIGURES (Continued) Page

27 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.456 Radius 41

28 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.633 Radius 42

29 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.781 Radius 43

30 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.963 Radius 44

31 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake of Experiments 8, 19, and 21 45

32 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle of Experiments 8, 19, and 21 46

A-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 2..... 52

A-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 2..... 53

A-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 2..... 54

A-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 2..... 55

A-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 2..... 56

A-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations of Experiment 2..... 57

A-7 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 7..... 58

A-8 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 7..... 59

LIST OF FIGURES (continued)

Page

A-9 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 7 60

A-10 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 7 61

A-11 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 7 62

A-12 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 7 63

B-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiments 3 and 9 82

B-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiments 3 and 9 83

B-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiments 3 and 9 84

B-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiments 3 and 9 85

B-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 3 86

B-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 3 87

B-7 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 9 88

B-8 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 9 89

B-9 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 9 90

80 1201 055

LIST OF FIGURES (Continued) Page

B-10 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 9 91

B-11 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 9 92

B-12 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 9 93

C-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 4 112

C-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 4 113

C-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 4 114

C-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 4 115

C-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 4 116

C-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 4 117

D-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 5 128

D-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 5 129

D-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 5 130

D-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 5 131

D-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 5 132

LIST OF FIGURES (Continued)

Page

D-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 5 133

E-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 6 144

E-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 6 145

E-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 6 146

E-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 6 147

E-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 6 148

E-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 6 149

F-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 8 160

F-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 8 161

F-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 8 162

F-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 8 163

F-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 8 164

F-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 8 165

G-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 19 176

LIST OF FIGURES (Continued)

Page

G-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 19 177

G-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 19 178

G-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 19 179

G-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 19 180

G-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 19 181

H-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 21 192

H-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 21 193

H-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio - 0.781 for Experiment 21 194

H-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 21 195

H-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 21 196

H-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 21 197

I-1 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.456 Radius 208

I-2 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.633 Radius 209

I-3 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.781 Radius 210

I-4 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.963 Radius 211

LIST OF TABLES

Page

1 - Ship and Model Data for R/V ATHENA Represented by DTNSRDC Model 5365 47

2 - Catalog of Experiments Performed 48

3 - Summary of Wake Survey Experimental Data 49

4 - Effect of Speed on the Circumferential Mean Velocities, Mean Advance Angle and its Variations, and the First Four Harmonics .. 50

A-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 2 64

A-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 2 65

A-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 2 66

A-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 2 67

A-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 2 69

A-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 2 70

A- 7 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 7 72

A- 8 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and Other Derived Quantities at the Experimental and Interpolated Radii for Experiment 7 73

A- 9 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 7 74

A-10 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 7 75

A-11 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 7 77

A-12 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 7 78

LIST OF TABLES (Continued)

Page

B-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 3 94

B-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 3 95

B-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 3 96

B-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 3 97

B-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 3 99

B-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 3 100

B- 7 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 9 102

B- 8 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and Other Derived Quantities at the Experimental and Interpolated Radii for Experiment 9 103

B- 9 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 9 104

B-10 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 9 105

B-11 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 9 107

B-12 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 9 108

LIST OF TABLES (Continued)

Page

C-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 4.....118

C-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 4.....119

C-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 4.....120

C-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 4.....121

C-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 4.....123

C-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 4.....124

D-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 5.....134

D-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 5.....135

D-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 5.....136

D-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 5.....137

D-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 5.....139

D-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 5.....140

E-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 6.....150

E-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 6.....151

E-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 6.....152

LIST OF TABLES (Continued)

Page

E-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 6..... 153

E-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 6..... 155

E-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 6..... 156

F-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 8..... 166

F-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 8..... 167

F-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 8..... 168

F-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 8.....169

F-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 8..... 171

F-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 8..... 172

G-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 19..... 182

G-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 19..... 183

G-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 19..... 184

G-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 19..... 185

G-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 19..... 187

LIST OF TABLES (Continued)

Page

G-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 19.....188

H-1 - Input Data for Harmonic Analysis for R/V ATHENA, Model 5365, Experiment 21.....198

H-2 - Listing of the Mean Velocity Component Ratios, the Mean Advance Angles and other Derived Quantities at the Experimental and Interpolated Radii for Experiment 21.....199

H-3 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Experimental Radii for Experiment 21.....200

H-4 - Harmonic Analyses of Longitudinal Velocity Component Ratios at the Interpolated Radii for Experiment 21.....201

H-5 - Harmonic Analyses of Tangential Velocity Component Ratios at the Experimental Radii for Experiment 21.....203

H-6 - Harmonic Analyses of Tangential Velocity Component Ratios at the Interpolated Radii for Experiment 21.....204

I-1 - Input Data for Harmonic Analysis of Wake Data for R/V ATHENA...212

NOTATION

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
A_N	COS COEF	The cosine coefficient of the Nth harmonic*
B_N	SIN COEF	The sine coefficient of the Nth harmonic*
C	C	Pressure reading at center hole of 5-hole pitot tube
D	---	Propeller diameter
J_V	J_V	Apparent advance coefficient $J_V = \frac{V}{nD}$ (dimensionless)
N	N	Harmonic number
n	---	Propeller revolutions
P	P	Pressure
r/R or x	Radius or RAD.	Distance (r) from the propeller axis expressed as a ratio of the propeller radius (R)
R_n	R_n	Reynolds number
R1, R2	R1, R2	Pressure reading at radial holes of 5-hole pitot tube
T1, T2	T1, T2	Pressure reading at tangential holes of 5-hole pitot tube
U/U_∞	U/U_∞	Non-dimensional longitudinal velocity measured by means of boundary layer pitot tubes
V	V	Actual model or ship velocity
$V_b(x,\theta)$	---	Resultant inflow velocity to blade for a given point
$\bar{V}_b(x)$	---	Mean resultant inflow velocity to blade for a given radius
$V_r(x,\theta)$	VR	Radial component of the fluid velocity for a given point (positive toward the shaft centerline)

(*see footnote on page xviii)

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
$\overline{V}_r(x)$	---	Mean radial velocity component for a given radius
$V_r(x,\theta)/V$	VR/V	Radial velocity component ratio for a given point
$\overline{V}_r(x)/V$	VRBAR	Mean radial velocity component ratio for a given radius
$V_t(x,\theta)$	VT	Tangential component of the fluid velocity for a given point (positive in a counterclockwise direction looking forward)
$\overline{V}_t(x)$	---	Mean tangential velocity component for a given radius
$V_t(x,\theta)/V$	VT/V	Tangential velocity component ratio for a given point
$\overline{V}_t(x)/V$	VTBAR	Mean tangential velocity component ratio for a given radius
$(\tilde{V}_t(x)/V)_N$	AMPLITUDE	Amplitude (B_N for single screw symmetric; C_N otherwise) of Nth harmonic of the tangential velocity component ratio for a given radius*
$V_x(x,\theta)$	VX	Longitudinal (normal to the plane of survey) component of the fluid velocity for a given point (positive in the astern direction)
$\overline{V}_x(x)$	---	Mean longitudinal velocity component for a given radius
$V_x(x,\theta)/V$	VX/V	Longitudinal velocity component ratio for a given point
$V_x(x)/V$	VXBAR	Mean longitudinal velocity component ratio for a given radius
$(\tilde{V}_x(x)/V)_N$	AMPLITUDE	Amplitude (A_N for single screw symmetric; C_N otherwise) of Nth harmonic of the longitudinal velocity component ratio for a given radius*

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
x/L_{WL}	x/L_{WL}	Non-dimensional longitudinal location of boundary layer pitot tubes
ϕ_N	PHASE ANGLE	Phase angle of Nth harmonic*

*The harmonic amplitudes of any circumferential velocity distribution f (θ) are the coefficients of the Fourier Series:

$$f(\theta) = A_o + \sum_{N=1}^{N} A_N \cos(N\theta) + \sum_{N=1}^{N} B_N \sin(N\theta)$$
$$= A_o + \sum_{N=1}^{N} C_N \sin(N\theta + \phi_N)$$

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
$1-w(x)$	1-WX	Volumetric mean velocity ratio from the hub to a given radius

$$1-w(r/R) = \left[\frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{V}_{x_c}(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2} \right]$$

where $\bar{V}_{x_c}(x)/V = \int_0^{2\pi} \left[\frac{V_{x_c}(x,\theta)}{2\pi V} \right] d\theta$

and $V_{x_c}(x,\theta)/V = (V_x(x,\theta)/V) - (V_t(x,\theta)/V) \tan(\beta(x,\theta))$

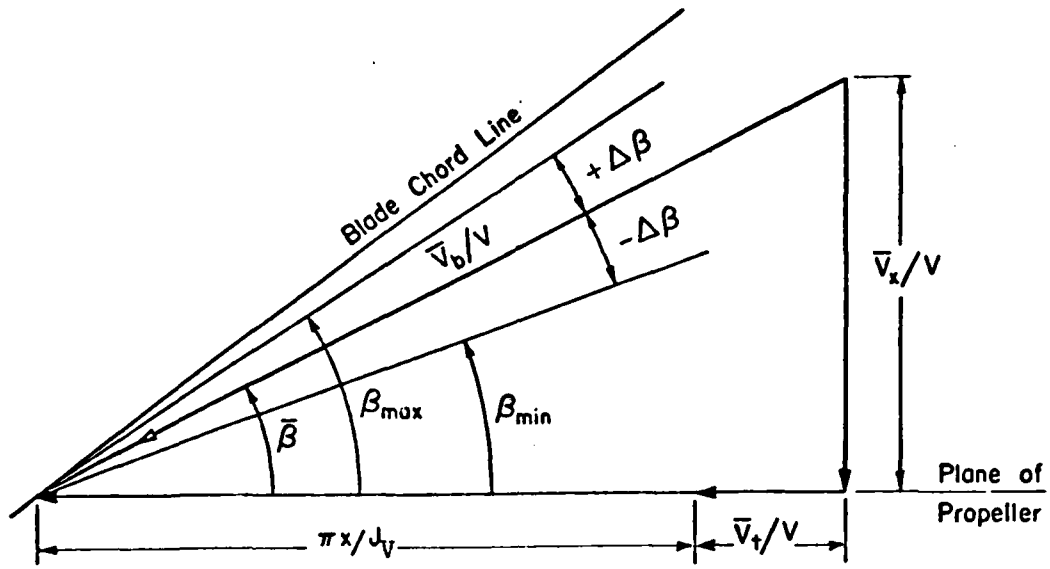
$1-w_v(x)$	1-WVX	Volumetric mean velocity ratio from the hub to a given radius (without the tangential velocity correction)

$$1-w(r/R) = \left[\frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{V}_x(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2} \right]$$

$\beta(x,\theta)$	---	Advance angle in degrees for a given point
$\bar{\beta}(x)$	BBAR	Mean advance angle in degrees for a given radius
$+\Delta\beta$	BPOS	Variation of the maximum advance angle from the mean for a given radius

NOTATION (CONTINUED)

$-\Delta\beta$	BNEG	Variation of the minimum advance angle from the mean for a given radius
θ	Angle in degrees	Position angle (angular coordinate) in degrees



VELOCITY DIAGRAM OF BETA ANGLES

ENGLISH/SI EQUIVALENTS

ENGLISH	SI
1 inch	25.400 millimetres [0.0254 m (metres]
1 foot	0.3048 m (metres)
1 foot per second	0.3048 m/sec (metres per second)
1 knot	0.5144 m/sec (metres per second)
1 degree (angle)	0.01745 rad (radians)
1 inch Water (60°F)	248.8 pa (pascals)

ABSTRACT

A series of wake survey experiments were conducted on Model 5365 representing the R/V ATHENA in the DTNSRDC towing tank. Longitudinal, tangential, and radial velocity components for experiments at model speeds of 2.87 knots (1.48 m/s), 5.22 knots (2.68 m/s), 6.96 knots (3.58 m/s), and 13.5 knots (6.94 m/s) are presented. Several comparisons are made between wake surveys with different water depths, trims, and speeds. A comparison between full-scale and model-scale towing tank wake survey measurements is also presented. Harmonic analyses of the circumferential distribution of the velocity component ratios were performed on the model experimental data and the results are reported herein.

ADMINISTRATIVE INFORMATION

This work was performed under the Controllable Pitch Propeller Research Program sponsored by the Naval Sea Systems Command (NAVSEA 05R) and administered by the David W. Taylor Naval Ship R&D Center (DTNSRDC). The project was funded under Task Area S0379001 and DTNSRDC Work Unit Numbers 1524-641 and 1524-684.

INTRODUCTION

The David W. Taylor Naval Ship R&D Center (DTNSRDC) conducted a full-scale wake survey aboard the R/V ATHENA as part of its overall project to adapt controllable pitch propellers to high speed combatant ships. The primary project goal was to obtain propeller disk velocity component ratios in the wake of a full-scale ship. A description of the R/V ATHENA full-scale measurements, instrumentation, trial procedures, and measured data was presented by Day et al.[1] The full-scale propeller disk measurements were followed by model wake survey experiments in a wind tunnel and a towing tank. The wind tunnel experiments and correlation with full-scale measurements were presented by Hurwitz and Jenkins.[2]

A series of wake surveys were conducted on Model 5365 representing the R/V ATHENA in the towing tank at DTNSRDC. The velocity component

---

[1] References are listed on page 13.

ratios were measured at radii corresponding exactly to the full-scale wake survey radii, allowing a direct one-to-one comparison between model and full-scale data. These experiments were designed to evaluate the differences in the model wake in the starboard propeller plane with and without the port propeller operating. The initial wake survey was conducted at a model speed corresponding to the Froude-scaled speed of the ship without the operating propeller. The model propeller was removed from the shafting and replaced by a dummy hub during the wake surveys. The initial model correlation data with the R/V ATHENA data were not particularly good. Additional wake surveys were run to try to improve the model correlation by varying the speed with and without the port propeller operating.

The effects of Reynolds number were investigated on the model-scale wake by running at an increased speed. The speed chosen was the highest speed for which steady data could be obtained. These variations made no significant improvement in the correlation of the tangential velocity components.

In addition, wake surveys were conducted with and without the Bass Dynamometer Boat, Model 5271, mounted behind Model 5365. This information was needed for the Bass Dynamometer Boat effect on the flow into the propeller disk area. The results of these Bass Dynamometer Boat wake surveys will be presented in a future report.

Finally, in an attempt to further improve the correlation of model- and full-scale data, another group of experiments was run to investigate the water depth and trim effects on the R/V ATHENA. These wake surveys were conducted in deep water, and at a water depth scaled to the full-scale trial water depth. The term shallow water will be used only to differentiate between the scaled water depth and the normal (deep) water depth used experimentally in this report. Shallow water can change the wave system due to the model and possibly affect the flow pattern around the model hull.

The results of the model wake survey conducted on Model 5365 representing the R/V ATHENA in deep and shallow water are also presented in this report. Comparisons are made between the shallow and deep water wake surveys with different speeds and trims. Full-scale data are presented as a comparison with the data obtained from the towing tank

experiments.

DESCRIPTION OF MODEL AND INSTRUMENTATION

Model 5365, representing the R/V ATHENA, was constructed of fiberglass having a scale ratio of one to 8.25. The model principal dimensions are listed with the ship dimensions in Table 1. During the wake survey experiments, the model was appended with shafts, main Vee-struts, roll stabilizer fins, and a centerline skeg. Model rudders were not installed during the first group of experiments. Figure 1 shows the body plan and bow and stern profiles of the model.

The full-scale parameters for the model experiments were at a displacement of 263 tons (267 metric ton) salt water and a mean draft of 5.63 feet (1.72 meters). The velocity surveys were conducted in the propeller plane located 146.2 feet (44.56 meters) aft of the forward perpendicular on the starboard shaft. Figure 2 shows a drawing of the Controllable Pitch Propeller.

The full-scale propeller disk was six feet (1.83 meters) in diameter. The radii at which the measurements were made were expressed as ratios of the propeller radius (r/R), and were 0.456, 0.633, 0.781, and 0.963 as shown in Figure 3. The model details during the deep water wake survey experiments are shown in Figures 4 through 7. The photographs indicate the relationship of the pitot tube rake, in the propeller plane, to the hull and its appendages for these wake surveys.

Figures 8 through 10 present the model details for the shallow water wake surveys. During these experiments, Model 5365 was appended with the port rudder and starboard strut barrel extension to better represent the R/V ATHENA configuration. Wave profiles for a ship speed corresponding to 15 knots (7.72 m/s) full-scale in shallow and deep water from Experiments 19 and 21 are shown in Figures 11 through 14.

The shape of the pitot tube rake was such that the rake could possibly change the hull trim or heel while the model was towed. In order to insure the proper trim throughout an individual or group of similar experiments, the model was locked into either a deep water trim as in Experiments 1 through 12, or the shallow water trim for Experiments 17 through 22.

The model wake measurement system consisted of the rake, a set of four differential pressure gages, a stepping motor, and an angle indicator. Experiments 1 through 16 had one set of gages and Experiments 17 through 22 had two sets. The base pressure for each tube was the center hole. A description of the use and calibration of five-hole pitot tubes is given by Hadler and Cheng[3], Hale and Norris[4], and Pien[5]. The carriage computer integrated, over a 5-second period, the four pressure signals from each pitot tube, the model speed, and the angular rake position. Digital voltmeters and frequency counters were used to monitor the values obtained by the computer. The pressure data were collected and processed according to established procedures.

The first phase of the data analysis consists of changing the pressure data into velocity component ratios. The velocity component ratios are double interpolated in both the radial and circumferential directions. This process yields interpolated data at every 2.5 degrees (0.044 radian) for the experimental radii and any additional selected radii. The second phase consists of a harmonic analysis of these interpolated data which determines a Fourier Series, with the results presented as amplitudes and phase angles of a sine series.

EXPERIMENTS

The experimental program consisted of a series of twenty-two experiments in deep and shallow water performed in two phases. Phase one wake measurements were made on the starboard shaft with and without the port propeller operating. These included Experiments 1 through 16 which were conducted in deep water at the static initial trim of 0.58 feet (0.18 meters) full-scale by the stern without rudders fitted to the model. The calibration of the pressure gages and a check-out of the entire measurement system was Experiment 1. Experiments 2, 3, 4, 5, 6, 8, 9, and 10 were deep water wake survey experiments for model speeds of 2.87 knots (1.48 m/s), 5.22 knots (2.68 m/s), 6.96 knots (3.58 m/s), and 13.5 knots (6.94 m/s). Experiment 7 was a short check of values obtained in Experiment 2. Wake survey experiments conducted with the bass dynamometer boat and Model 5365 with a wake screen at various inclined angles were designated Experiments 11 through 16. The results from Experiments 10 through 16

will be presented in a separate report.

In phase two, Experiments 17 through 22 were performed with the model ballasted to a static initial trim of 0.58 feet (0.18 meters) full-scale by the stern. The model was then run in shallow water at the desired speed, allowed to assume a shallow water running trim, and locked in place at this shallow water trim. Experiment 17 consisted of the calibration of the pressure gages and Experiment 18 was a shallow and deep water wake survey for four radii at twenty degree (0.349 radian) increments around the propeller disk. Experiments 20 and 22 were run in deep water only for two radii for a full disk and twenty degree (0.349 radian) increments, respectively. Experiment 19 was a wake survey in deep water at the shallow water trim setting and Experiment 21 was a wake survey in shallow water at the shallow water trim setting. Table 2 presents the experimental program with notes identifying each specific wake survey experiment. Variations in model speed, trim setting, with or without port propeller, and water depth for each experiment are included in this table.

PRESENTATION OF RESULTS OF VELOCITY SURVEYS

PHASE ONE - EXPERIMENTS 2, 3, 4, 5, 6, 7, 8, AND 9

The velocity component ratios were measured at radii corresponding exactly to the full-scale wake survey on the R/V ATHENA. This allowed a direct one-to-one comparison of the data as presented in Reed and Day[6]. Experiments 2, 7, and 8 were performed at a 5.22 knot (2.68 m/s) speed, corresponding to a Froude-scaled speed of 15 knots (7.72 m/s) full-scale. Experiments 2 and 7 were performed without the port propeller. Experiment 7 was an abbreviated repeat of Experiment 2. Experiment 3 was performed without the operating port propeller.

Appendices A and F present the velocity component ratios from Experiments 2, 7, and 8. Composite plots have been produced which show Experiments 2 and 8, along with the full-scale data on one grid. These composite plots presented in Figures 15 through 18 show the effect of the operating propeller on the velocity components for the four experimental radii.

Experiment 3 was conducted at a model speed of 6.96 knots (3.58 m/s) without the port propeller. Experiment 9 was a check of Experiment 3 with

data obtained at least every 45 degrees (0.785 radians). The results of Experiments 3 and 9 are shown in Appendix B.

Experiment 4 investigated the effect of Reynolds number on the model wake. This wake survey was run at a speed of 13.5 knots (6.94 m/s) without the port propeller. This was the highest speed for which steady state data could be obtained. The trim was locked at the running trim assumed at the 5.22 knot (2.68 m/s) speed. This experiment also investigated the scaling laws of wake as close to full-scale conditions as possible. The data from this wake survey, Experiment 4, are presented in Appendix C. The velocity component ratios from Experiment 2 at 5.22 knots (2.68 m/s) and Experiment 4 at 13.5 knots (6.94 m/s) have been plotted together and are presented in Figures 21 through 24.

Wake survey Experiments 5 and 6 were run at a model speed of 2.87 knots (1.48 m/s) with and without the port propeller operating. Appendices D and E present the data for Experiments 5 and 6, respectively.

Harmonic analyses have been performed on the longitudinal and tangential velocity component ratios for the experiments of phase one. Figures 19, 20, 25, and 26 have been prepared as composites which show the results of Experiments 2 and 8, and 2 and 4. Tables of the individual harmonic amplitudes and phase angles are presented in Appendices A, B, C, D, E, and F for Experiments 2 and 7, 3 and 9, 4, 5, 6, and 8, respectively. In each of these appendices, the complete set of sixteen harmonics calculated for each experiment are presented for the four experimental radii and eight interpolated radii.

The mean longitudinal (VXBAR), tangential (VTBAR), radial (VRBAR) component ratios of the velocity vectors, and the volumetric mean wake velocity ratio (1-WX) are presented in each Appendix. These quantities except the radial component (VRBAR) are also shown graphically in each Appendix.

The calculated mean values of the advance angle (BBAR), and the maximum variations thereof (BPOS) and (BNEG) are shown in tables and figures plotted as a function of radius in the Appendices. The advance angles were calculated using an advance coefficient, J_V, of 0.739. A diagram showing the relationship between the longitudinal and tangential

velocity vectors, the advance coefficient, and the advance angles is presented on page xx.

PHASE TWO - EXPERIMENTS 19 AND 21

Wake survey experiments were conducted in shallow and deep water at the shallow water trim setting. Experiments 19 and 21 were run from west to east on Carriage One at a model speed of 5.22 knots (2.68 m/s) with the propeller operating. The R/V ATHENA trial depth of 55.7 feet (17.0 meters) was determined from a Coast and Geodetic Survey Chart and could be considered less than "deep water." The corresponding model-scale water depth was 6.75 feet (2.06 meters). The data from Experiments 19 in deep water and 21 in shallow water are presented in Appendices G and H, respectively. Experiment 21 data have an integration time of one second at three locations in the shallow water basin. These points were at 90 feet (27.4 meters), 60 feet (18.3 meters), and 30 feet (9.14 meters) from the end of the shallow water basin. The data from Experiments 8, 19, and 21 have been plotted together in Figures 27 through 30 to show the effects of shallow water and shallow water trim.

Harmonic analyses of the circumferential distribution of the longitudinal and tangential velocities have been performed. The amplitudes and phase angles for the experimental and interpolated radii are shown in tabular form in Appendices G and H. Circumferential mean velocity component ratios, volumetric mean velocities and the advance angles for each survey are presented in both tabular and graphical form in these Appendices. Figures 31 and 32 present the composite results of the harmonic analyses of Experiments 8, 19, and 21. The advance angles were calculated using an advance coefficient, J_V, of 0.739.

DISCUSSION OF RESULTS

ACCURACY OF INSTRUMENTATION

The measurement system used in these velocity surveys has been described by Grant and Lin[7]. The accuracy of the pressure transducer system is approximately plus or minus three hundredths of an inch of water pressure (7.5 pascal). The accuracy of the entire velocity survey apparatus is estimated to be $\pm$ 1 percentage point on the longitudinal

velocity component ratio (VX/V), except in areas where steep velocity gradients occur. In these areas, such as behind a shaft strut, the accuracy is significantly less.

EFFECT OF HIGHER MODEL SPEED - EXPERIMENTS 2 AND 4

The data from the wake surveys at 5.22 knots (2.68 m/s), Experiment 2, and 13.5 knots (6.94 m/s), Experiment 4, are presented in Figures 21 through 26. The longitudinal and radial velocity component ratios at these two speeds show no significant difference except at the 0.781 radius. This may be due to the roll stabilizer fins not being properly aligned at the higher speed. The tangential velocity component ratios obtained from Experiment 4 have peaks which are 4 to 6 percent lower than those obtained from Experiment 2. The VXBAR shows the same trend, but with a higher value at the 0.781 radius for Experiment 4 than for Experiment 2. The VTBAR, 1-WX, and 1-WVX values are all the same.

EFFECT OF OPERATING PORT PROPELLER - EXPERIMENTS 2 AND 8

No significant differences were observed with the longitudinal and radial velocity component ratios of both these experiments. Generally, however, the longitudinal velocity component ratios are higher for Experiment 8 than Experiment 2 especially for the outer two radii - which would be affected more by the propeller operating on the port side. The tangential velocity component ratios for all four radii of Experiment 8 are lower than those from Experiment 2 from 80 to 240 degrees. Except at the extrapolated values for VXBAR, VTBAR, 1-WX, and 1-WVX near the hub, the two experiments show no significant differences.

EFFECT OF SHALLOW WATER AND STRUT BARREL - EXPERIMENTS 8, 19, AND 21

As previously stated, the experimental set-up of Experiments 19 and 21 differed from that of Experiment 8 by the extension of the starboard strut barrel and the addition of the port rudder. The results from Experiments 19 and 21 indicate that there are no appreciable differences in the wake due to the water depth of the towing tank at the same trim setting. However, the setting of the shallow water trim does affect the results of the wake survey conducted in deep water. The three velocity

components from Experiments 19 and 21 show differences when compared to those of Experiment 8. The longitudinal velocity component ratios are lower for Experiments 19 and 21 than those for Experiment 8, except for the 0.781 radius ratio. The tangential velocity component ratios are generally lower for Experiments 19 and 21 than those of Experiment 8, except for the outermost radius ratio of 0.963. These differences in the data are just beyond experimental accuracy. Mixed conclusions are drawn from results with the radial velocity component ratios. For radius ratios of 0.456 and 0.781, the values are marginally lower; while for radius ratios of 0.633 and 0.963, the ratios are significantly higher for the shallow water trim experiments. The VTBAR shows no marked difference due to trim. However, the VXBAR, 1-WX, and 1-WVX show trends of lower values for shallow water trim with the shallow water results being the lowest.

DIFFERENCES IN VELOCITY COMPONENT RATIOS BETWEEN EXPERIMENTS

Table 3 presents some of the results from harmonic analysis of the data from Experiments 2, 7, 3, 9, 4, 8, 19, and 21 for the 0.781 radius. The analysis of experimental data for these wake surveys shows a trend toward a higher circumferential mean longitudinal velocity component ratio for the model trimmed in shallow water with the port propeller turning. The repeatability of this quantity is good between the R/V ATHENA model experiments. There is little difference in mean longitudinal velocity due to the port propeller turning for Experiments 2 and 8. There are no differences in this quantity for Experiments 19 and 21 due to water depth at the same trim setting. For Experiments 2 and 4, the difference in mean longitudinal velocity is about 2%. This difference is explained by the increased Froude number and change in wave pattern while restraining the trim to a set value.

The trend in the mean longitudinal data is clearly an increase with increasing speed-length ratio. Table 4 presents the data for mean velocity components and advance angles for four speeds at a radius ratio of 0.781. The trend of increasing mean longitudinal velocity with ship speed is clearly shown in Table 4.

The data from Experiment 2 without the port propeller operating were compared to that of Experiment 8 with the propeller operating. No

significant differences were observed in the longitudinal and radial velocity component ratios. However, the tangential velocity component ratio shows about a 2% change due to the propeller operating. The agreement is considered to be within experimental accuracy with the present instrumentation.

COMPARISON OF MODEL- AND FULL-SCALE DATA

Experiments 2 and 8 were performed to provide model-scale data for correlation with full-scale wake survey data. The velocity component ratios computed from ship and model data are presented in Figures 15 through 18. Table I-1 presents the velocity component ratios for the full-scale wake survey experiment.

The data from model experiments agree with the full-scale measurements reasonably well for the outer radii. The large differences in the longitudinal velocity component in the innermost radius are most probably due to difficulties measuring model velocities in the vicinity of the large propeller hub, which is at a significant angle to the flow due to the shaft angle. The differences between full-scale and model-scale measurements of the tangential velocity components are also larger for the innermost radius measured.

The results of the model experiments in deep water at the deep water trim setting, Experiment 8, and in shallow water at the shallow water trim setting, Experiment 21, are presented in Figures I-1 through I-4 along with the full-scale data. A study of the velocity component ratios presented in these figures shows that the degree of scatter of the full-scale data is higher than that of the model data in deep and shallow water. In particular, the full-scale data for the longitudinal velocity component ratios at the innermost radius of 0.456 show the largest scatter, and the greatest deviation from the model-scale wake. In part, this scatter is also due to the fact that the longitudinal velocity component ratios presented are an average of the longitudinal component calculated from the radial and tangential velocity component ratios. This tends to magnify any scatter in the radial and tangential velocity component ratios. Another possible contributing factor to the scatter

of the innermost radius is the close proximity of the pitot tube to the strut bossings.

The longitudinal velocity component ratios at the innermost radius are about 10% lower for the ship than for the model, while the peaks of the tangential velocity component ratios are about 10% higher for the ship than for the model. At the two outer radii of 0.781 and 0.963, the longitudinal velocity component ratios for the ship are 2 to 4 percent lower than those for the model. The peaks of the tangential velocity component ratios at the outer radii are 8 to 10 percent higher for the ship than for the model. The radial velocity component ratios at the two outermost radii are about 8 to 10 percent lower for the ship than for the model.

The periodic propeller blade loads on high speed transom stern vessels such as the R/V ATHENA arise primarily from the first harmonic of the tangential velocity component ratio. Calculations of periodic blade loads by the method of Kerwin and Lee[8] indicate that the periodic blade loads in the wake as measured full-scale would be approximately 27 percent higher than in the wake as measured model-scale.

CONCLUSIONS

1. No significant effect on the mean wake distribution due to the operating port propeller was observed.

2. The longitudinal and radial velocity component ratios between wake surveys at 5.22 knots (2.68 m/s) and 13.5 knots (6.94 m/s) show no difference except at the 0.781 radius due to the change in model speed above 5.22 knots (2.68 m/s) when the trim was held the same. The tangential velocity component ratios obtained at 13.5 knots (6.94 m/s) have peaks which are 4 to 6 percent lower than those obtained at 5.22 knots (2.68 m/s).

3. The mean longitudinal velocity component increases with increasing speed when the trim is fixed. The velocity defect from the shafts is less with increasing speed. Only slight increases occur in the radial velocity components with a change in speed.

4. No appreciable difference in the wake is shown due to the water depth of the towing tank when the model is fixed at the same trim setting.

5. The setting of the shallow water trim does seem to affect the results of the wake survey conducted in deep water. However, this difference is not significant enough to explain the differences between the previous model and full-scale experiments.

REFERENCES

1. Day, W. G., A. M. Reed, and R. B. Hurwitz, "Full-Scale Propeller Disk Wake Survey and Boundary Layer Velocity Profile Measurements on the 154-Foot Ship R/V ATHENA," DTNSRDC Ship Performance Department Report, DTNSRDC/SPD-0833-01 (Sep 1980).

2. Hurwitz, R. B. and D. S. Jenkins, "Analysis of Wake Survey and Boundary Layer Measurements for the R/V ATHENA Represented by Model 5366 in the Anechoic Wind Tunnel," DTNSRDC Ship Performance Department Report, DTNSRDC/SPD-0833-02 (Jul 1980).

3. Hadler, J. B. and H. M. Cheng, "Analysis of Experimental Wake Data in Way of Propeller Plane of Single- and Twin-Screw Ship Models," Trans. Soc. Naval Arch. and Mar. Eng., Vol. 73, pp. 287-414 (1965).

4. Hale, M. R. and D. H. Norris, "The Analysis and Calibration of the Five-Hole Spherical Pitot Tube," ASME Paper 67-WA/FE-24, 8p, (1967).

5. Pien, P. C., "Five-Hole Spherical Pitot Tube," DTNSRDC Report 1229, (May 1958).

6. Reed, A. M. and W. G. Day, "Wake Scale Effects on a Twin-Screw Displacement Ship," Twelfth Symposium on Naval Hydrodynamics, (Jun 1978).

7. Grant, J. W. and A. C. M. Lin, "The Effects of Variations of Several Parameters on the Wake in Way of the Propeller Plane for Series 60 - 0.60 C_B Models," Appendices A and D, NSRDC Report 3024, pp 105, (Jun 1969).

8. Kerwin, J. E. and C. S. Lee, "Prediction of Steady and Unsteady Marine Propeller Performance by Numerical Lifting Surface Theory," Transactions of the Society of Naval Architects and Marine Engineers, V-1. 86, pp. 218-253, (1978).

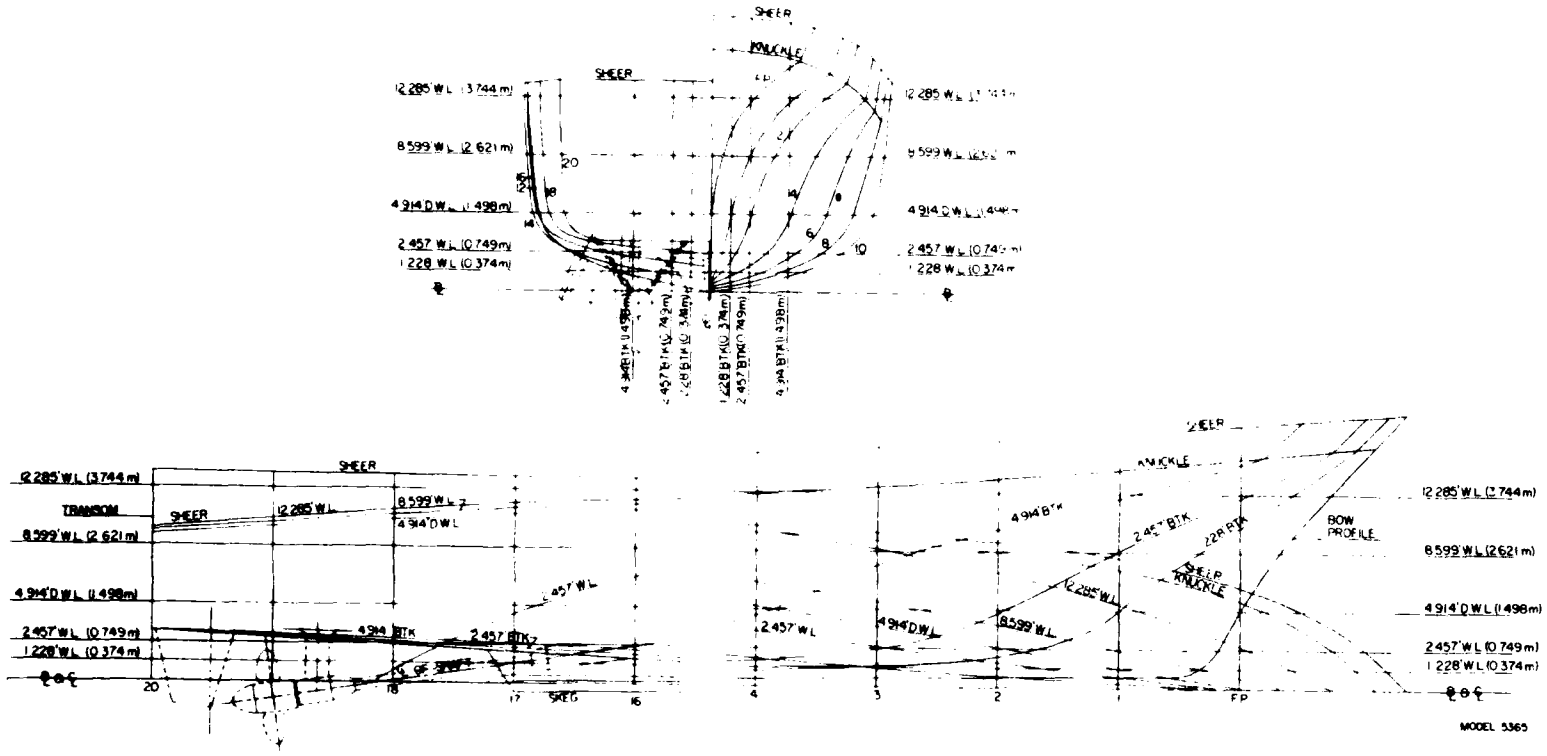


Figure 1 - Profile Lines and Body Plan for the R/V ATHENA Represented by Model 5365

	PROP NO	LINEAR RATIO	DIA MODEL	DIA SHIP	PITCH MODEL AT 70 PCT	PITCH SHIP AT 70 PCT	PITCH RATIO AT 70 PCT	NUMBER OF BLADES	EXP AREA	E.A./D.A.	M.W.R.	PROJ AREA	P.A./D.A.	B.T.F.	RAKE ANGLE AT TIP	ROTATION		SECTION LENGTH MODEL AT 70 PCT.
INCHES MM	4710	8.250	8.727 221.67	72.000 1828.80	9.697 246.30	80.000 2032.00	1.111	4	46.358 29908.6	0.775	0.443	40.100 25871.1	0.670	0.048	0.000	R.H.		4.698 119.33
INCHES MM	4711	8.250	8.727 221.67	72.000 1828.80	9.697 246.30	80.000 2032.00	1.111	4	46.358 29908.6	0.775	0.443	40.100 25871.1	0.670	0.048	0.000	L.H.		4.698 119.33

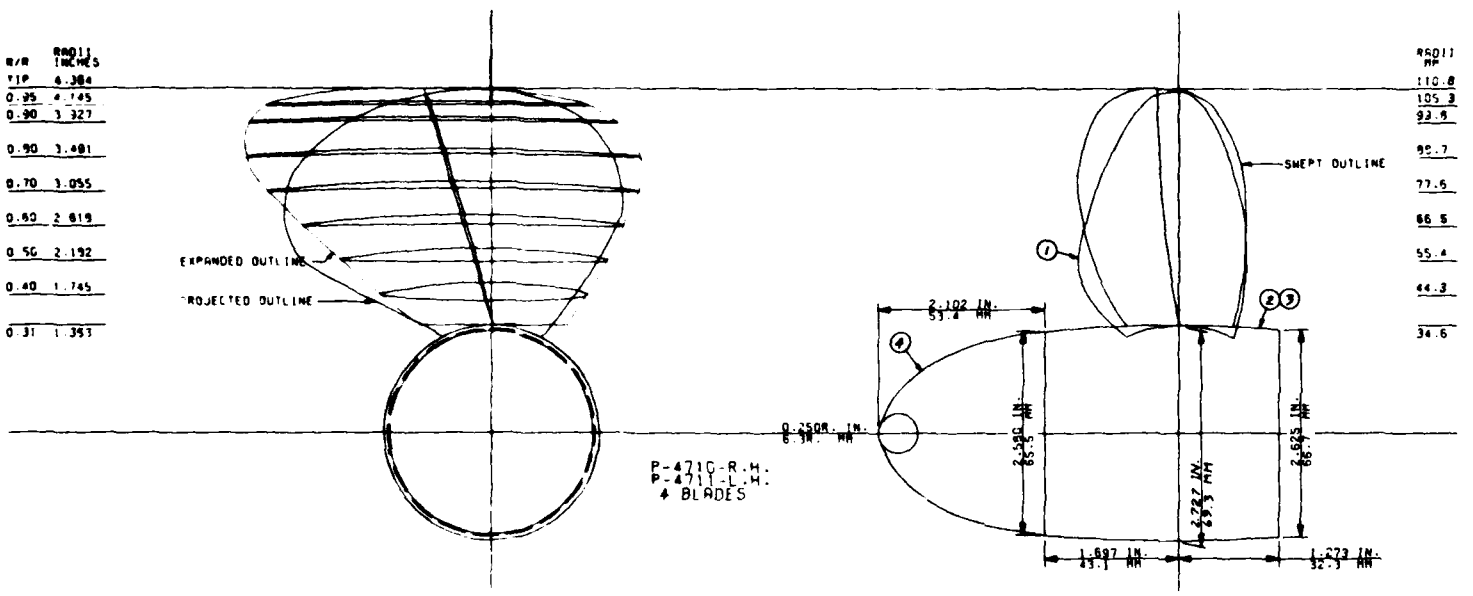


Figure 2 - Controllable Pitch Propeller Geometry

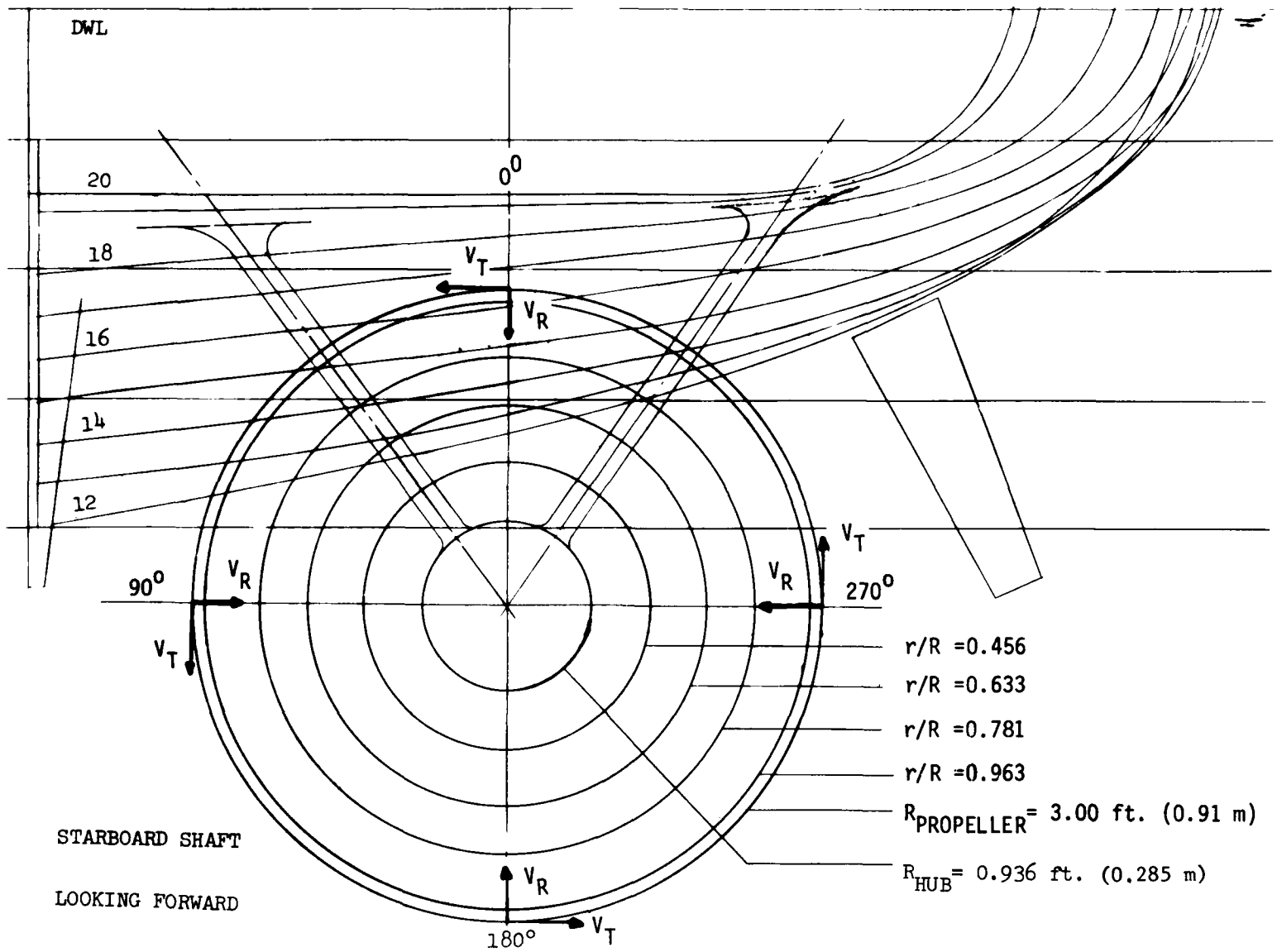


Figure 3 - Afterbody of Hull Showing Radii of Wake Survey Measurements

PSD-0604-5-78-3

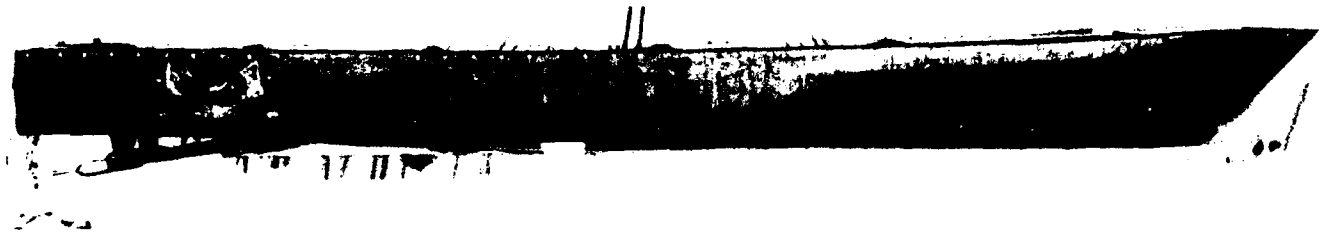


Figure 4a - Fitting Room Photograph of Model 5365 Representing the R/V ATHENA for Experiments 2,3, 4, 5, 7, and 9 without Propeller

PSD-0604-5-78-2

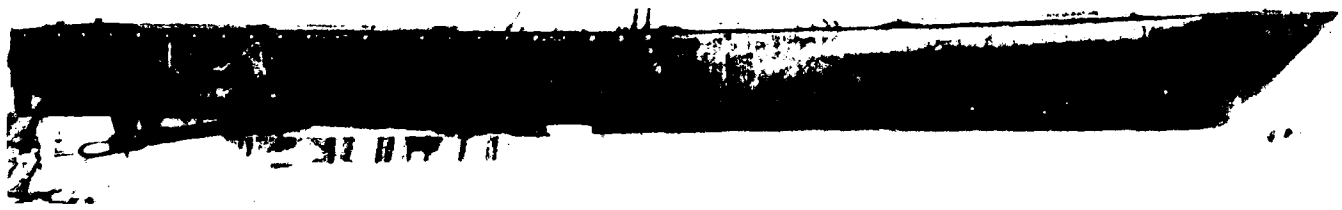


Figure 4b - Fitting Room Photograph of Model 5365 Representing the R/V ATHENA for Experiments 6 and 8 with Propeller

Figure 4 - Fitting Room Photographs of DTNSRDC Model 5365 Representing the R/V ATHENA

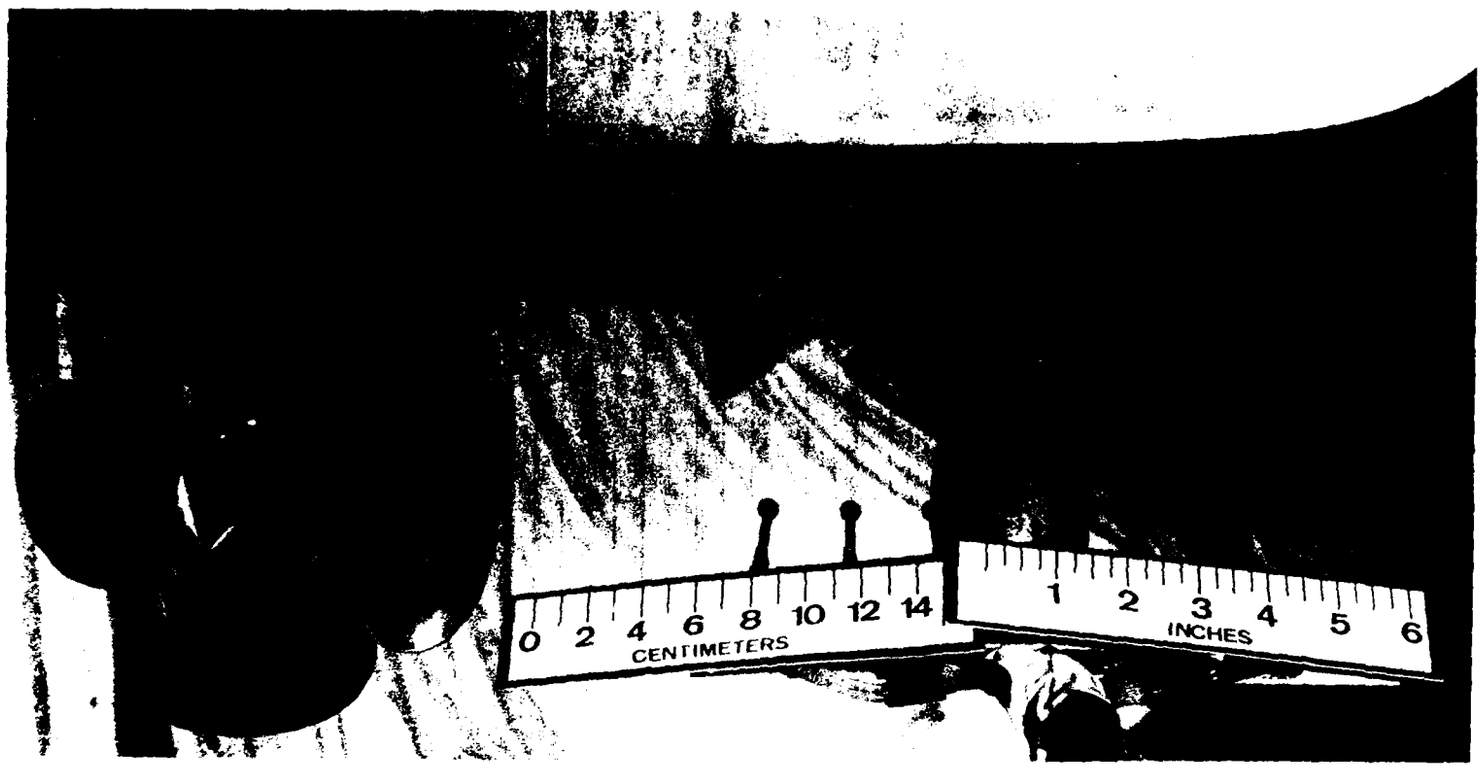


Figure 5 - After End View of DTNSRDC Model 5365 Fitted with a Rake of Five-Hole Pitot Tubes on the Starboard Shaft

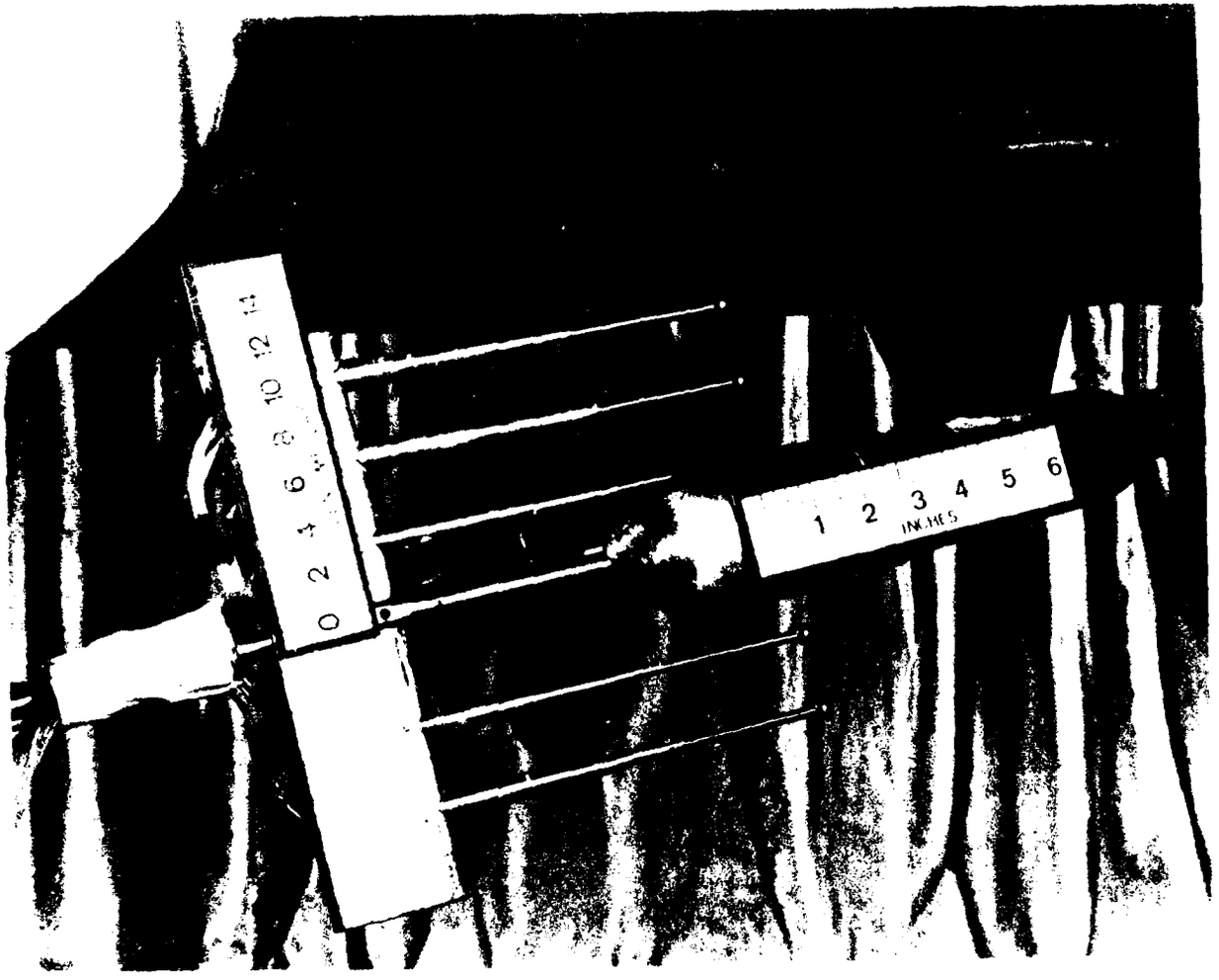


Figure 6 - Afterbody Quarter View of DTNSRDC Model 5365 Fitted with a Rake of Five-Hole Pitot Tubes on the Starboard Shaft

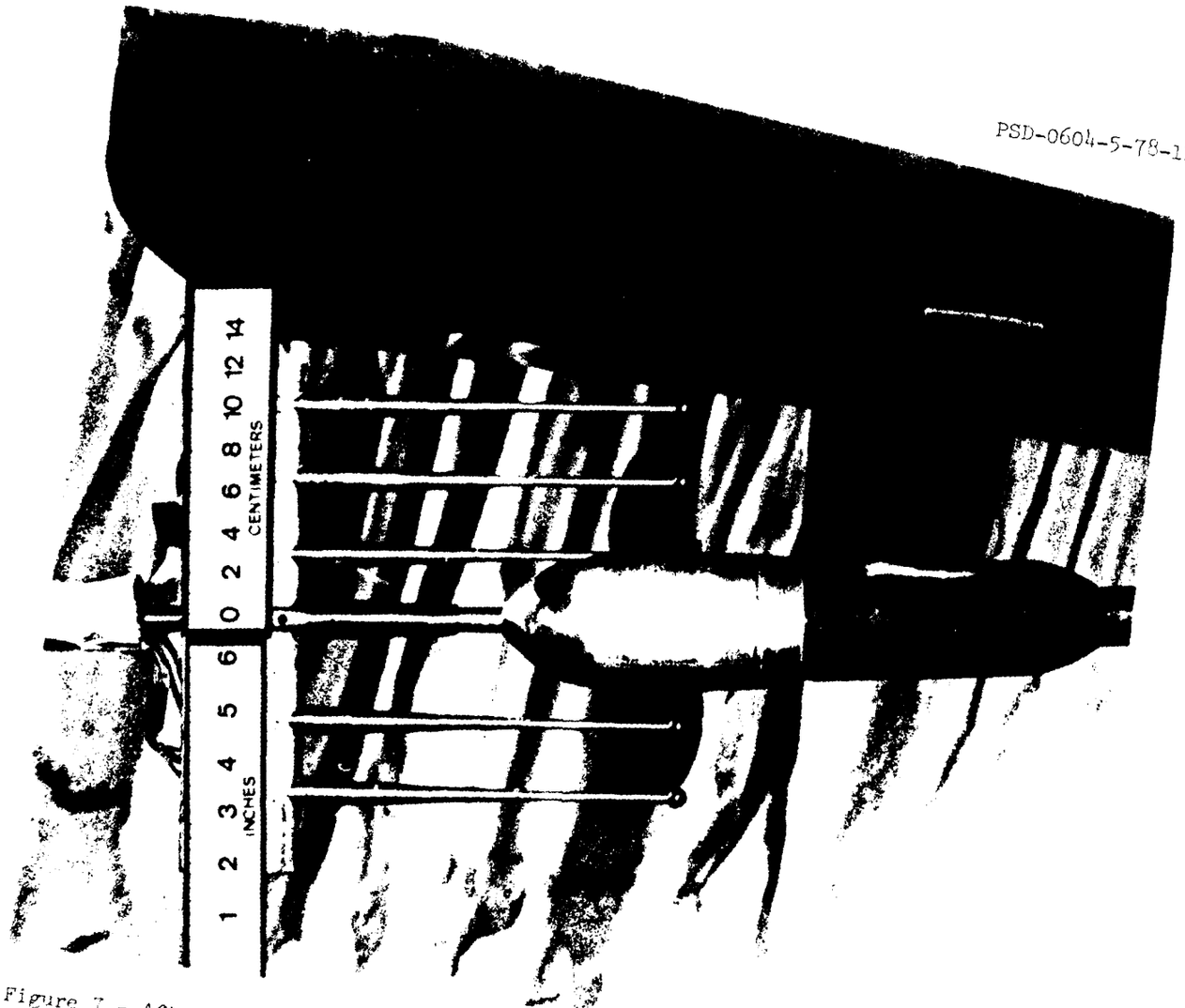


Figure 7 - Afterbody Profile View of DTNSRDC Model 5201 Fitted with a Rake of Five-Hole Pitot Tubes on the Starboard Chine

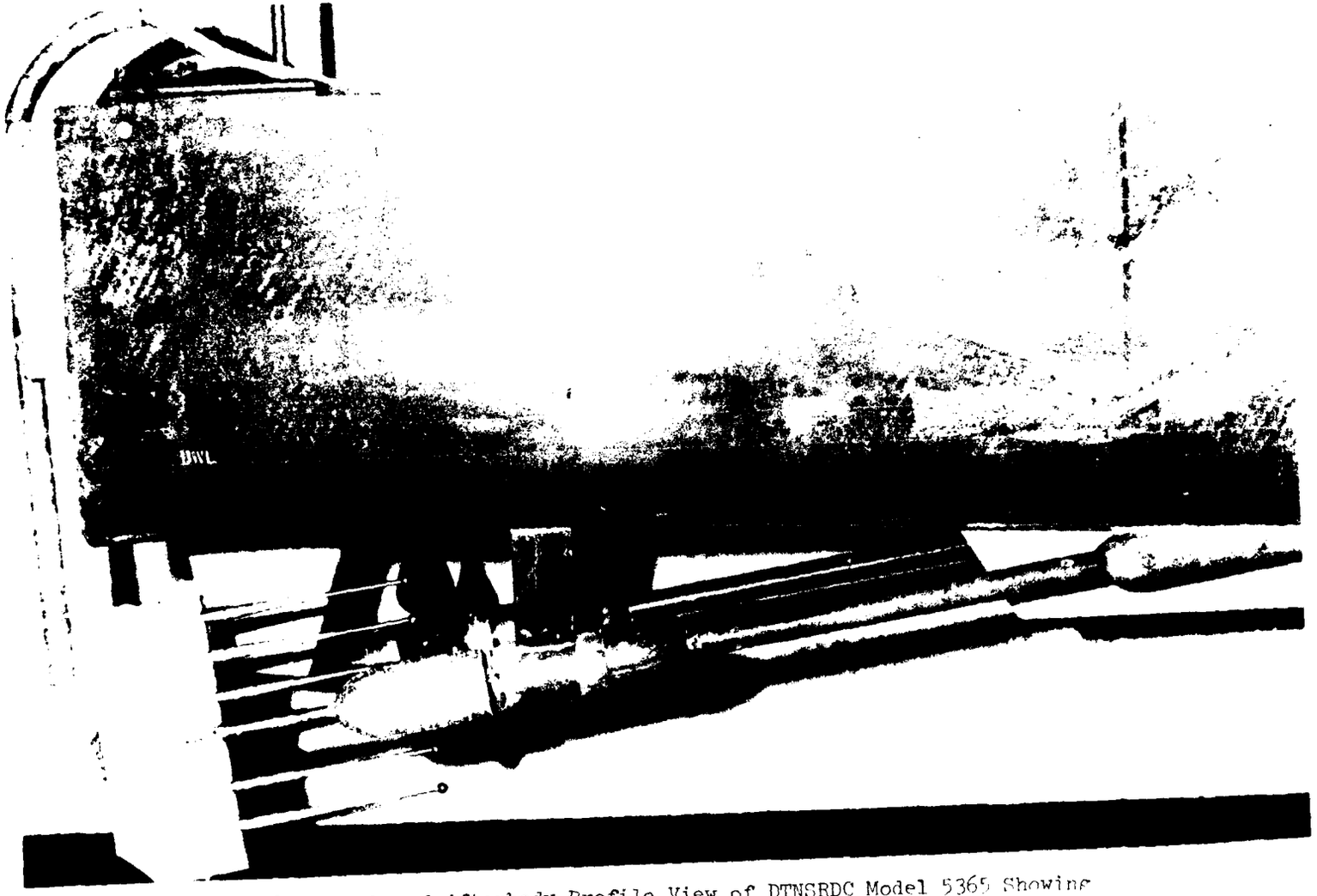


Figure 8 - Starboard Afterbody Profile View of DTNSRDC Model 5365 Showing Strut Barrel Extension

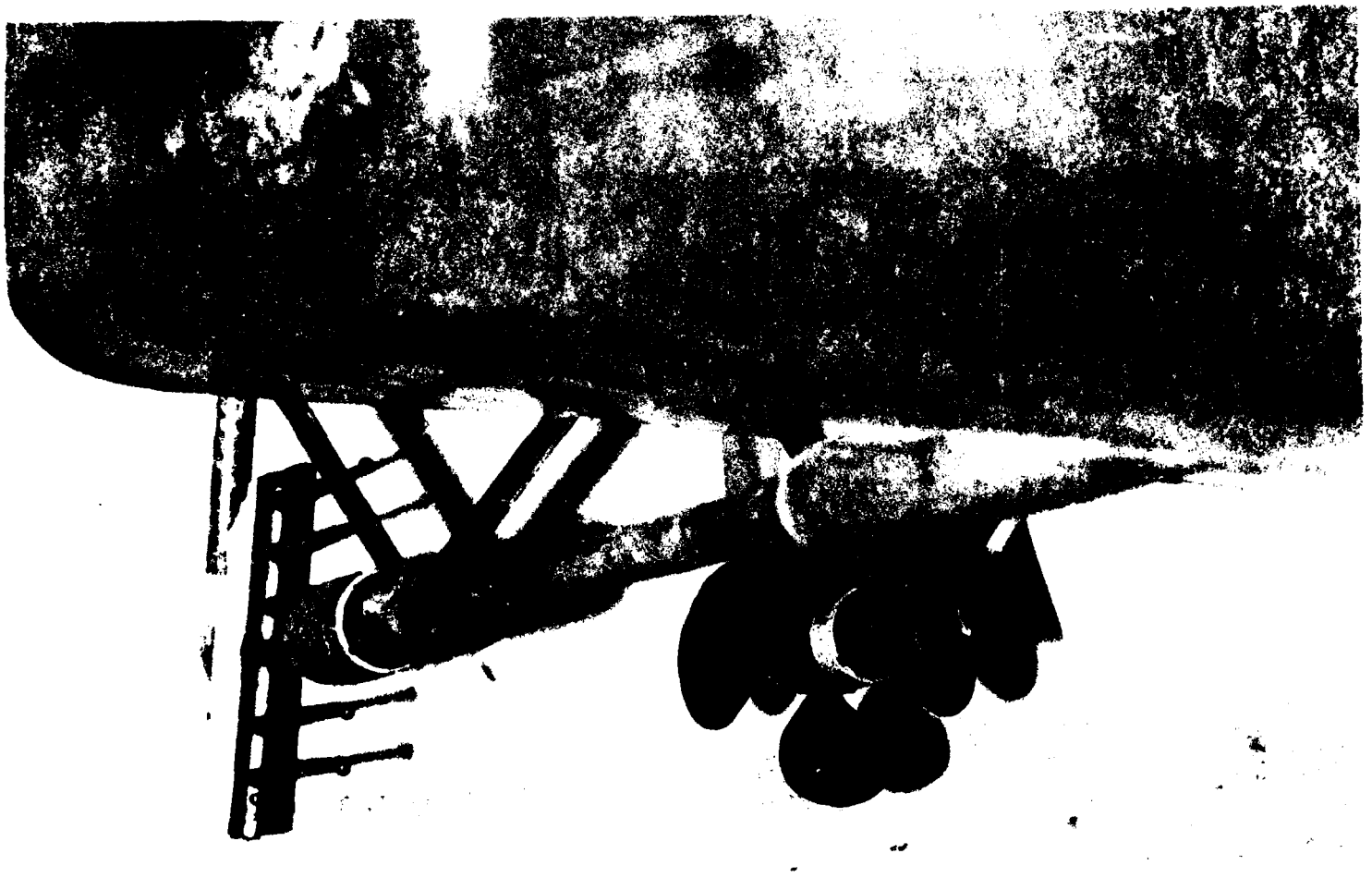


Figure 9 - Starboard Quarter View of DTNSRDC Model 5365 Showing Strut Barrel Extension

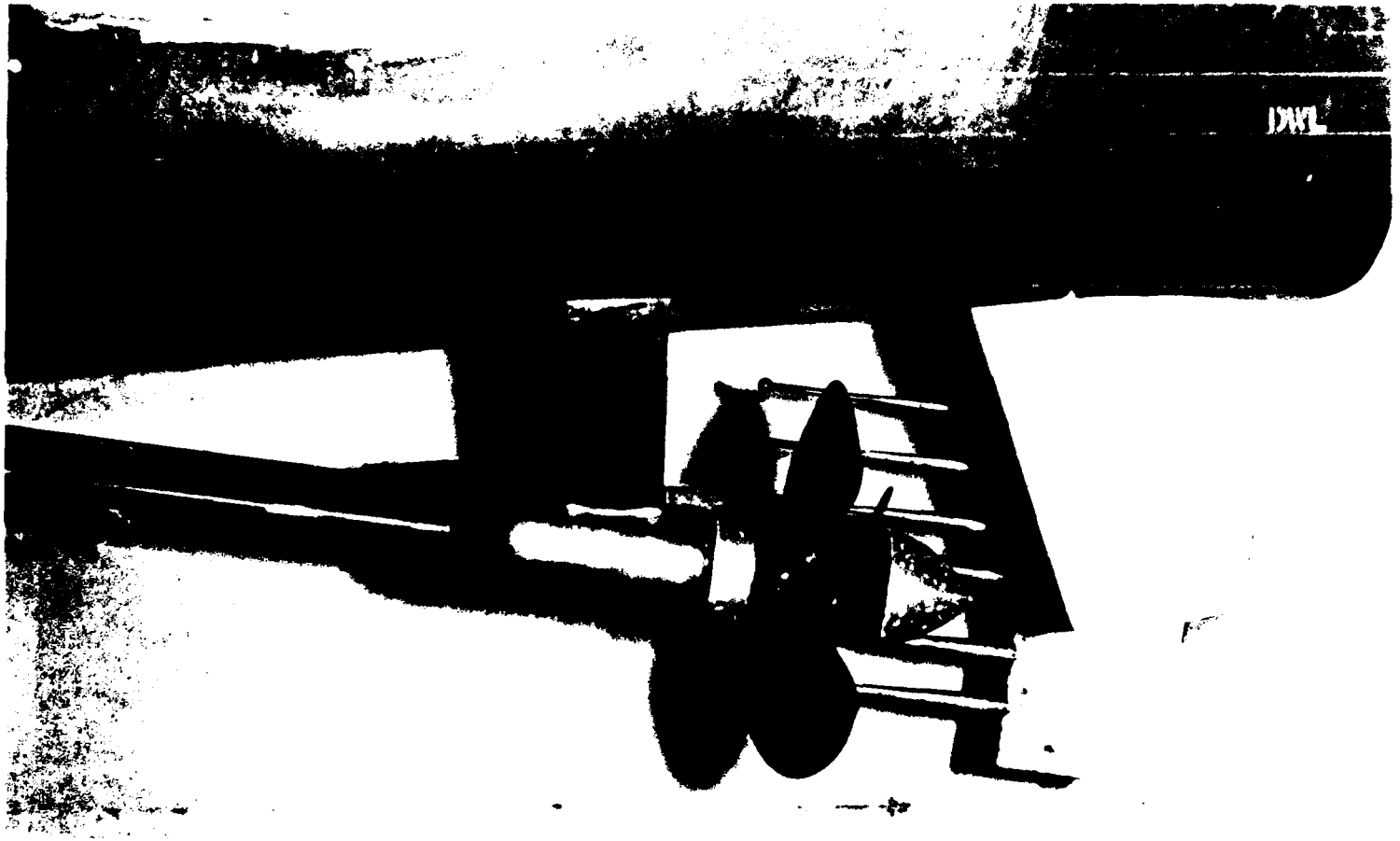


Figure 10 - Port Afterbody Profile View of DTNSRDC Model 5365 Showing Propeller and Rudder

Figure 11 - Bow Wave Profile of DTNSRDC Model 5365 in Shallow Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 Knots, Full-Scale

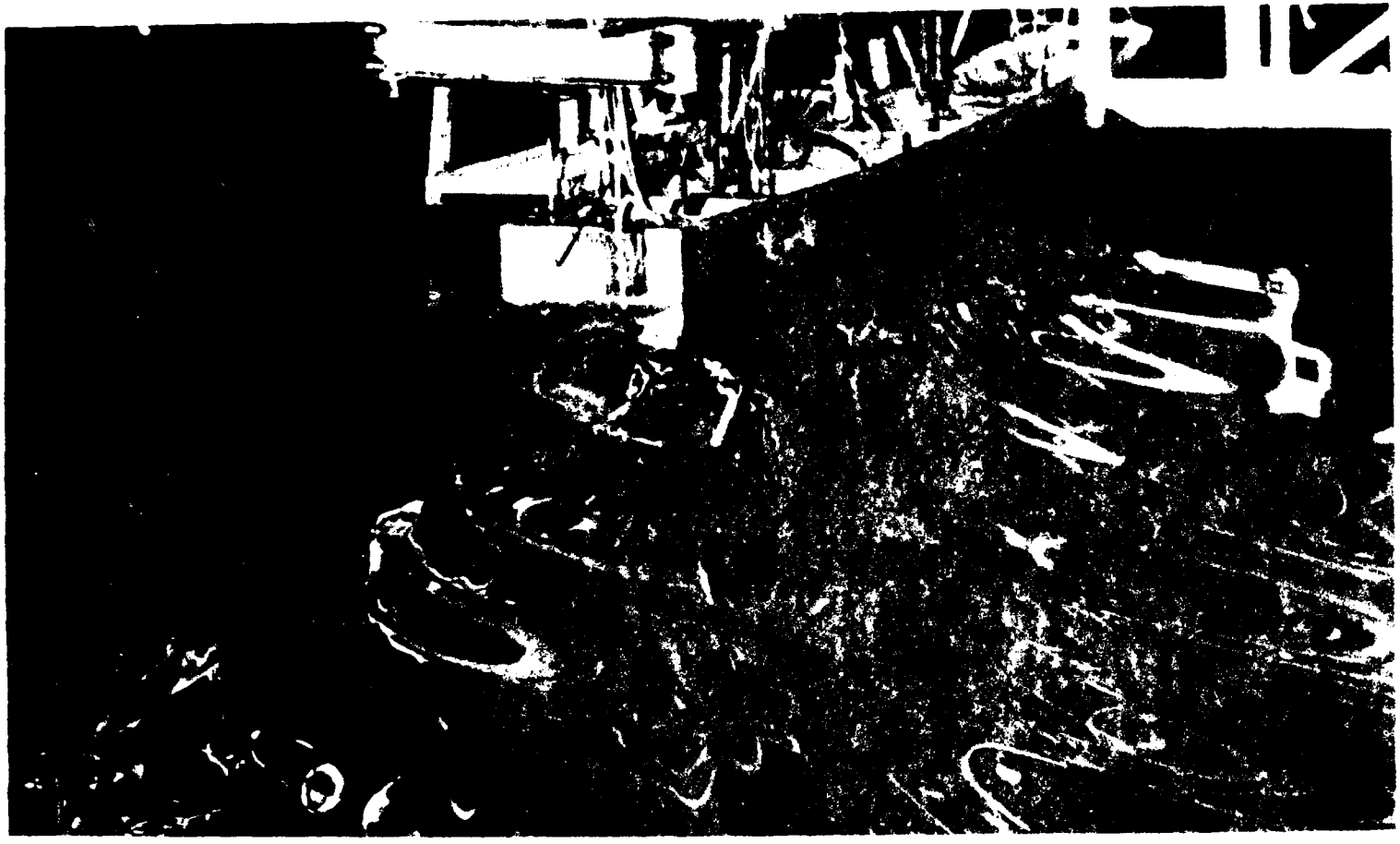


Figure 12 - Stern Wave Profile of DTMSRDC Model 5365 in Shallow Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 Knots, Full-Scale

Figure 13 - Bow Wave Profile of DTNSRDC Model 5365 in Deep Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 Knots, Full-Scale

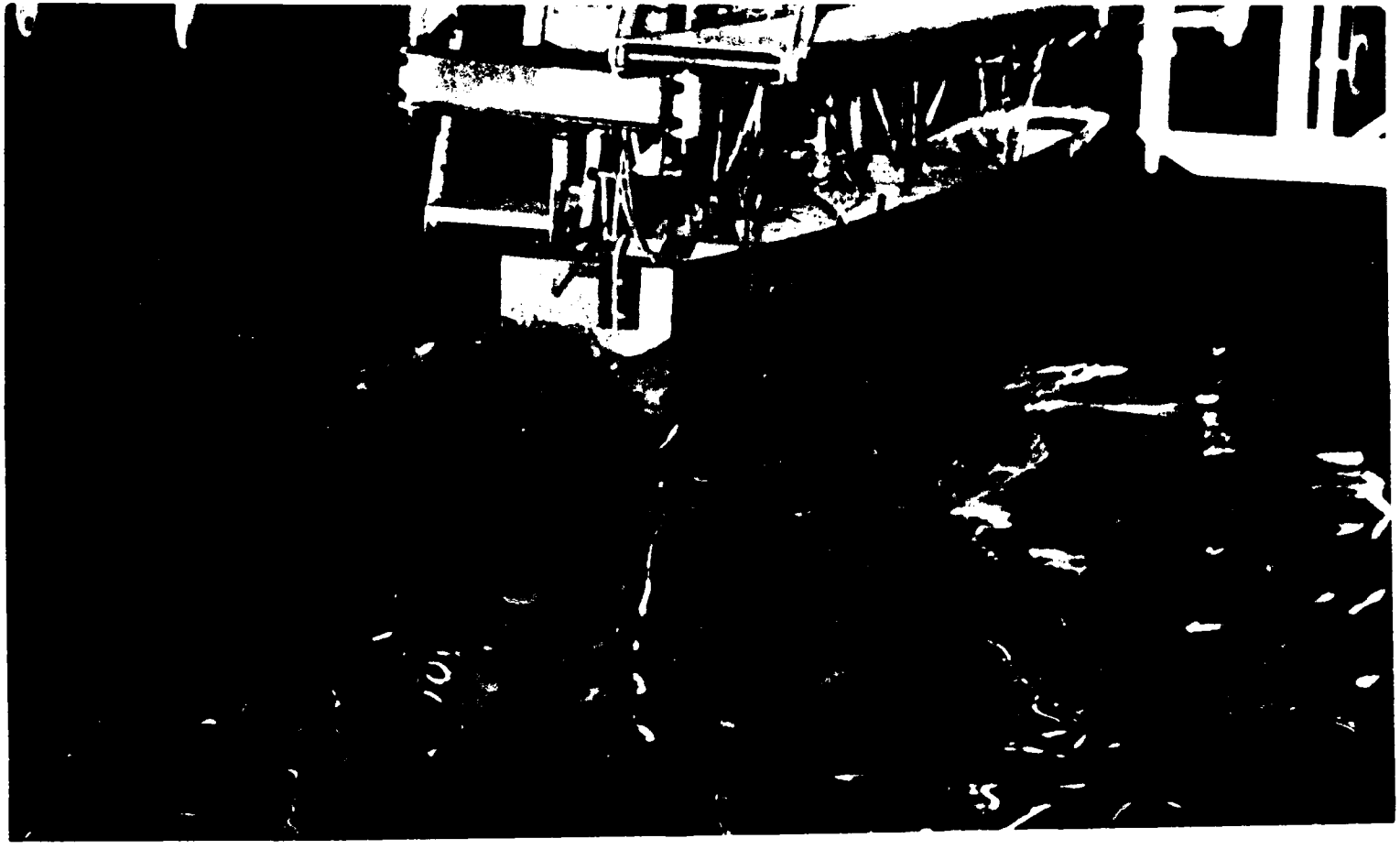


Figure 14 - Stern Wave Profile of DTNSRDC Model 5365 in Deep Water at the Shallow Water Trim Setting at a Speed Corresponding to 15 knots, Full-Scale

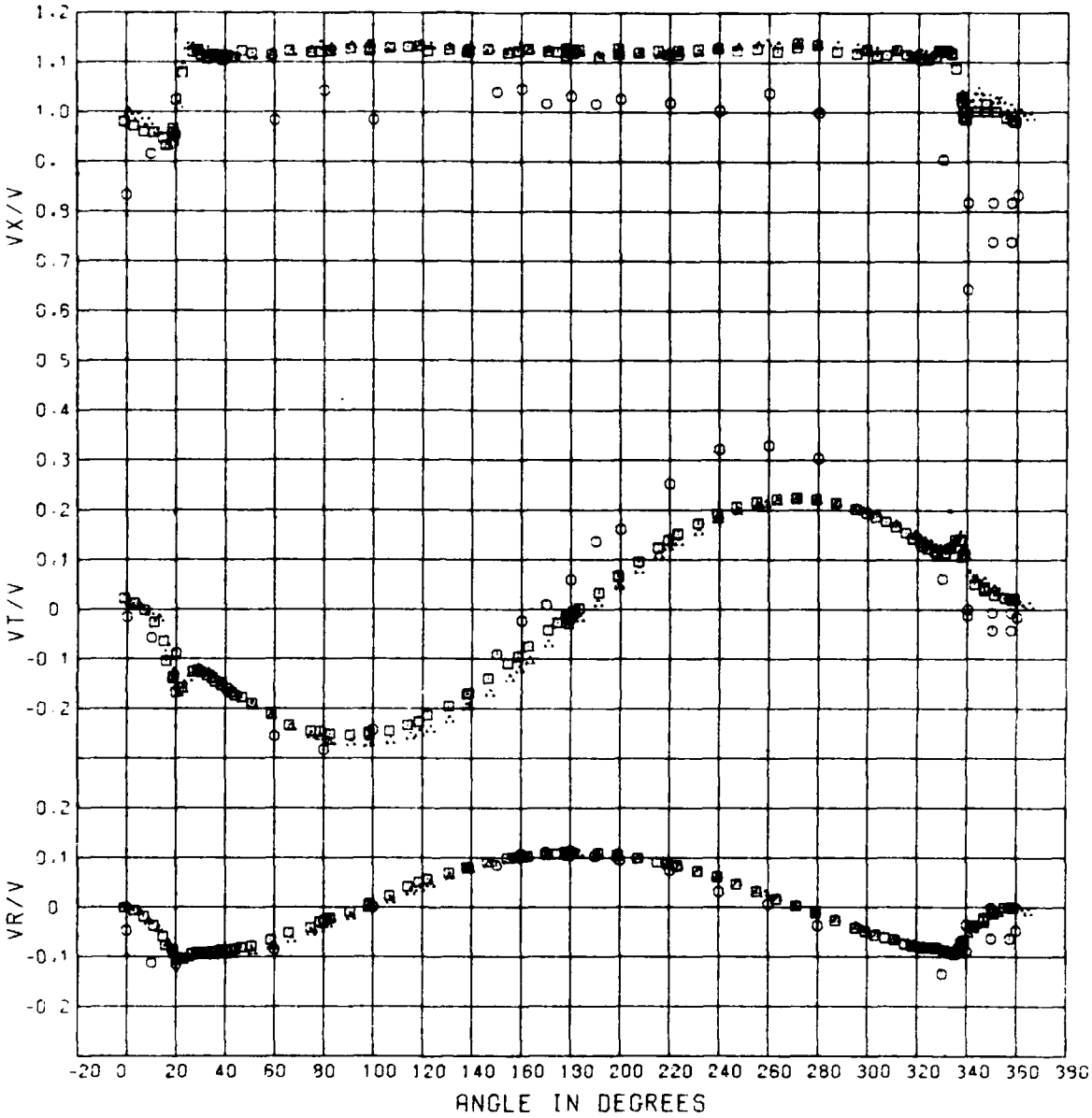
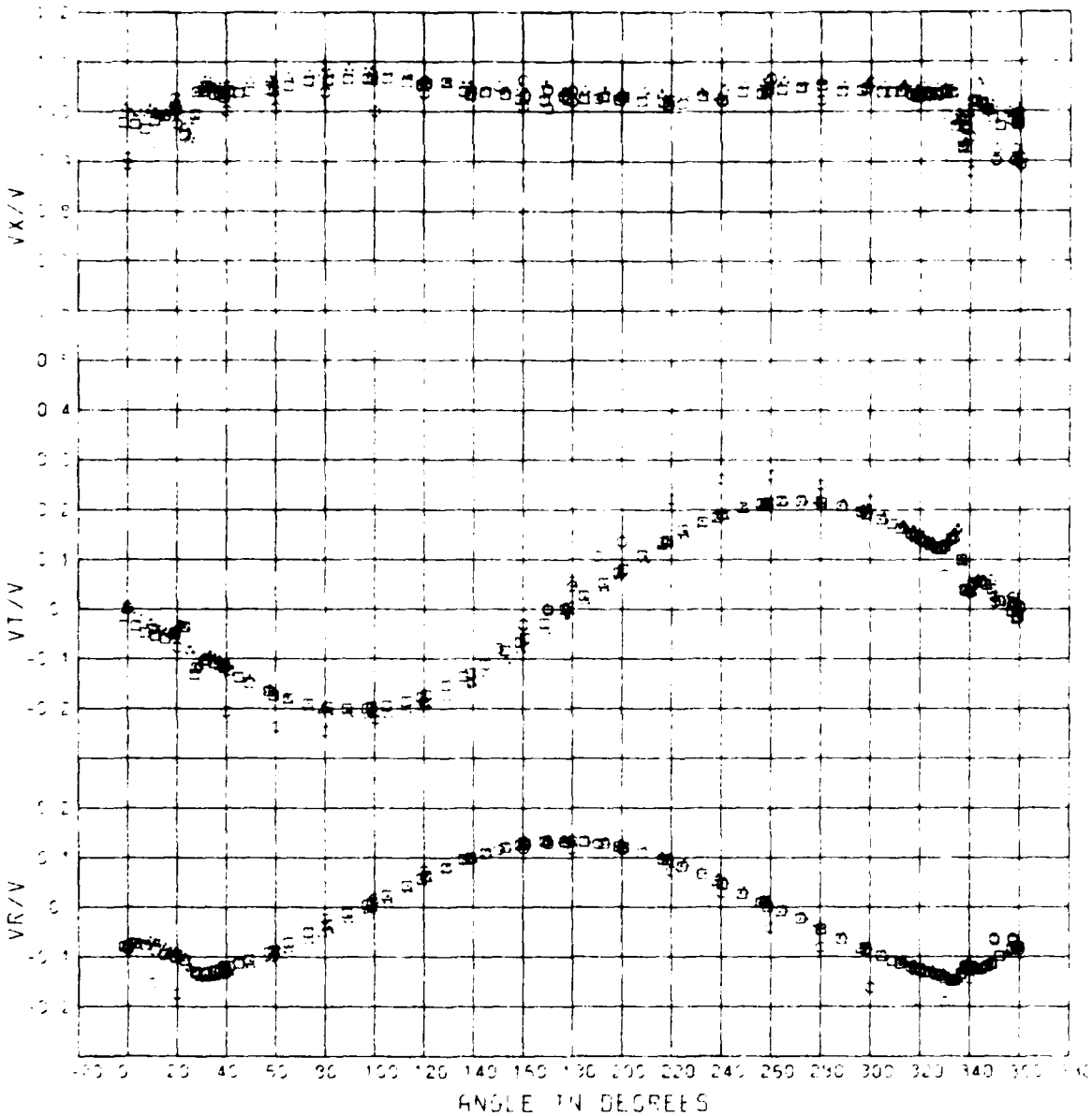


Figure 15 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.456 Radius



MODEL 5365, EXPERIMENT 2 WITHOUT PROPELLER
MODEL 5365, EXPERIMENT 8 WITH PROPELLER
FULL-SCALE R/V ATHENA

0.633 RAD

Figure 16 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.633 Radius

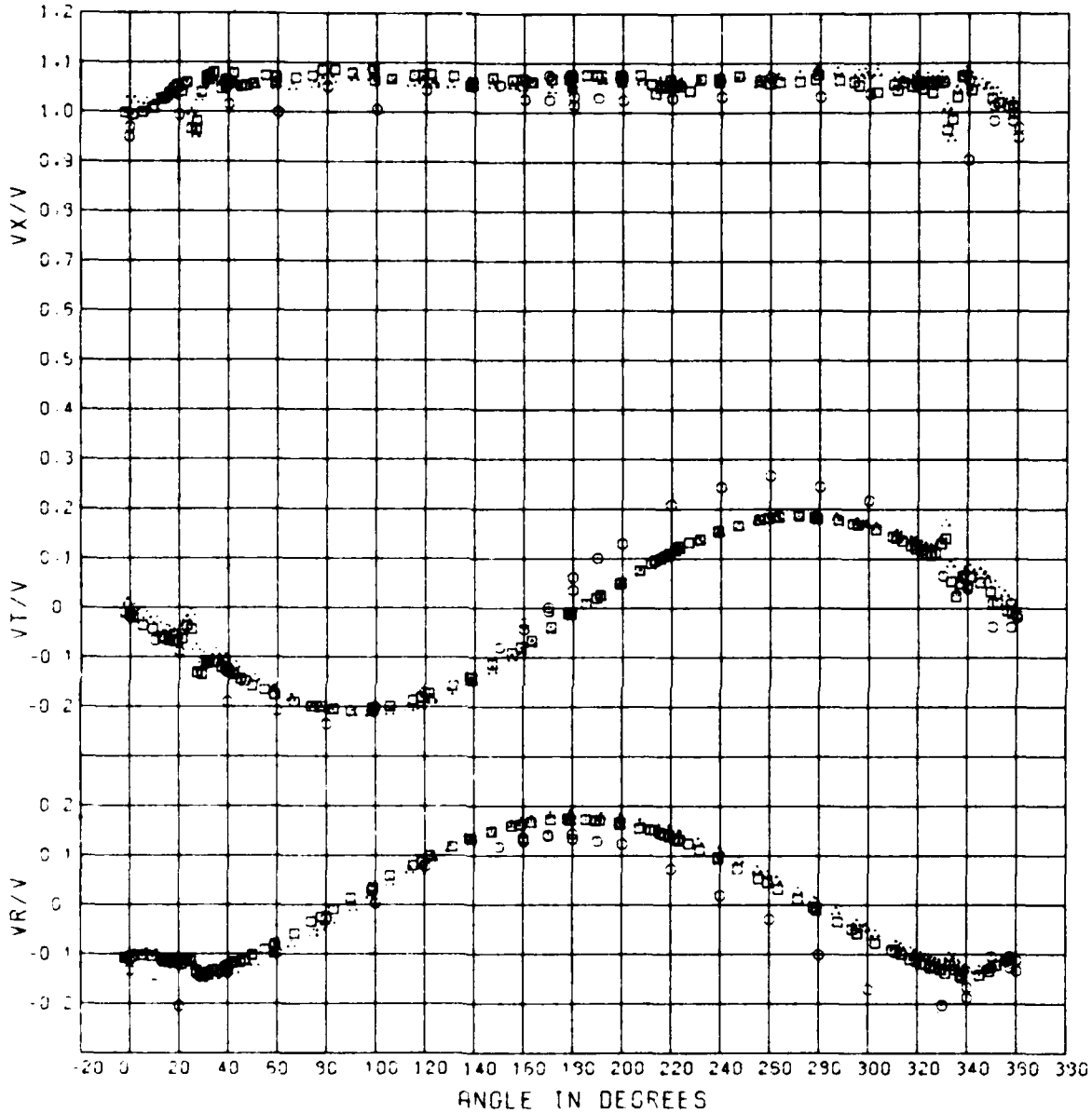


Figure 17 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.781 Radius

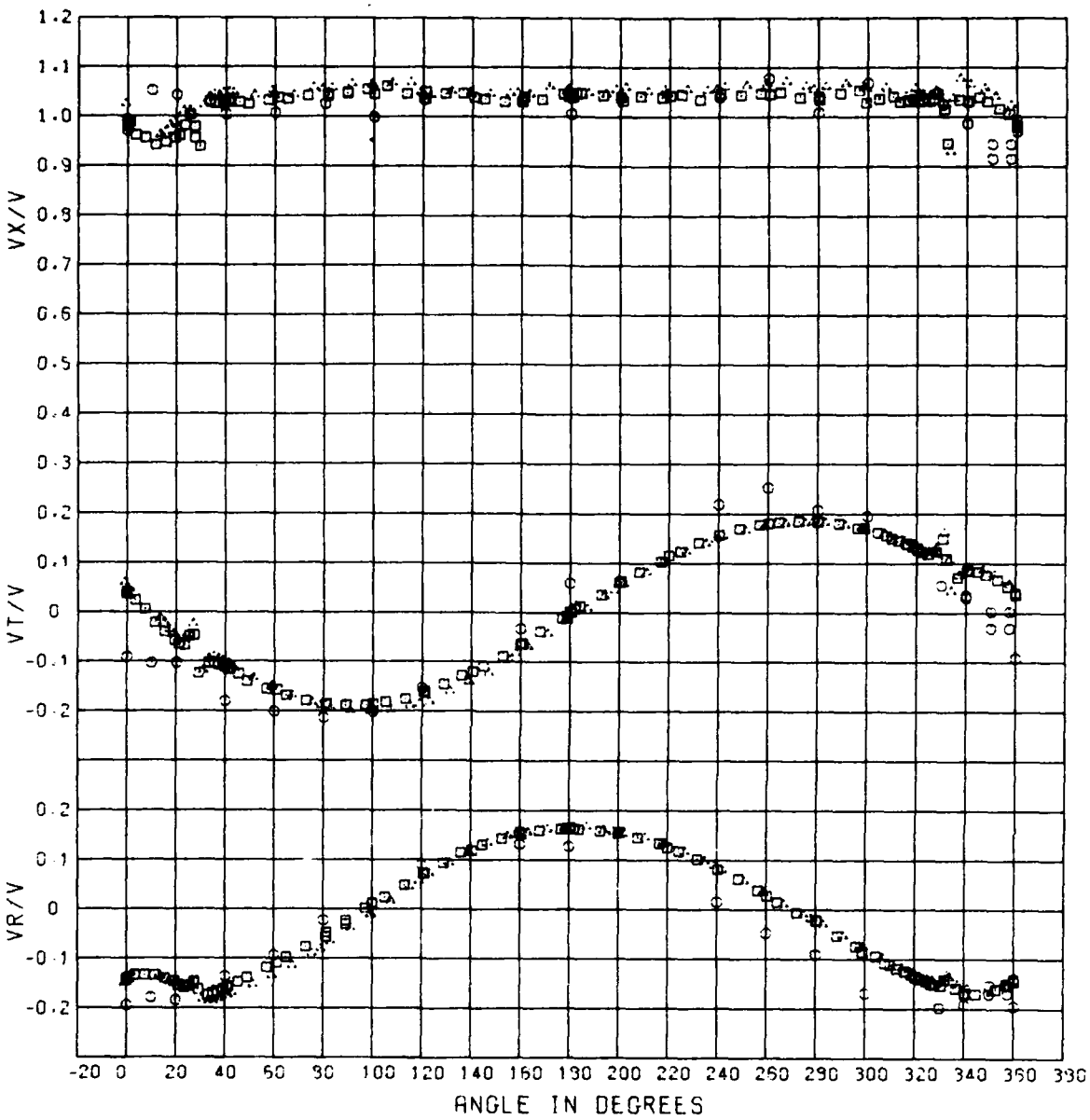


Figure 18 - Composite Plot of Velocity Component Ratios from R/V ATHENA and Model Experiments 2 and 8 for the 0.963 Radius

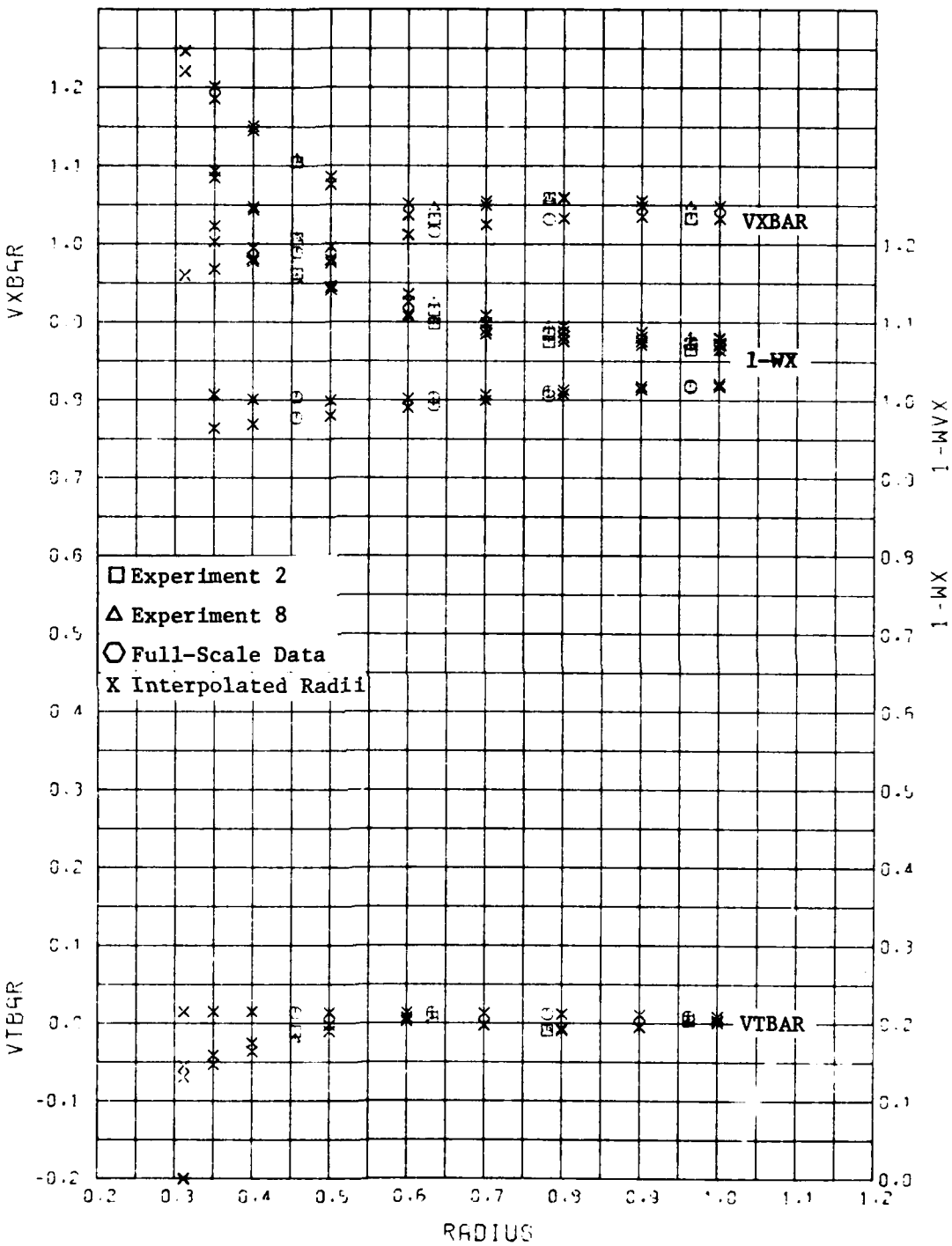


Figure 19 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake from R/V ATHENA and Experiments 2 and 8

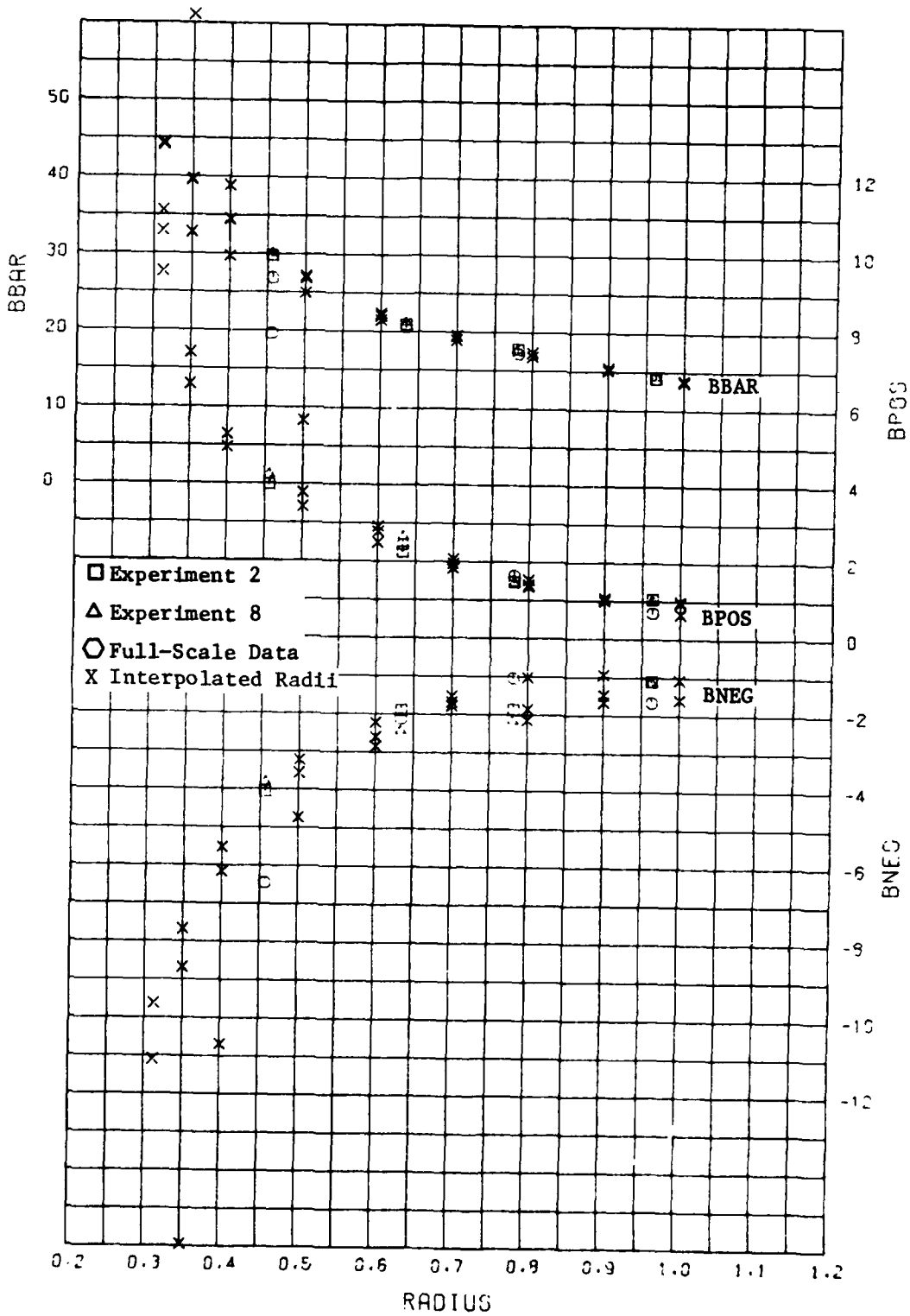


Figure 20 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle from R/V ATHENA and Experiments 2 and 8

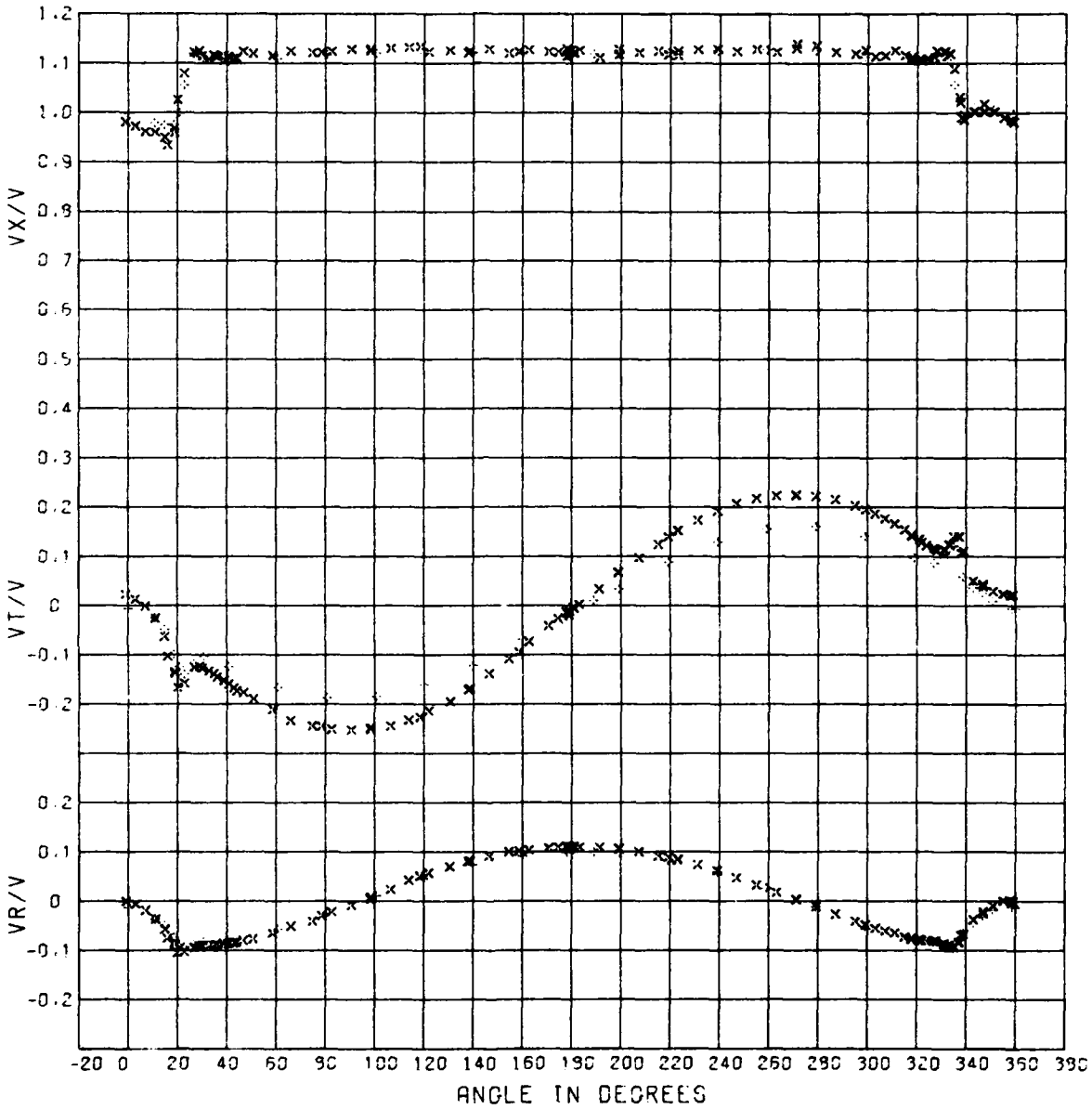


Figure 21 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.456 Radius

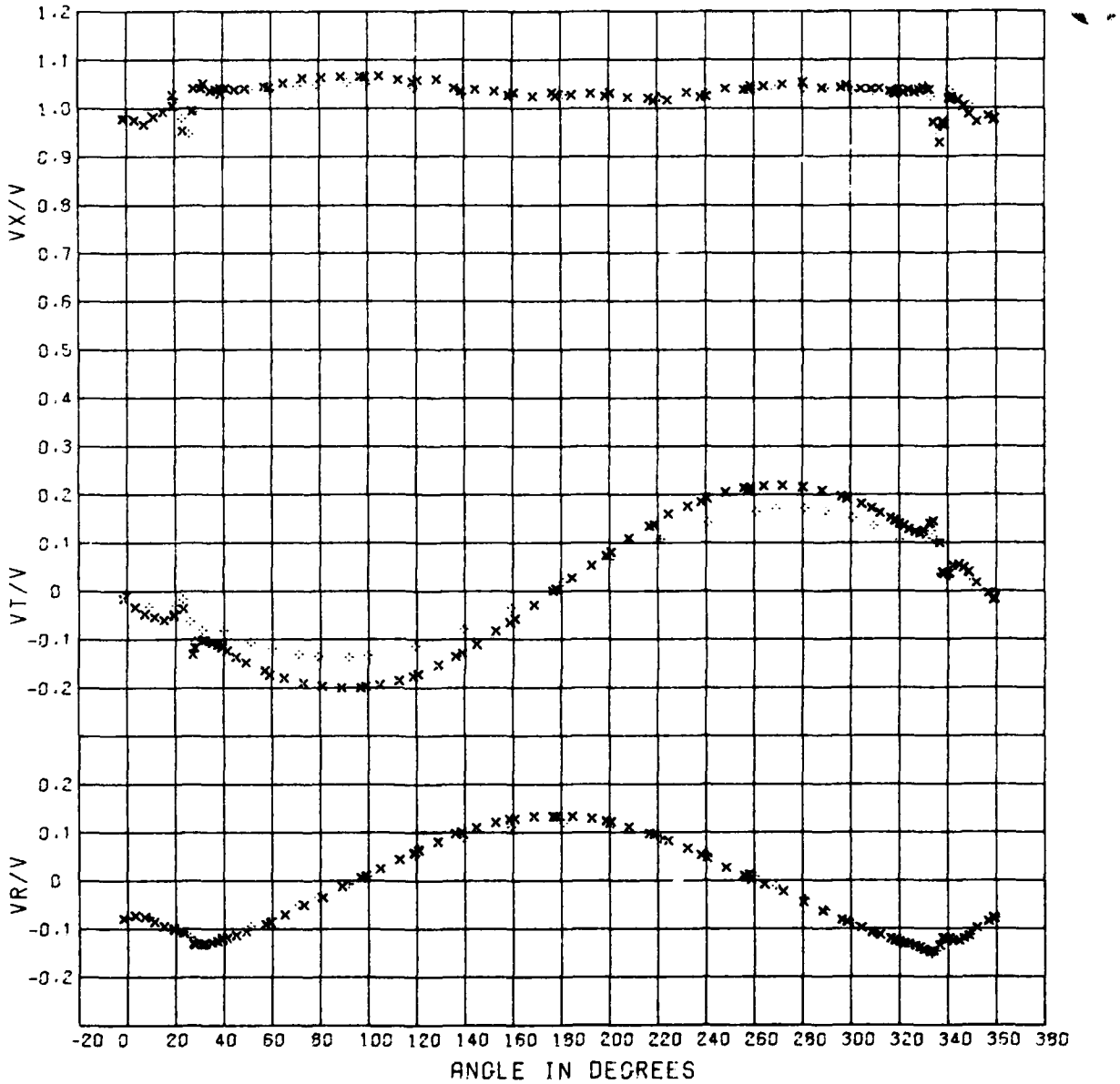


Figure 22 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.633 Radius

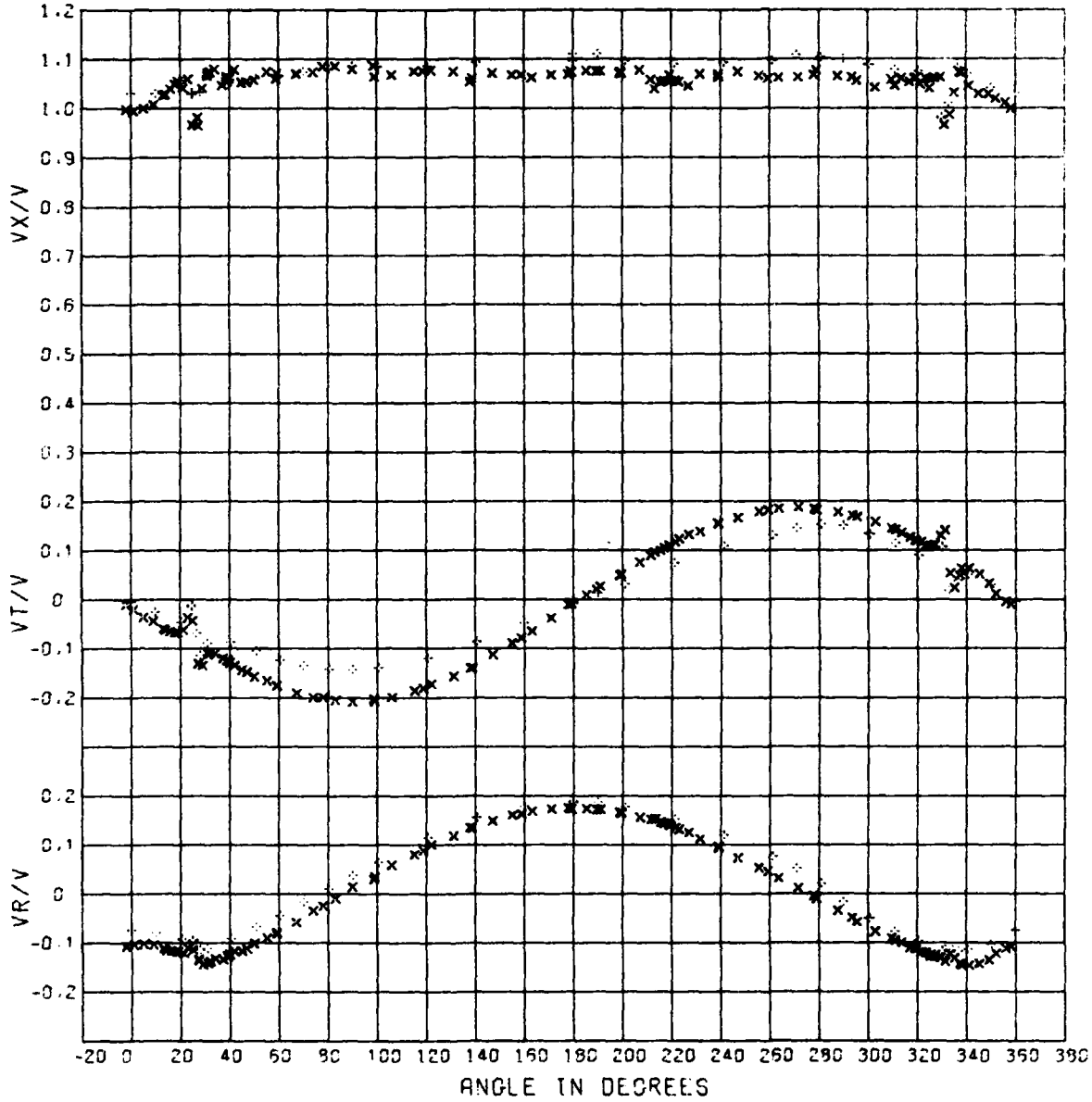


Figure 23 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.781 Radius

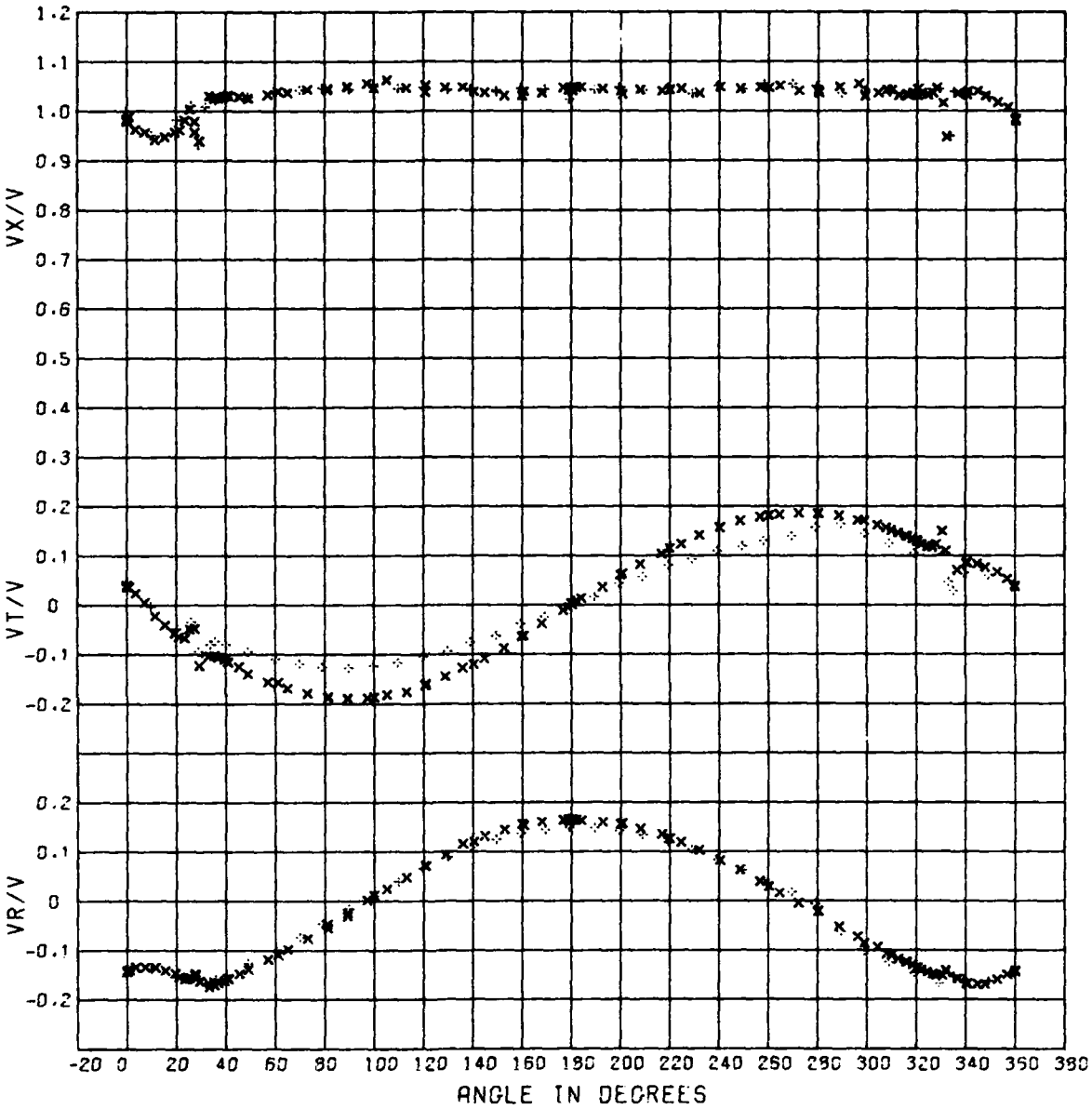


Figure 24 - Velocity Component Ratios of Experiments 2 and 4 for Two Model Speeds for the 0.963 Radius

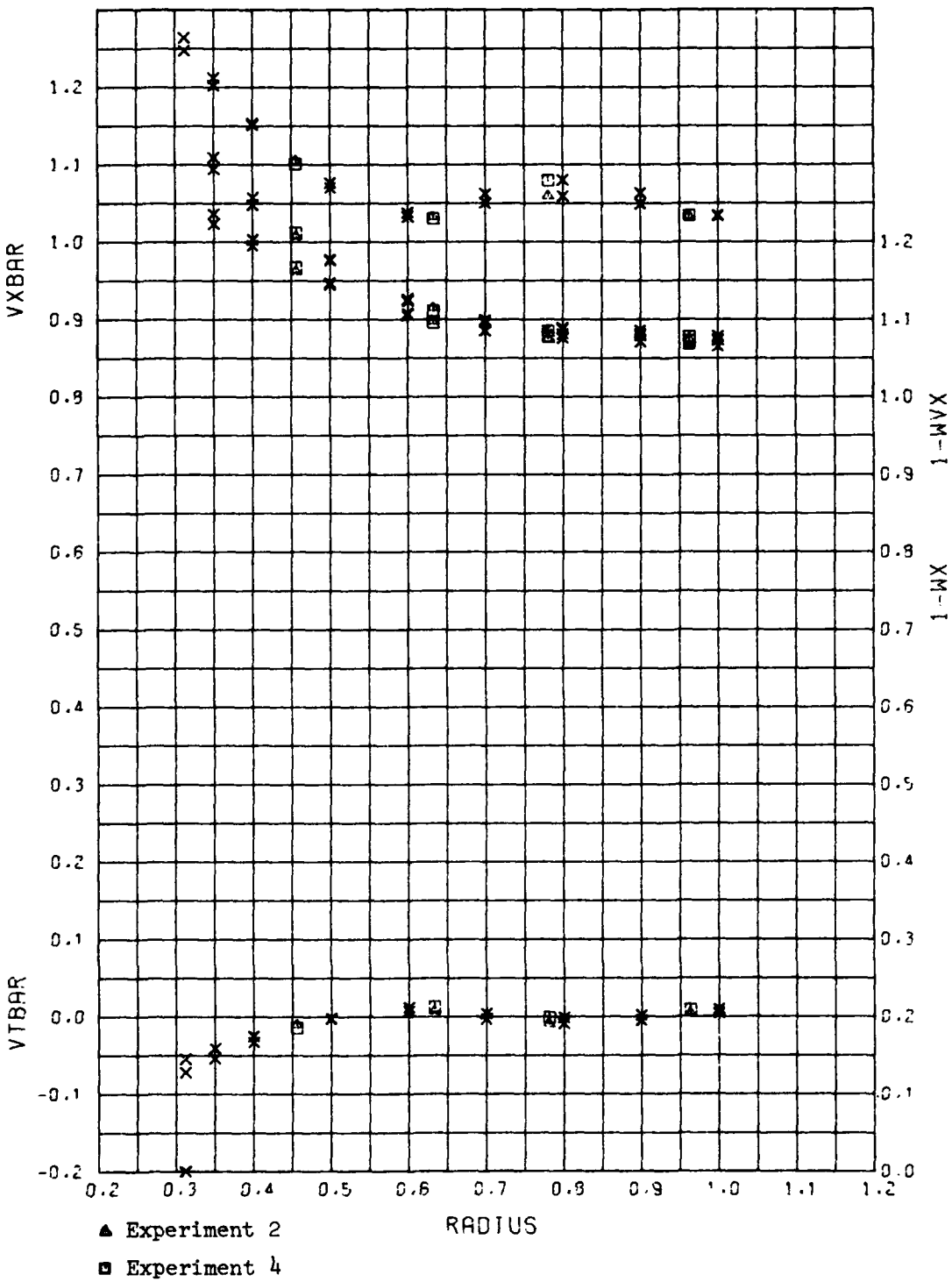


Figure 25 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake of Experiments 2 and 4

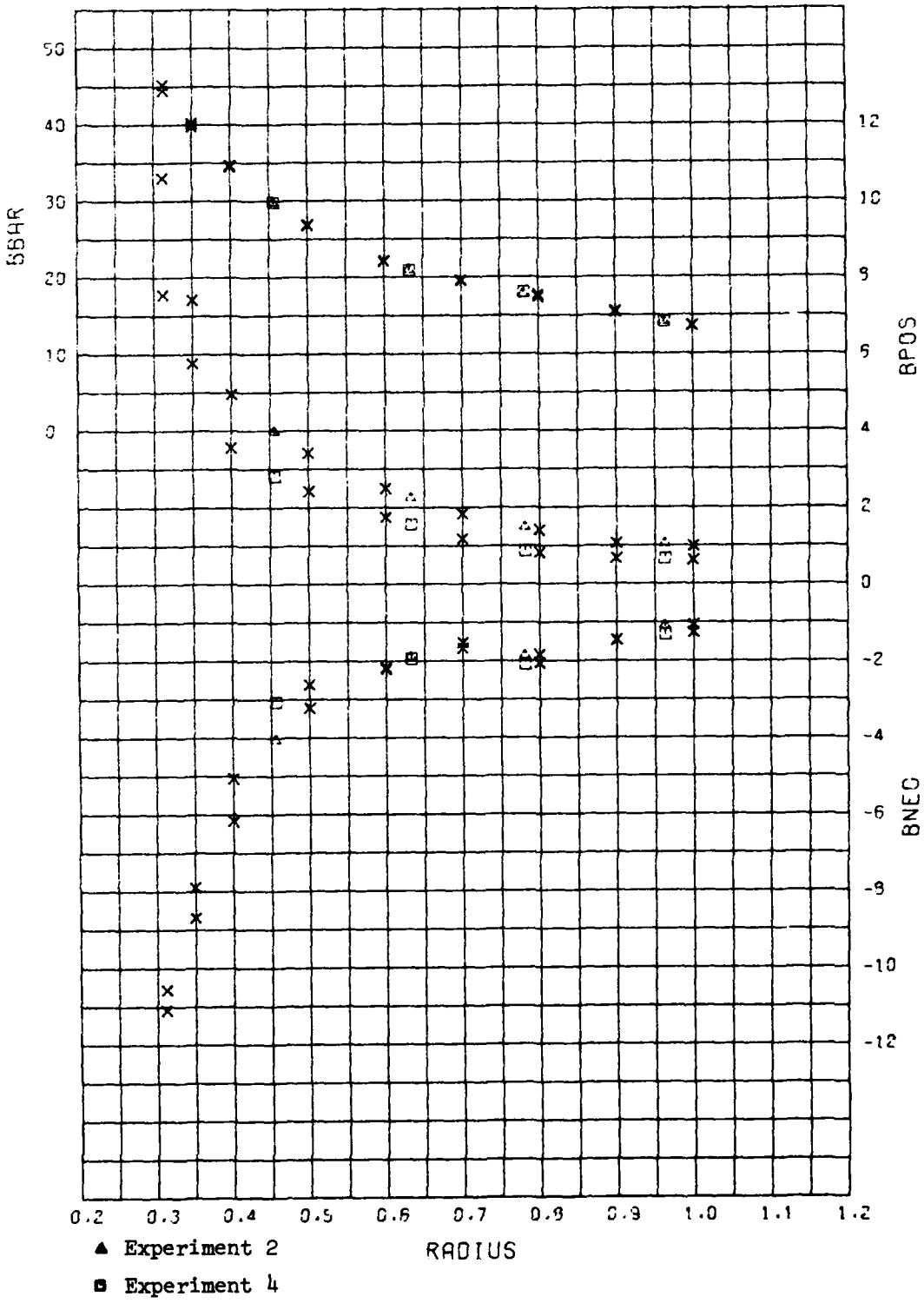


Figure 26 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle of Experiments 2 and 4

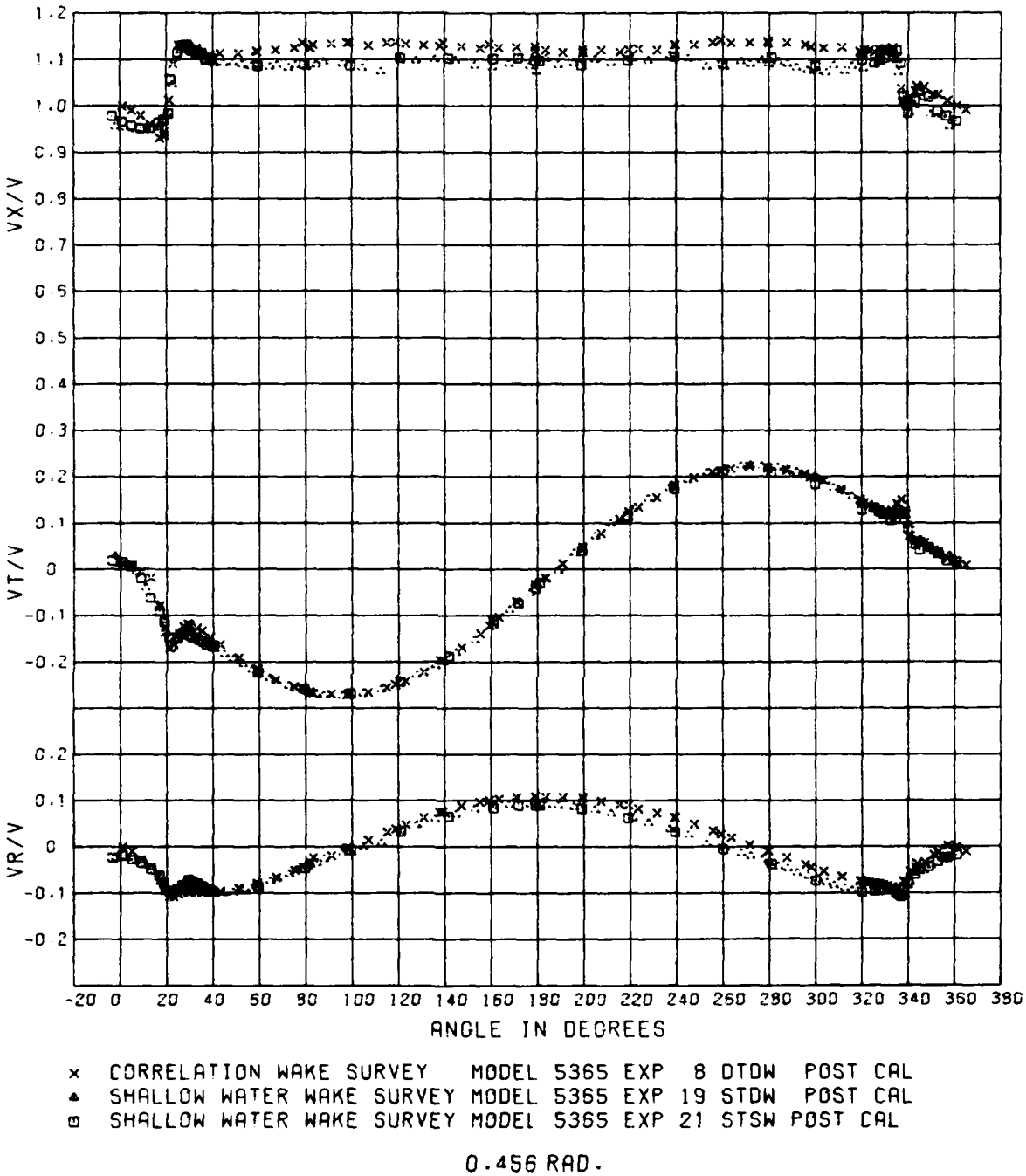


Figure 27 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.456 Radius

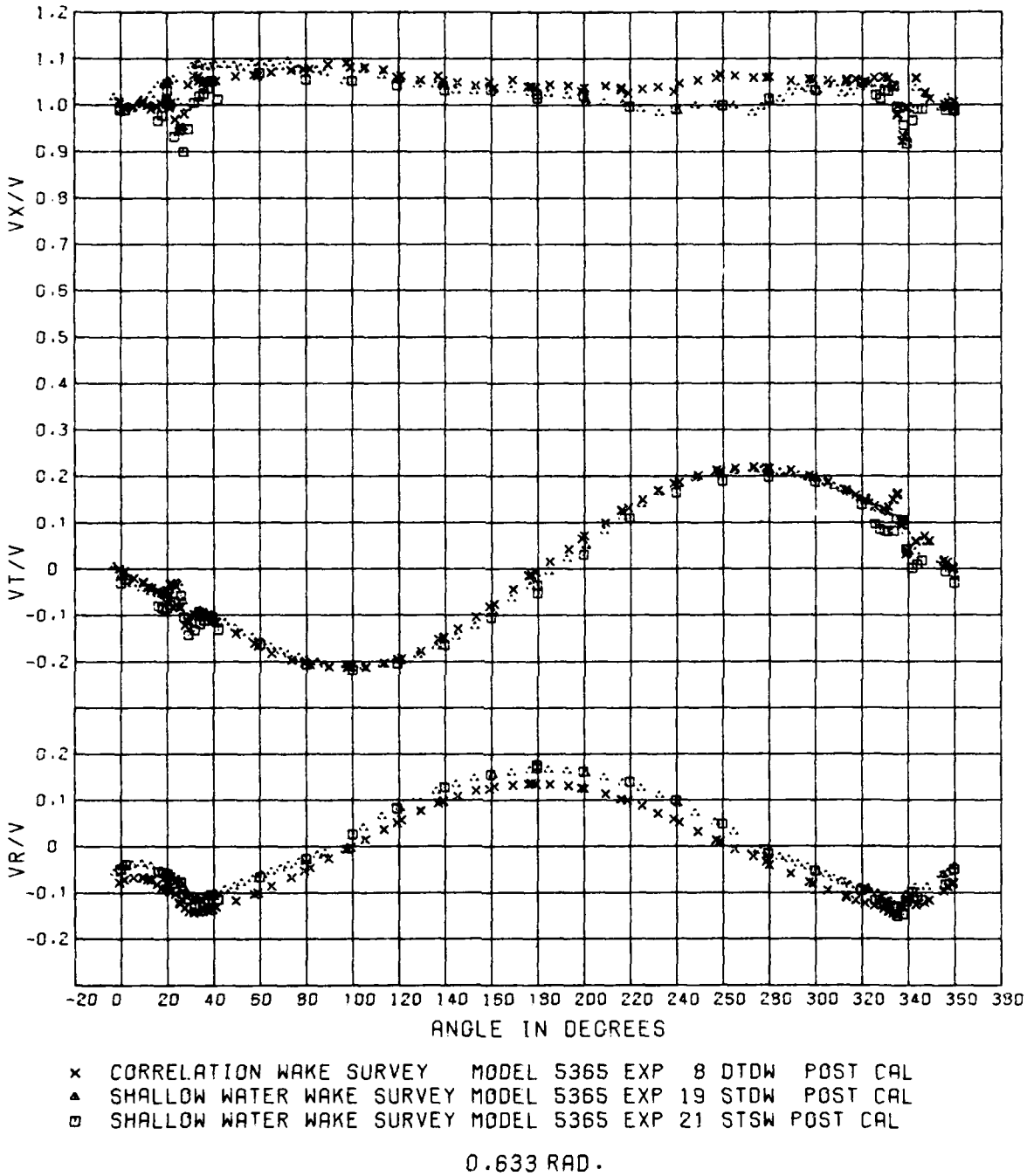


Figure 28 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.633 Radius

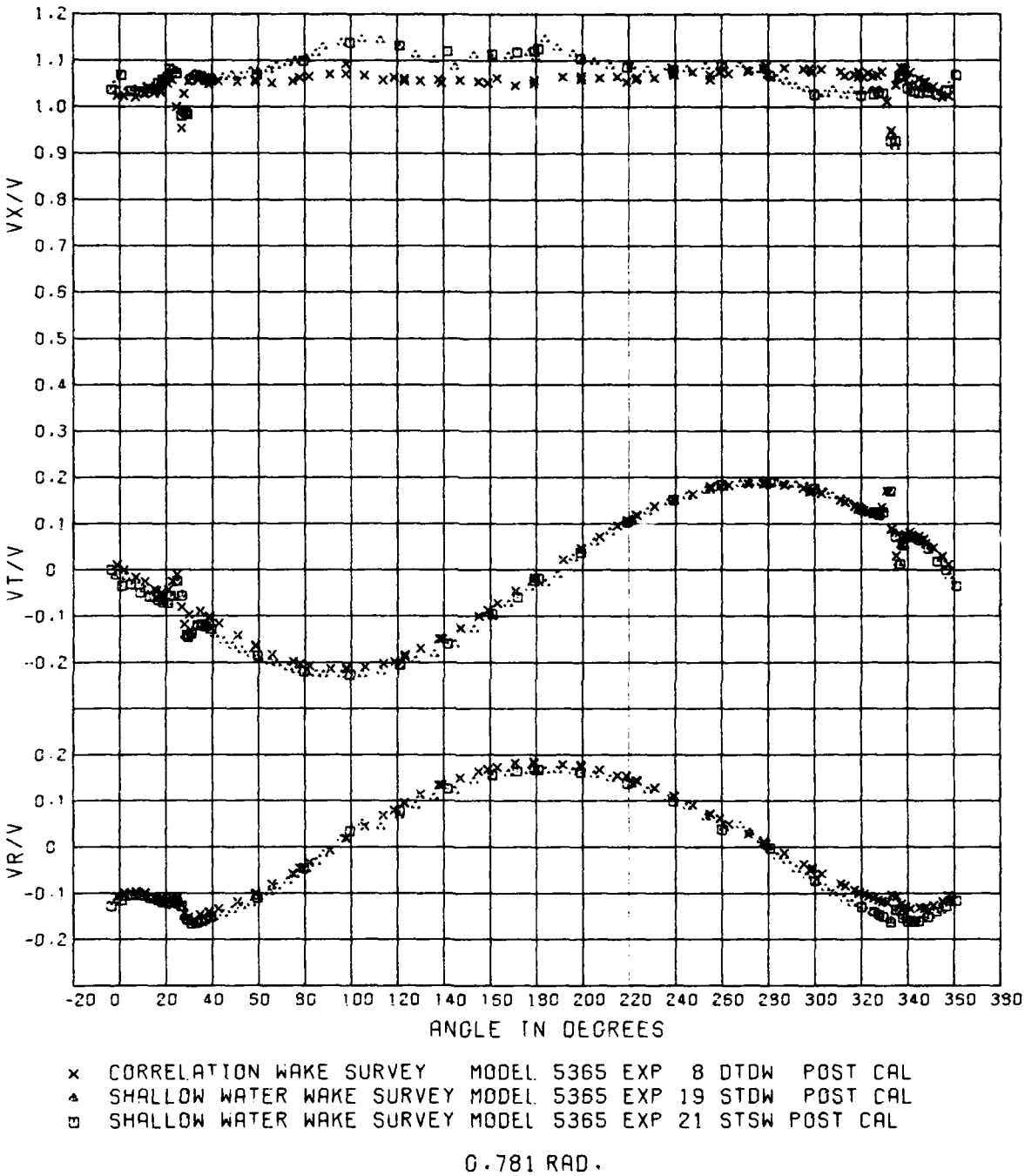


Figure 29 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.781 Radius

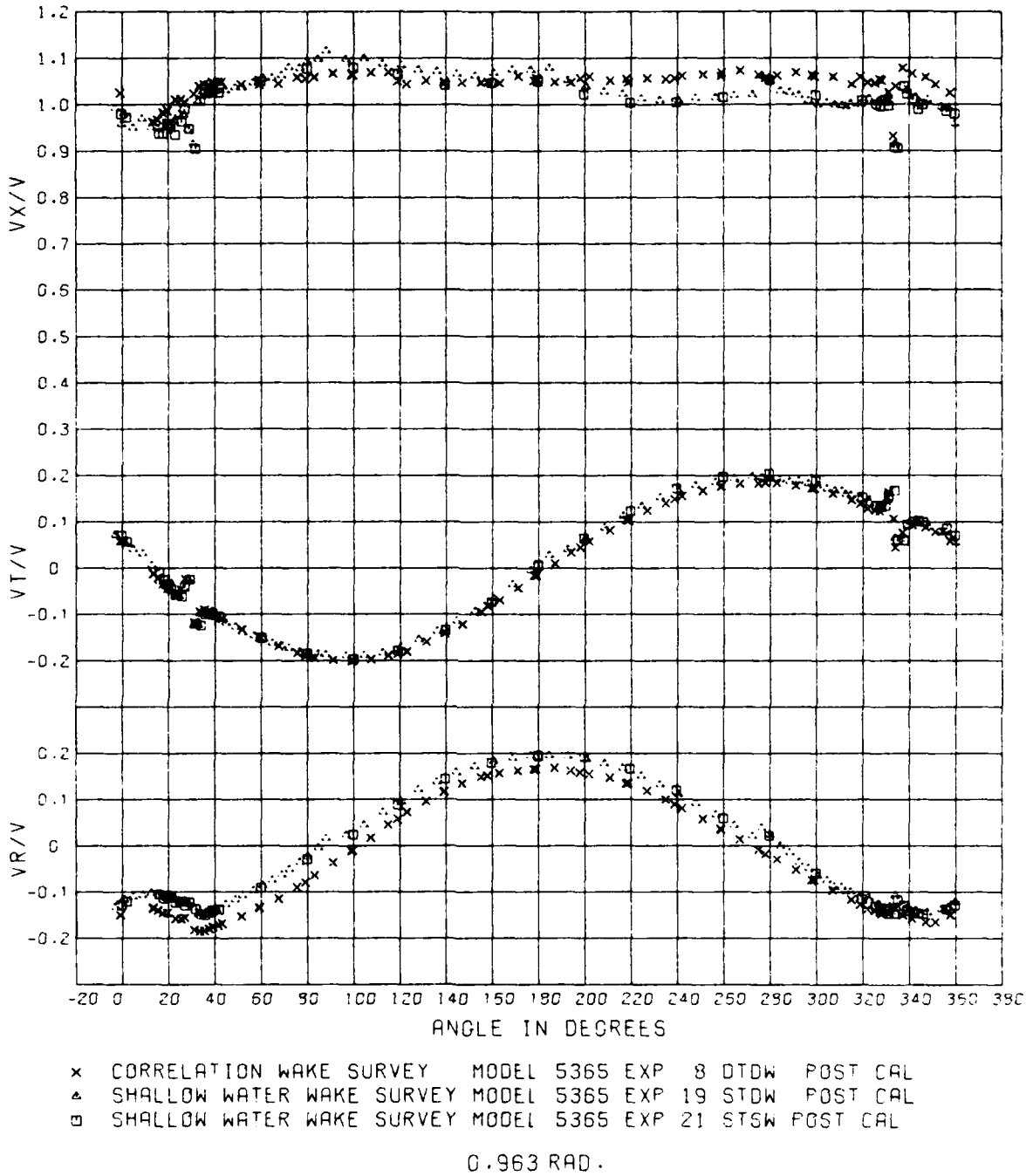


Figure 30 - Composite Plot of Velocity Component Ratios for Experiments 8, 19, and 21 for the 0.963 Radius

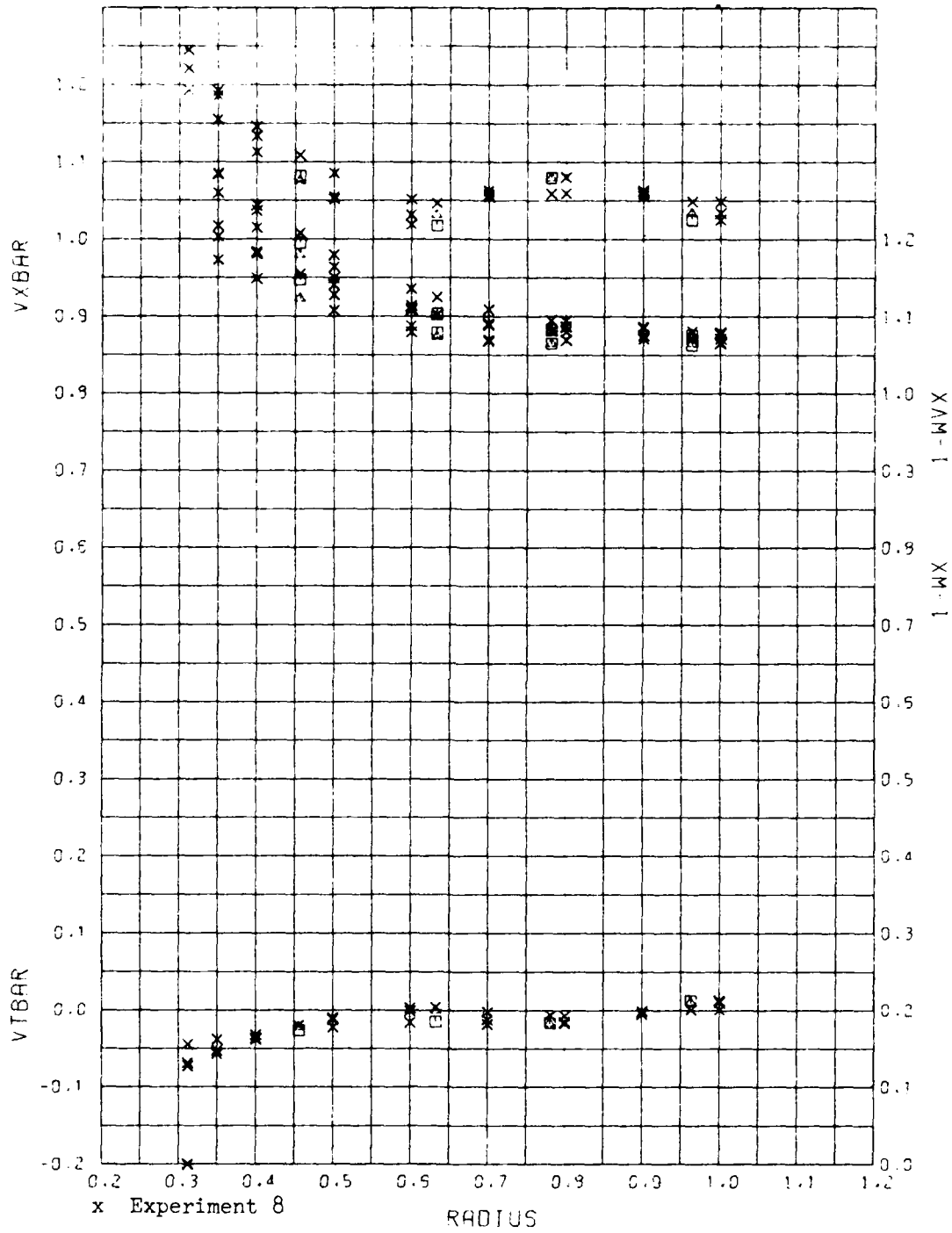
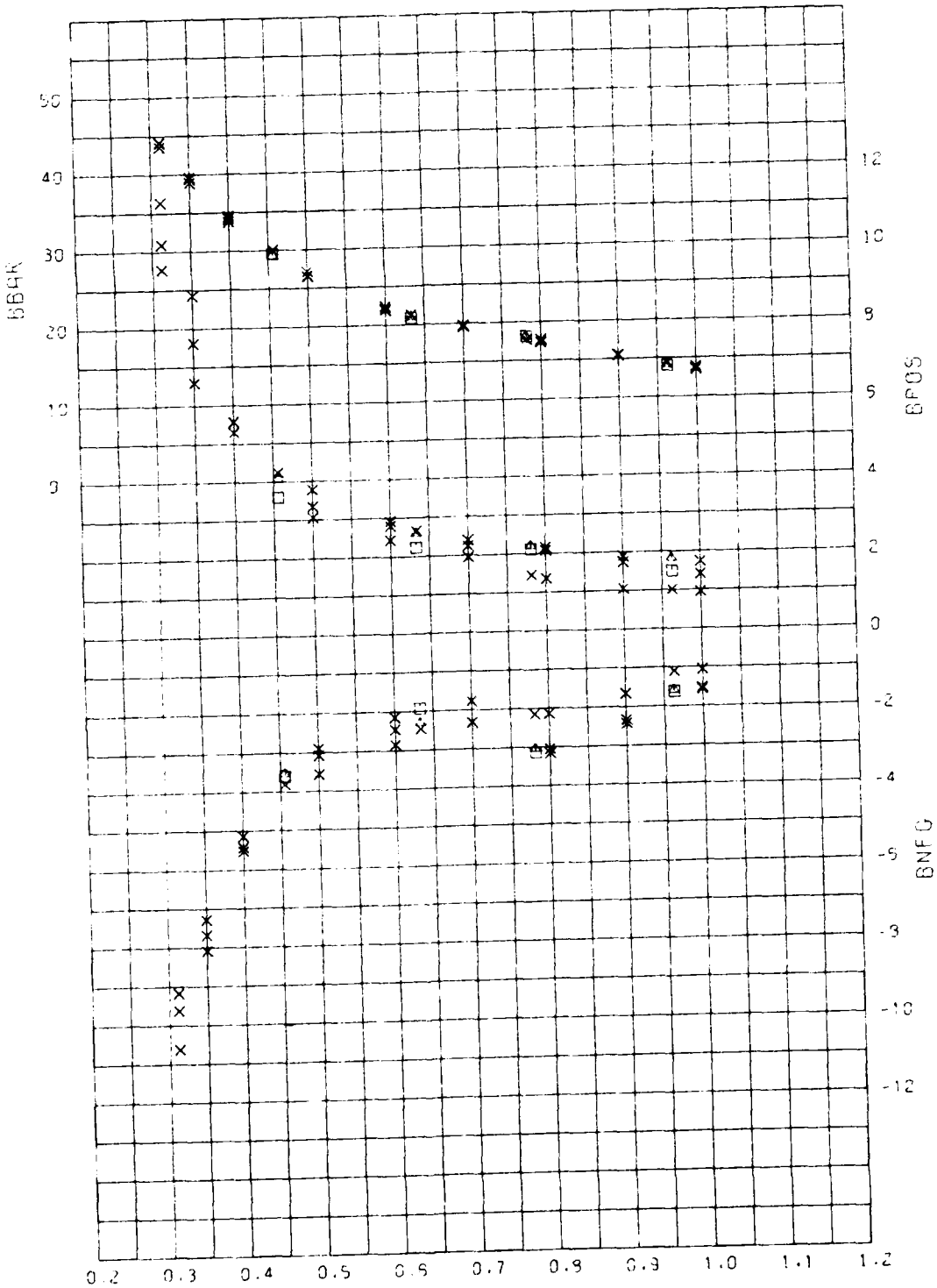


Figure 31 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake of Experiments 8, 19, and 21



x Experiment 8
▲ Experiment 19
◘ Experiment 21

Figure 32 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle of Experiments 8, 19, and 21

TABLE 1

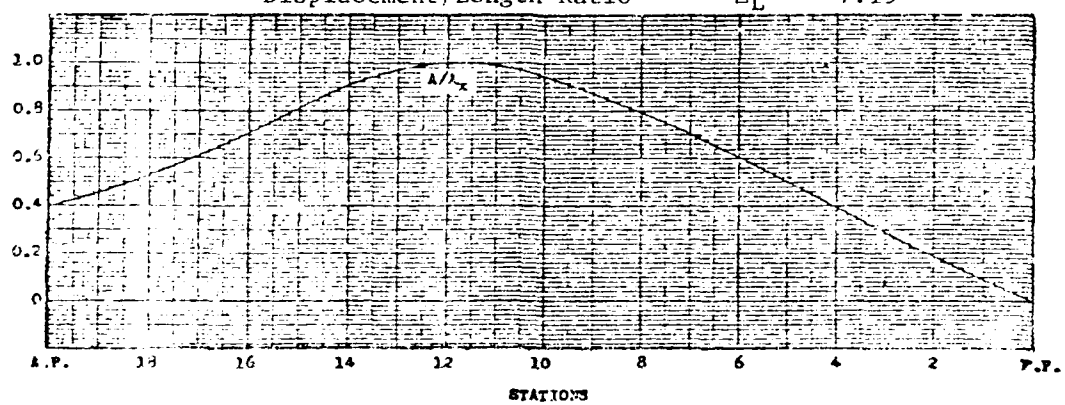
SHIP AND MODEL DATA FOR R/V ATHENA REPRESENTED BY DTNSRDC MODEL 5365

Appendages: Shafts, Vee-Struts, Rudder, Centerline Skeg, Stabilizer Fins

	Ship	Model
Length Overall	165.0 ft (50.3 m)	20.01 ft (6.10 m)
Length on Waterline	154.2 ft (47.0 m)	18.70 ft (5.70 m)
Length Between Perpendiculars	153.9 ft (46.9 m)	18.67 ft (5.69 m)
Beam (Maximum)	21.9 ft (6.68 m)	2.66 ft (0.81 m)
Draft (Mean)	5.63 ft (1.72 m)	0.682 ft (0.208 m)
Displacement	263 ton (267 t)	1020 lbs (463 kg)
Wetted Surface	3,413 ft^2 (317.1 m^2)	50.16 ft^2 (4.66 m^2)

Coefficients

Scale Ratio	$\lambda = L_S/L_M$	8.25
Block Coefficient	C_B	0.48
Prismatic Coefficient	C_P	0.63
Length/Beam Ratio	L/B	7.04
Beam/Draft Ratio	B/T	3.89
Displacement/Length Ratio	Δ_L	7.15



STATIONS	0	0.5	1.0	1.5	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18.5	19	19.5	20
A/A_X	0	.04	.08	.14	.18	.28	.39	.50	.60	.70	.79	.87	.94	.99	1.0	.97	.91	.81	.71	.61	.53	.49	.46	.4[illegible]	[illegible]

TABLE 2

CATALOG OF EXPERIMENTS PERFORMED

EXPERIMENT NUMBER	MODEL SPEED	WATER DEPTH	TRIM SETTING SPEED	DESCRIPTION	DATA IN APPENDIX
2	5.22 knots (2.68 m/s)	Deep	5.22 knots (2.68 m/s)	Without Port Propeller	A
3	6.96 knots (3.58 m/s)	Deep	6.96 knots (3.58 m/s)	Without Port Propeller	B
4	13.50 knots (6.94 m/s)	Deep	5.22 knots (2.68 m/s)	Without Port Propeller	C
5	2.87 knots (1.48 m/s)	Deep	5.22 knots (2.68 m/s)	Without Port Propeller	D
6	2.87 knots (1.48 m/s)	Deep	5.22 knots (2.68 m/s)	With Port Propeller	E
7	5.22 knots (2.68 m/s)	Deep	5.22 knots (2.68 m/s)	Repeat of Experiment 2	A
8	5.22 knots (2.68 m/s)	Deep	5.22 knots (2.68 m/s)	With Port Propeller	F
9	6.96 knots (3.58 m/s)	Deep	6.96 knots (3.58 m/s)	Repeat of Experiment 3	B
10	6.96 knots (3.58 m/s)	Deep	6.96 knots (3.58 m/s)	With Port Propeller	*
18	5.22 knots (2.68 m/s)	Shallow and Deep	5.22 knots (2.68 m/s) Shallow Water	With Port Propeller 20 deg (0.349 rad) Increments	**
19	5.22 knots (2.68 m/s)	Deep	5.22 knots (2.68 m/s) Shallow Water	With Port Propeller	G
20	5.22 knots (2.68 m/s)	Deep	5.22 knots (2.68 m/s) Shallow Water	Without Port Propeller Two Radii	**
21	5.22 knots (2.68 m/s)	Shallow	5.22 knots (2.68 m/s) Shallow Water	With Port Propeller	H
22	5.22 knots (2.68 m/s)	Deep	5.22 knots (2.68 m/s) Shallow Water	With Port Propeller Two Radii 20 deg (0.349 rad) Increments	**

Experiments 1 and 17 were calibrations of the pressure gages. Experiments 1 through 17 were run in April 1978.

Experiments 11 through 16 inclusive were deep water towing tank wake surveys with the bass dynamometer boat and the wake screen.

Experiments 18 through 22 were run in October 1978 with a new starboard strut barrel fairing.

*The data from Experiment 10 will be presented in DTNSRDC Report SPD-0833-06.

**Experiments 18 and 22 were abbreviated experiments determining the effects of shallow water trim and an operating propeller. Experiment 22 was a repeat of Experiment 18.

TABLE 3

SUMMARY OF WAKE SURVEY EXPERIMENTAL DATA

EXPERIMENT NUMBER	2	7	3	9	4	8	19	21
CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY, V_X/V	1.059	1.044	1.080	1.064	1.079	1.059	1.080	1.080
CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY, V_T/V	-0.009	-0.002	-0.008	0.000	-0.001	-0.006	-0.017	-0.016
MEAN ADVANCE ANGLE, β	17.73	17.45	18.05	17.76	20.84	17.72	18.11	18.09
MAXIMUM POSITIVE ADVANCE ANGLE, $+\Delta\beta$	1.48	1.14	1.42	1.13	1.56	1.45	2.21	2.12
MAXIMUM NEGATIVE ADVANCE ANGLE, $-\Delta\beta$	-1.87	-0.84	-2.31	-0.98	-1.95	-2.15	-3.04	-3.14
FIRST LONGITUDINAL HARMONIC	0.0182	0.0152	0.0103	0.0196	0.0279	0.0102	0.0456	0.0512
SECOND LONGITUDINAL HARMONIC	0.0143	0.0191	0.0147	0.0151	0.0122	0.0145	0.0139	0.0105
THIRD LONGITUDINAL HARMONIC	0.0093	0.0075	0.0093	0.0069	0.0099	0.0066	0.0031	0.0059
FOURTH LONGITUDINAL HARMONIC	0.0017	0.0022	0.0025	0.0056	0.0043	0.0024	0.0144	0.0124
FIRST TANGENTIAL HARMONIC	0.1950	0.1885	0.1932	0.1873	0.1404	0.1981	0.2111	0.2092
SECOND TANGENTIAL HARMONIC	0.0016	0.0030	0.0037	0.0015	0.0094	0.0070	0.0030	0.0014
THIRD TANGENTIAL HARMONIC	0.0022	0.0020	0.0042	0.0044	0.0049	0.0035	0.0039	0.0044
FOURTH TANGENTIAL HARMONIC	0.0019	0.0016	0.0027	0.0021	0.0010	0.0022	0.0013	0.0028

All data for $r/R = 0.781$ Radius

TABLE 4
EFFECT OF SPEED ON THE CIRCUMFERENTIAL MEAN VELOCITIES, MEAN ADVANCE ANGLE AND ITS VARIATIONS, AND THE FIRST FOUR HARMONICS

EXPERIMENT NUMBER	5	2	3	4
SPEED CONDITIONS	2.87 knots (1.48 m/s)	5.22 knots (2.68 m/s)	6.96 knots (3.58 m/s)	13.5 knots (6.94 m/s)
CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY, V_X/V	1.030	1.059	1.080	1.079
CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY, V_T/V	-0.002	-0.009	-0.008	-0.001
MEAN ADVANCE ANGLE, β	17.24	17.73	18.05	20.84
MAXIMUM POSITIVE ADVANCE ANGLE, $+\Delta\beta$	1.10	1.48	1.42	1.56
MAXIMUM NEGATIVE ADVANCE ANGLE, $-\Delta\beta$	-1.85	-1.87	-2.31	-1.95
FIRST LONGITUDINAL HARMONIC	0.0248	0.0182	0.0103	0.0279
SECOND LONGITUDINAL HARMONIC	0.0185	0.0143	0.0147	0.0122
THIRD LONGITUDINAL HARMONIC	0.0079	0.0093	0.0093	0.0099
FOURTH LONGITUDINAL HARMONIC	0.0047	0.0017	0.0025	0.0043
FIRST TANGENTIAL HARMONIC	0.1966	0.1950	0.1932	0.1404
SECOND TANGENTIAL HARMONIC	0.0054	0.0016	0.0037	0.0094
THIRD TANGENTIAL HARMONIC	0.0021	0.0022	0.0042	0.0049
FOURTH TANGENTIAL HARMONIC	0.0022	0.0019	0.0027	0.0010

All data for r/R = 0.781 Radius

APPENDIX A

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENTS 2 AND 7

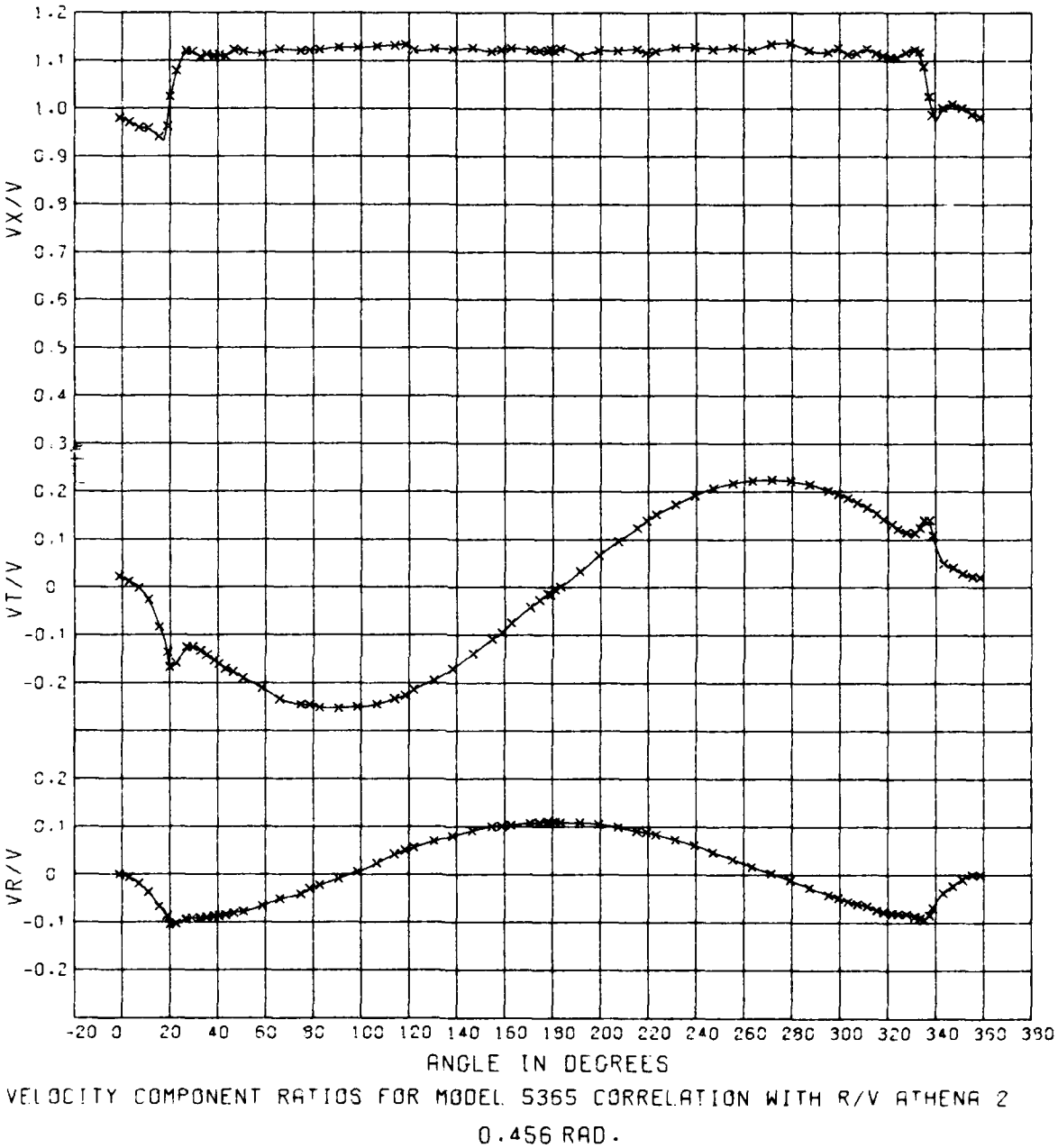


Figure A-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 2

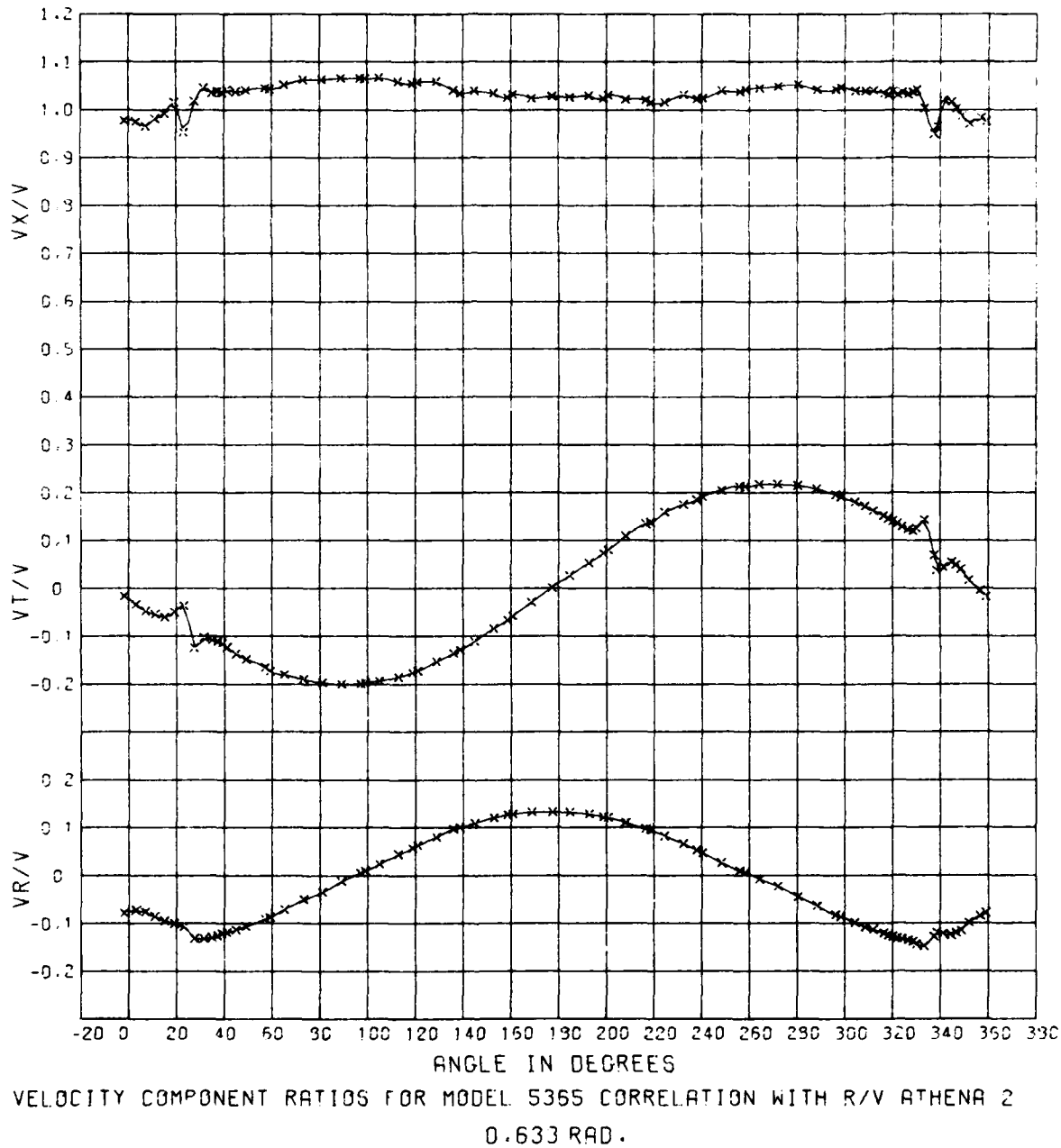


Figure A-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 2

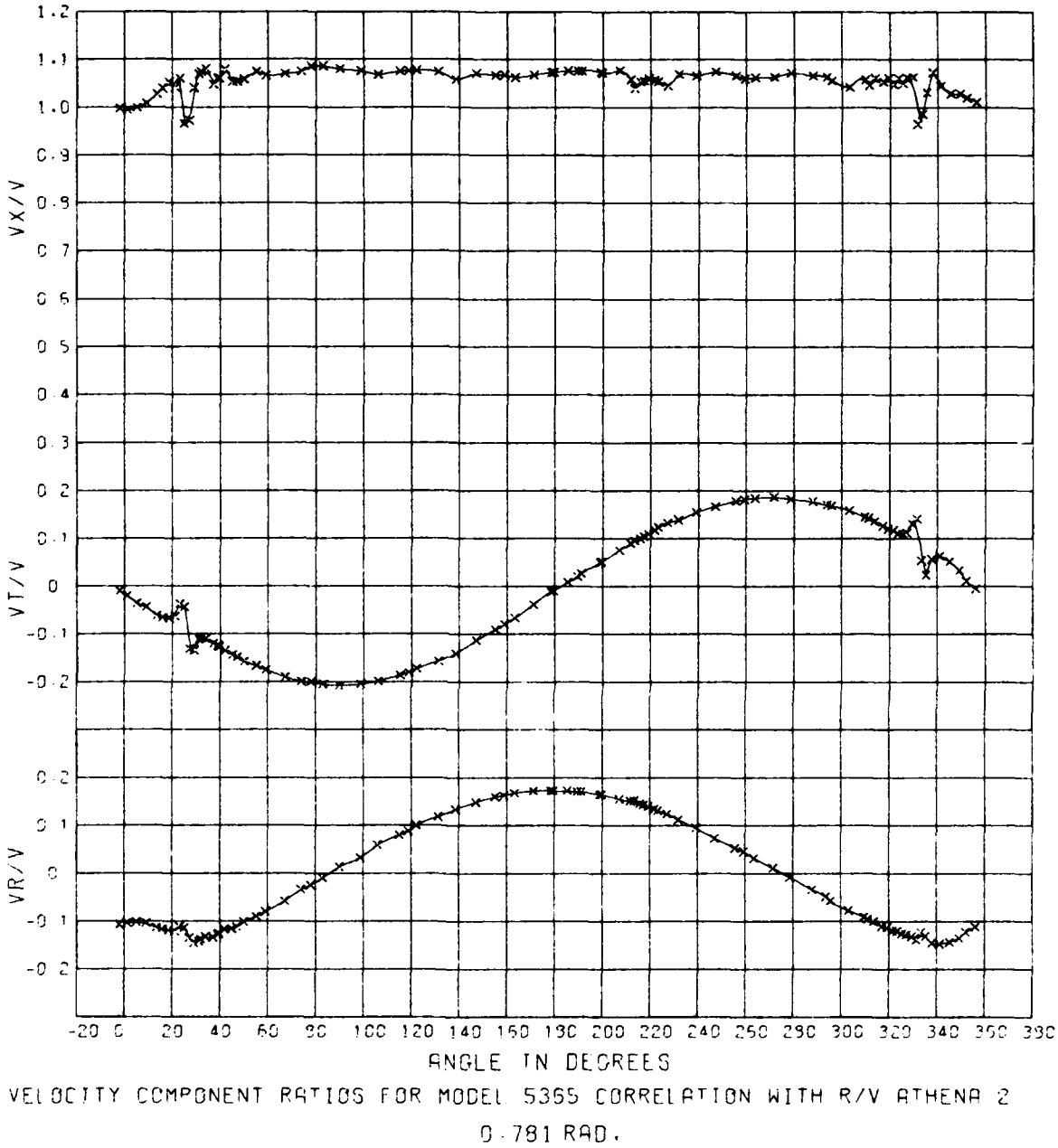


Figure A-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 2

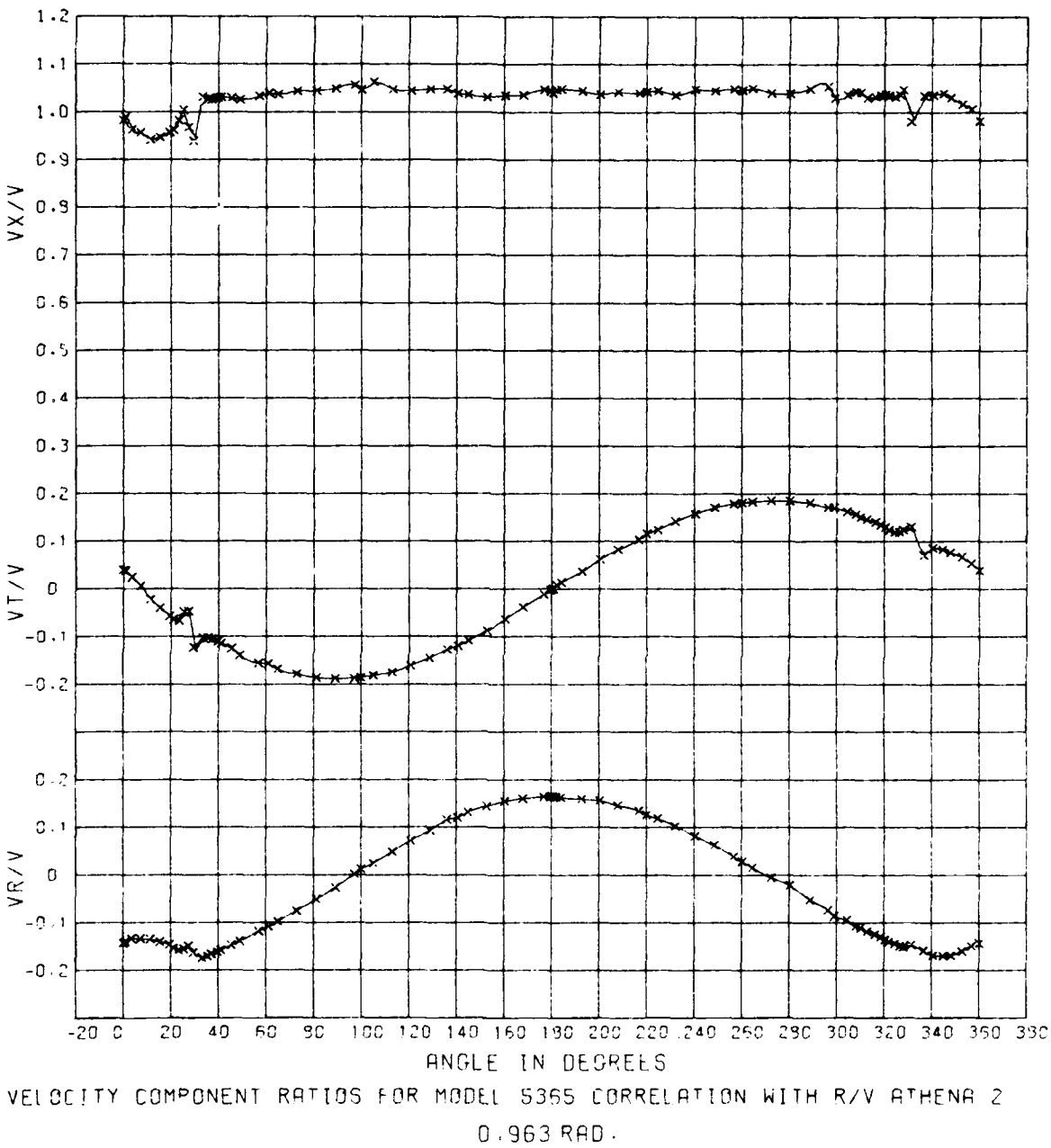


Figure A-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 2

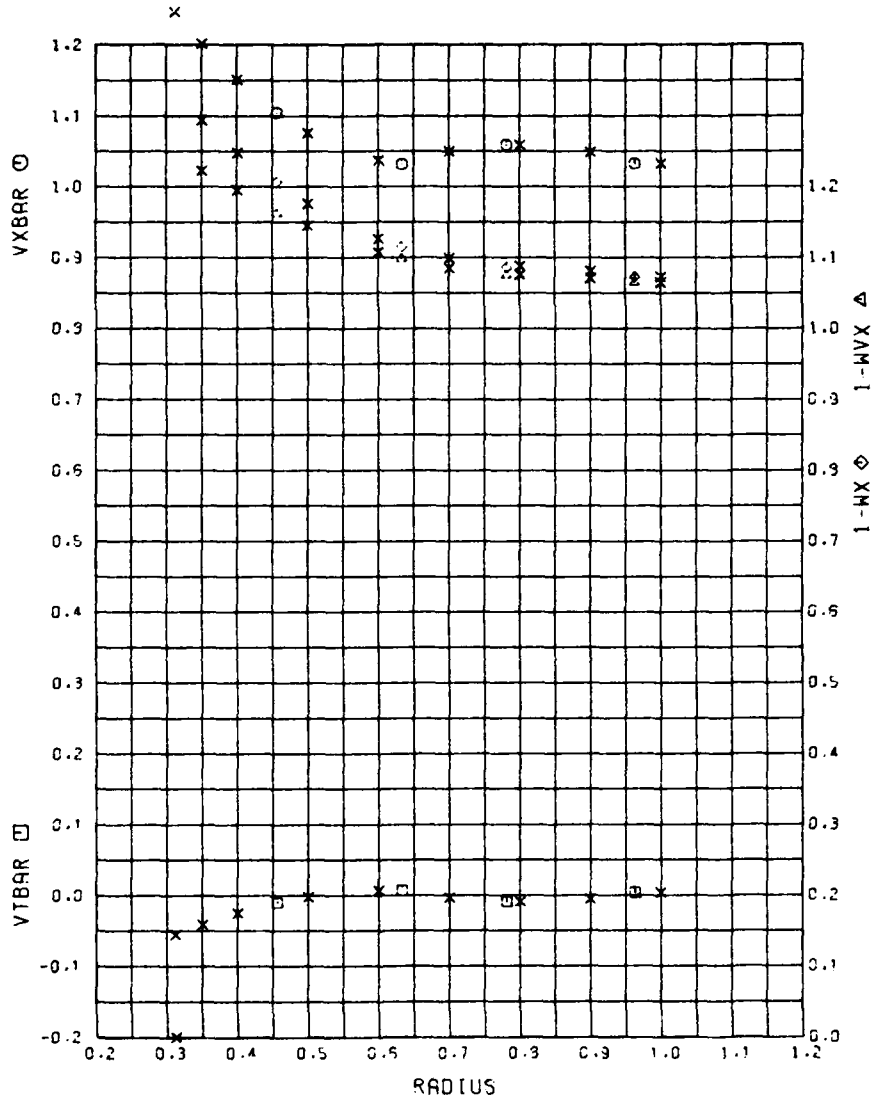


Figure A-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 2

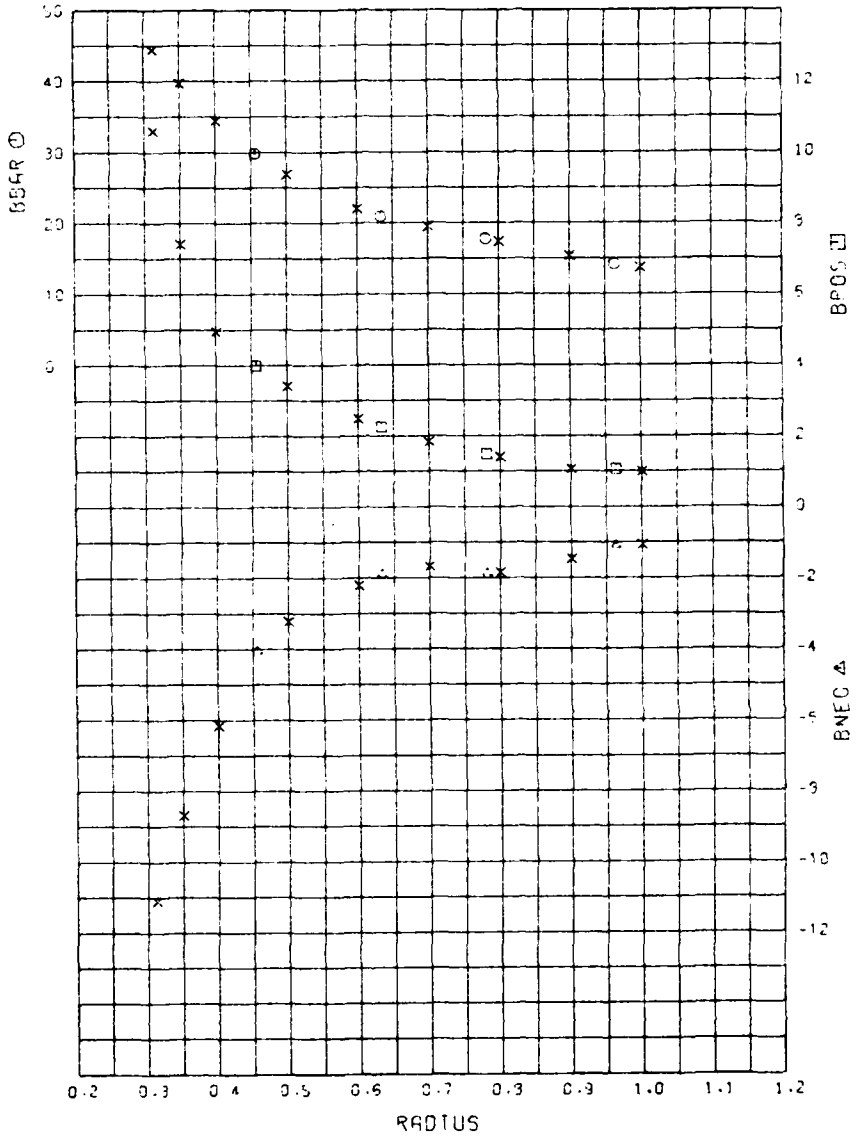


Figure A-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 2

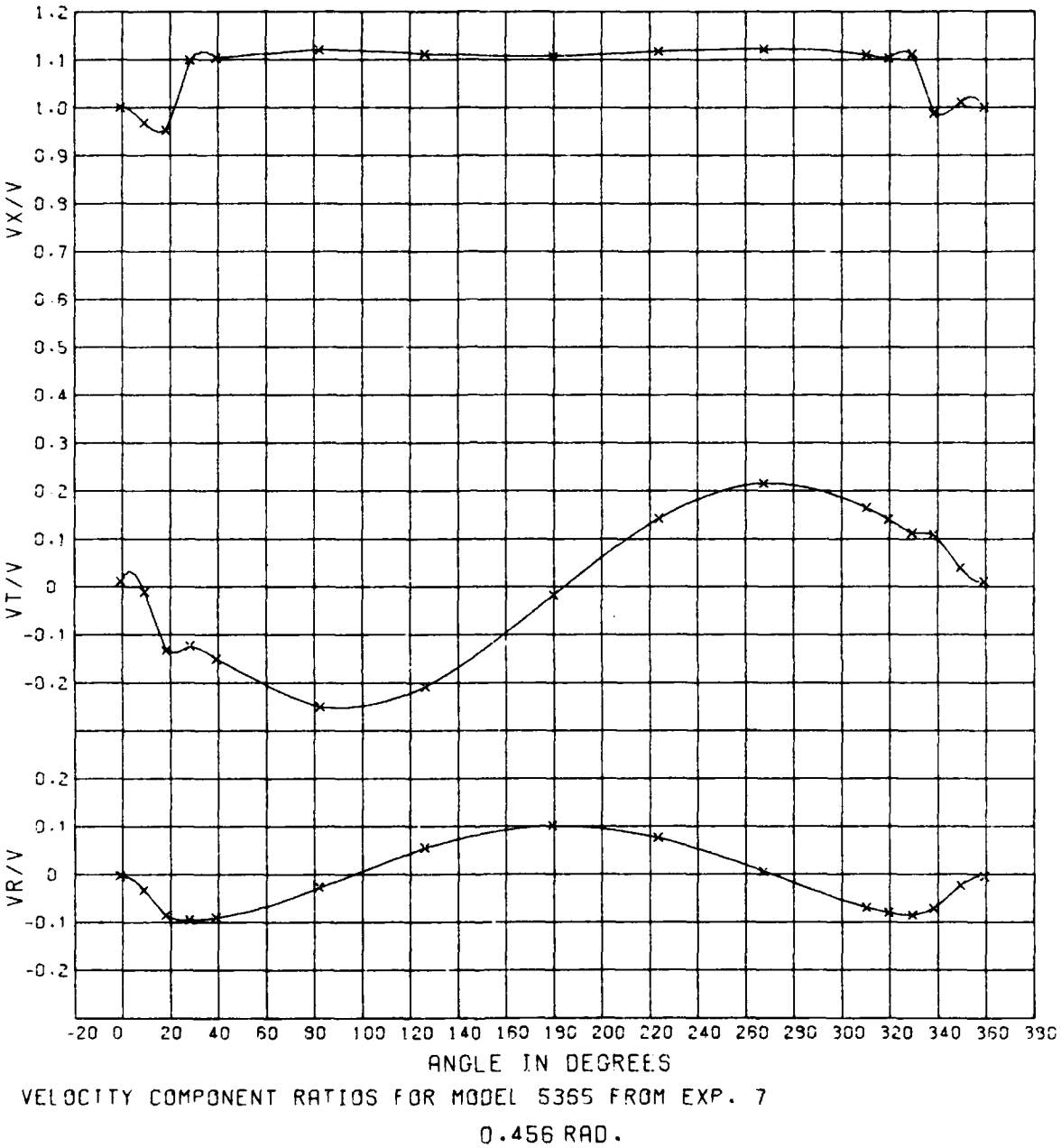


Figure A-7 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 7

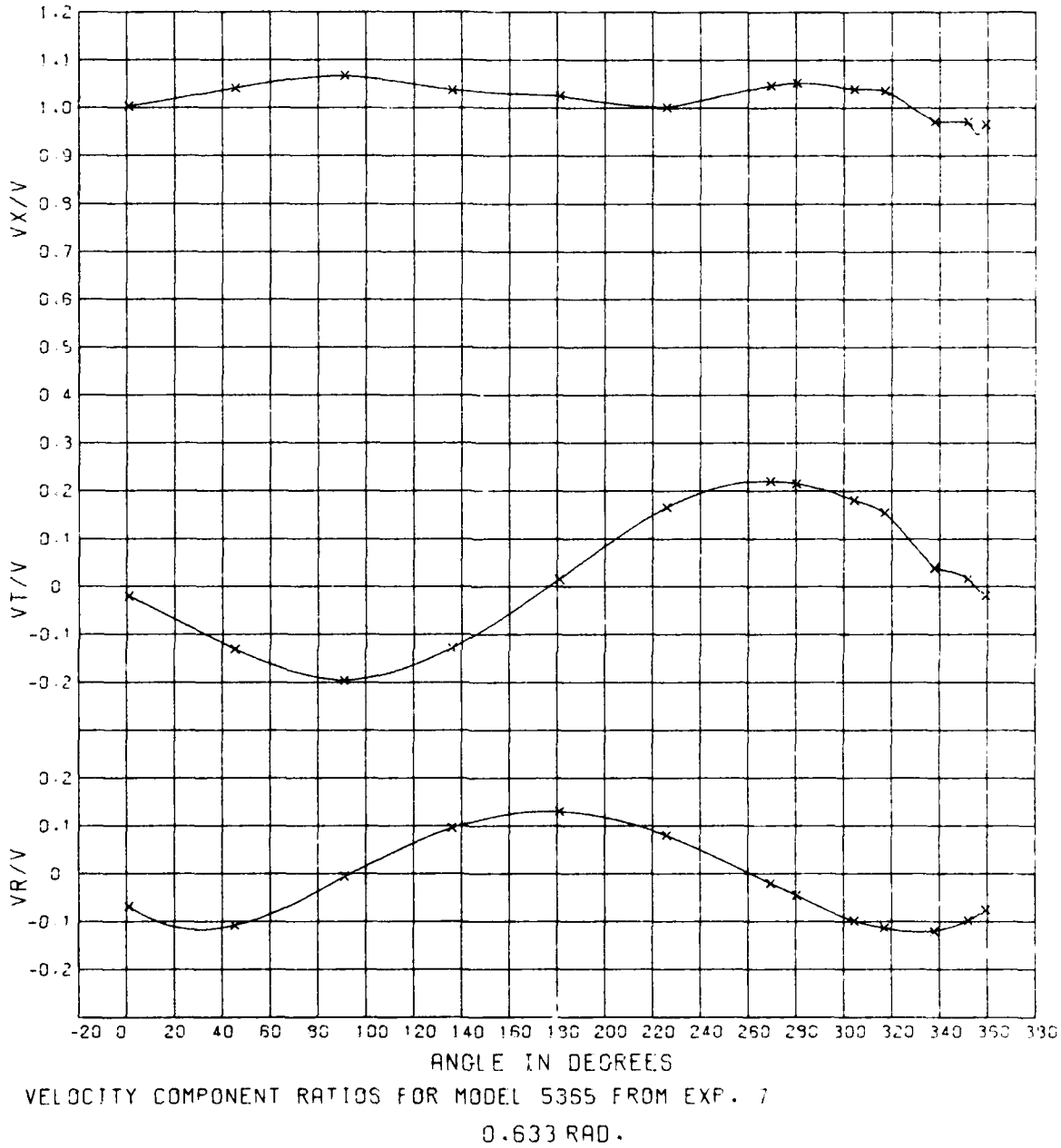


Figure A-8 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 7

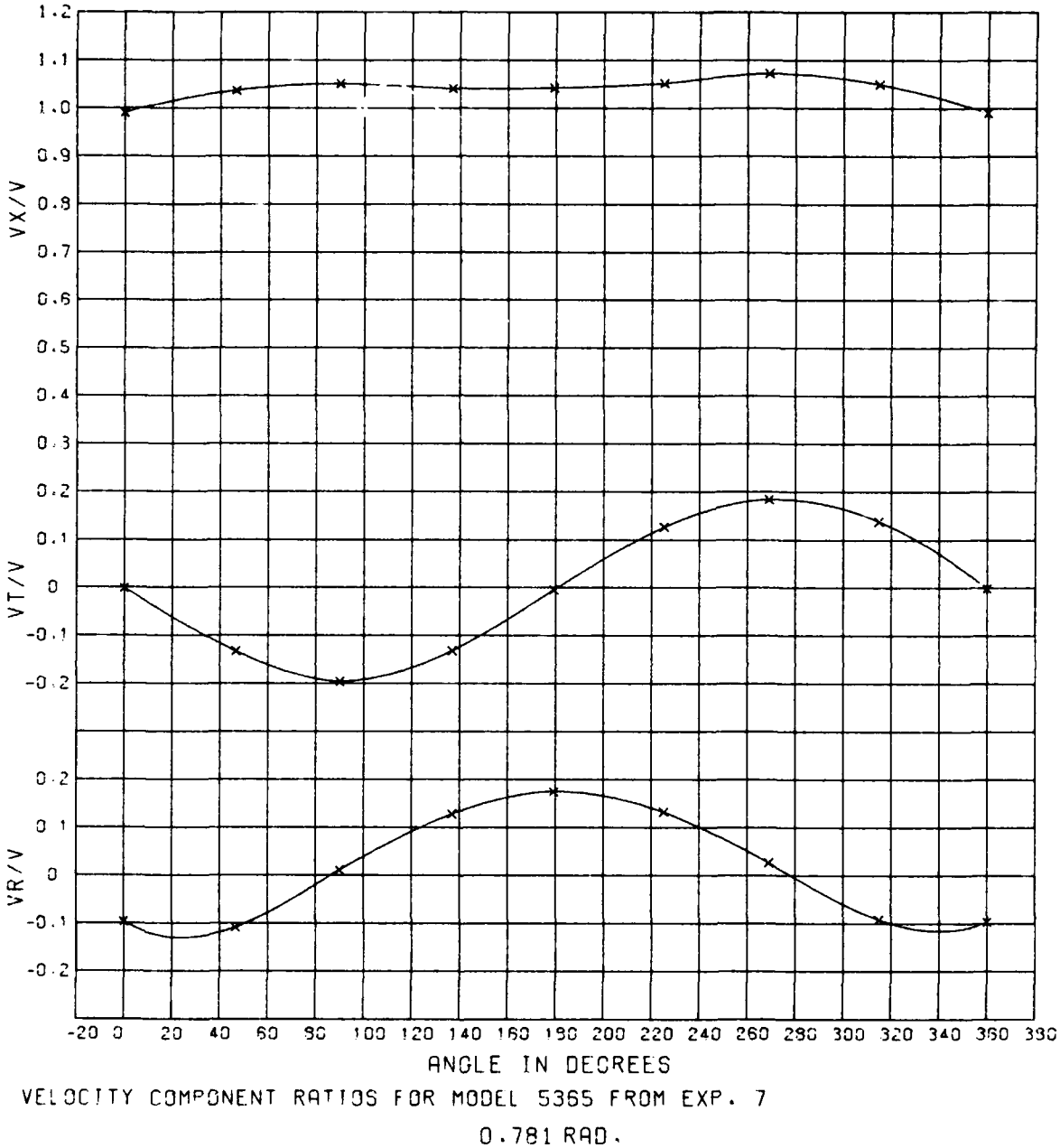


Figure A-9 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 7

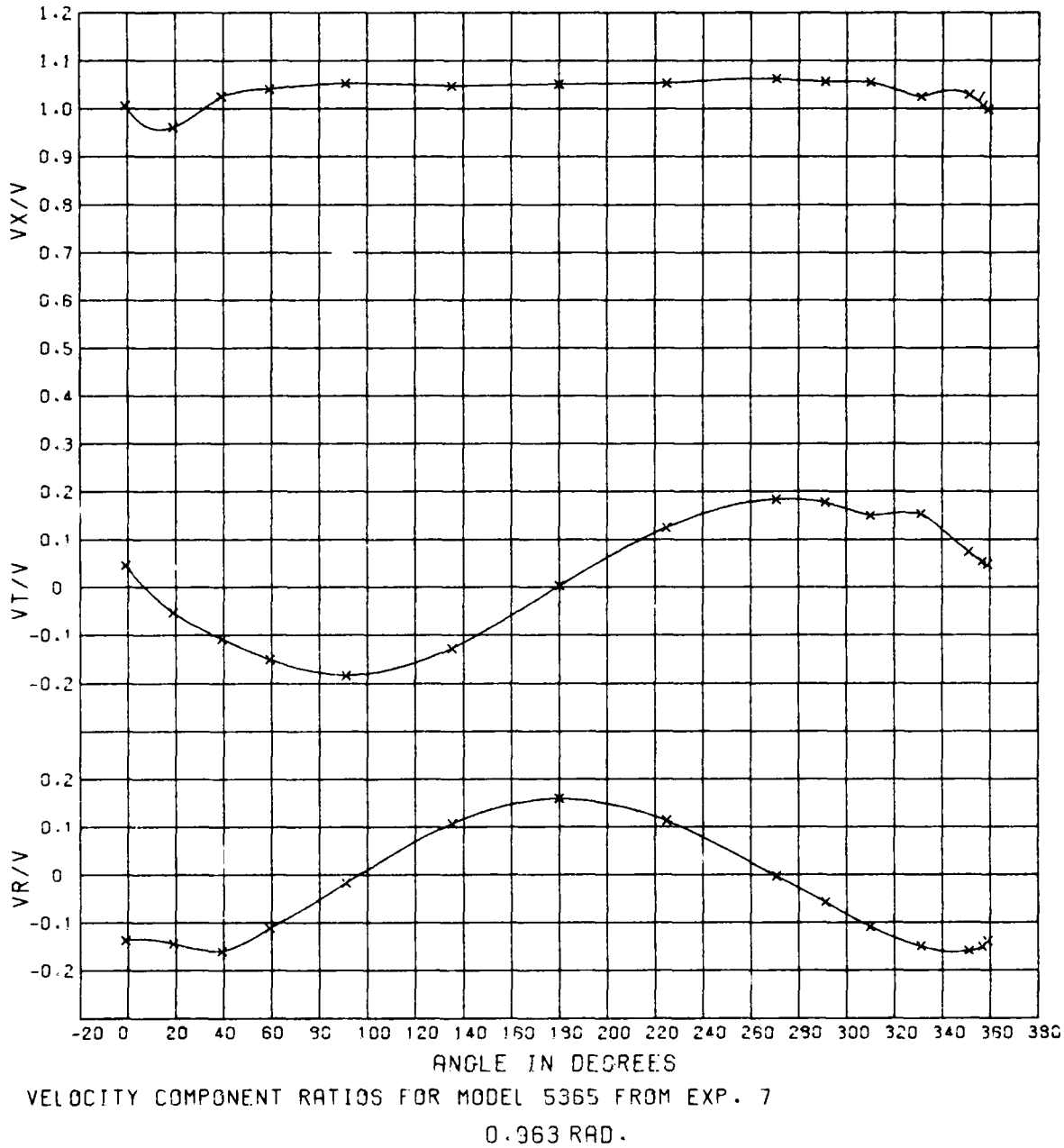


Figure A-10 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 7

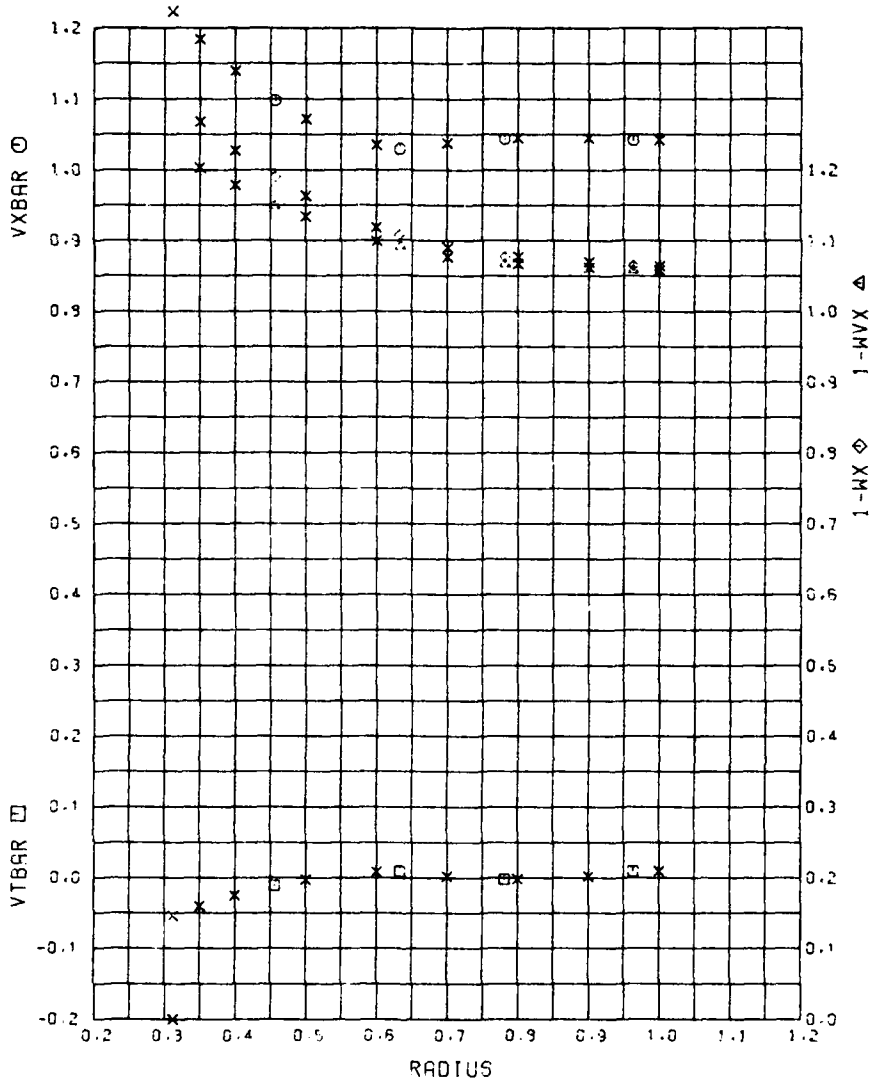


Figure A-11 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 7

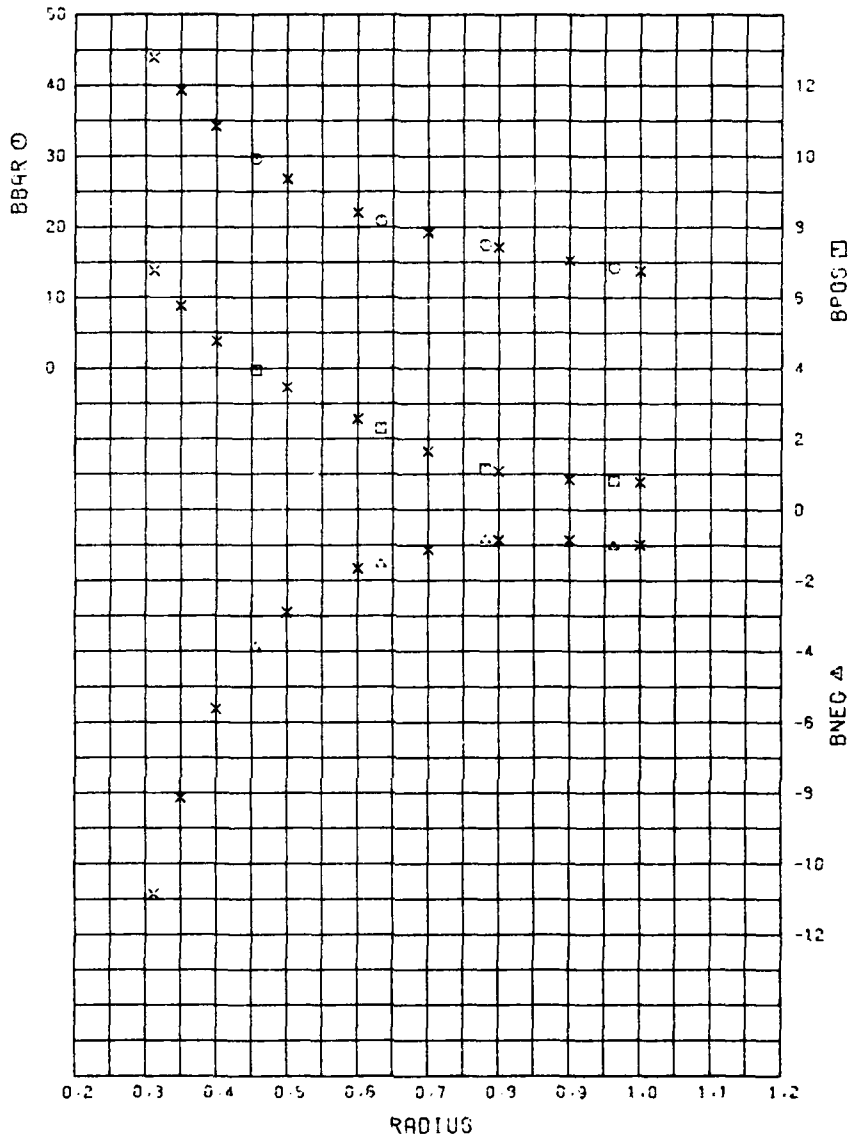


Figure A-12 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations of Experiment 7

TABLE A-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 2

RADIUS = .656

ANGLE	VX/V	VT/V	VR/V
-1.0	.941	.022	-.001
1.0	.972	.013	-.006
7.0	.968	-.002	-.019
11.0	.959	-.026	-.037
14.9	.969	-.044	-.058
14.0	.933	-.104	-.076
18.4	.967	-.135	-.084
18.9	.958	-.119	-.089
20.0	1.025	-.147	-.105
22.0	1.079	-.158	-.103
26.0	1.121	-.126	-.096
29.9	1.125	-.126	-.091
30.0	1.115	-.127	-.091
32.0	1.107	-.133	-.097
34.7	1.116	-.138	-.098
36.0	1.113	-.145	-.089
38.7	1.114	-.143	-.086
38.0	1.105	-.153	-.089
40.7	1.113	-.168	-.087
42.7	1.109	-.168	-.086
44.0	1.110	-.173	-.084
44.7	1.124	-.177	-.081
50.0	1.119	-.198	-.076
50.6	1.115	-.211	-.065
54.0	1.125	-.226	-.051
74.7	1.171	-.245	-.041
78.5	1.172	-.246	-.038
82.6	1.123	-.252	-.023
90.6	1.128	-.253	-.009
98.6	1.125	-.248	.006
98.5	1.129	-.252	.008
106.6	1.131	-.245	.024
114.0	1.132	-.233	.042
118.5	1.134	-.226	.051
122.0	1.123	-.216	.057
130.6	1.126	-.195	.069
138.0	1.121	-.171	.080
138.6	1.125	-.169	.081
146.5	1.127	-.139	.091
154.5	1.120	-.109	.100
158.6	1.123	-.095	.101
162.6	1.127	-.076	.103
170.6	1.123	-.062	.107
174.5	1.122	-.027	.108
174.0	1.113	-.014	.110
178.0	1.129	-.015	.112
179.0	1.122	-.020	.105
179.3	1.126	-.012	.110
180.7	1.128	-.005	.110
181.0	1.121	-.005	.110
183.1	1.127	.002	.109
191.3	1.111	.034	.109
199.0	1.120	.067	.106
199.2	1.117	.068	.105
207.3	1.121	.097	.100
215.2	1.175	.175	.091
219.2	1.117	.148	.089
223.2	1.115	.152	.083
223.2	1.125	.152	.085
231.3	1.128	.173	.073
239.3	1.129	.192	.062
247.0	1.126	.207	.047
255.2	1.128	.217	.032
263.2	1.173	.272	.017
271.2	1.130	.273	.003
271.3	1.140	.225	.002
279.2	1.137	.227	-.012
287.1	1.122	.219	-.027
295.1	1.118	.202	-.042
299.2	1.127	.195	-.048
303.2	1.114	.187	-.055
307.1	1.116	.177	-.061
311.1	1.126	.166	-.065
315.1	1.116	.154	-.074
319.0	1.118	.142	-.070
318.0	1.112	.143	-.077
321.1	1.108	.135	-.079
322.0	1.106	.124	-.081
323.0	1.107	.127	-.082
327.0	1.111	.117	-.082
326.0	1.129	.113	-.081
329.1	1.123	.114	-.087
331.3	1.125	.114	-.087
333.2	1.128	.124	-.091
335.3	1.110	.124	-.090
339.0	1.088	.140	-.094
337.1	1.091	.140	-.093
337.2	1.021	.140	-.094
338.0	.989	.107	-.070
340.0	.985	.111	-.067
343.0	1.001	.050	-.038
347.0	1.001	.039	-.026
347.0	1.017	.044	-.022
351.0	1.001	.029	-.010
355.1	.988	.023	0.000
359.0	.984	.020	.001
359.0	.991	.022	-.001

RADIUS = .633

ANGLE	VX/V	VT/V	VR/V
-1.7	.977	-.017	-.074
3.1	.975	-.034	-.073
7.1	.966	-.047	-.076
11.1	.982	-.053	-.046
15.2	.992	-.058	-.095
19.2	1.005	-.051	-.099
19.2	1.027	-.049	-.102
21.2	.993	-.036	-.107
27.2	.994	-.131	-.130
24.0	1.041	-.118	-.133
31.0	1.041	-.106	-.133
32.0	1.051	-.107	-.131
35.0	1.035	-.108	-.129
37.2	1.038	-.112	-.126
39.2	1.039	-.112	-.119
39.2	1.041	-.117	-.123
41.2	1.041	-.176	-.119
45.0	1.030	-.137	-.114
49.2	1.041	-.144	-.107
57.2	1.045	-.165	-.090
59.2	1.042	-.173	-.087
65.2	1.052	-.181	-.071
73.1	1.063	-.198	-.051
81.0	1.063	-.197	-.035
89.0	1.066	-.201	-.012
97.0	1.065	-.200	.006
99.0	1.064	-.198	.010
104.9	1.067	-.194	.024
112.9	1.059	-.188	.045
118.0	1.055	-.176	.057
120.9	1.057	-.172	.063
128.0	1.059	-.153	.080
130.0	1.041	-.136	.097
138.7	1.035	-.129	.099
144.7	1.039	-.111	.109
152.7	1.035	-.083	.121
158.6	1.026	-.066	.126
160.7	1.032	-.050	.128
168.6	1.024	-.029	.133
176.6	1.032	0.000	.133
178.0	1.025	.004	.132
184.6	1.026	.027	.137
192.6	1.030	.053	.128
198.6	1.024	.073	.127
200.6	1.031	.080	.121
204.0	1.022	.109	.118
216.5	1.020	.135	.097
214.5	1.015	.137	.095
224.4	1.016	.159	.082
232.4	1.032	.176	.066
234.0	1.023	.185	.053
240.4	1.024	.192	.047
248.3	1.040	.205	.026
256.0	1.034	.214	.010
254.0	1.039	.218	.013
258.7	1.046	.219	.001
264.2	1.045	.218	-.008
272.0	1.049	.218	-.023
280.3	1.053	.219	-.045
288.3	1.061	.209	-.064
296.2	1.062	.198	-.082
298.4	1.047	.192	-.086
304.3	1.048	.181	-.099
308.6	1.040	.172	-.107
312.0	1.041	.162	-.113
316.4	1.035	.153	-.121
318.0	1.032	.146	-.125
320.4	1.029	.146	-.125
324.0	1.034	.141	-.129
328.0	1.031	.135	-.131
326.0	1.037	.129	-.132
328.5	1.032	.123	-.135
324.5	1.037	.120	-.137
338.0	1.042	.126	-.144
332.6	1.038	.141	-.148
334.0	.971	.145	-.147
336.6	.979	.180	-.135
334.0	.972	.139	-.128
338.5	.986	.138	-.119
340.6	1.020	.139	-.120
342.0	1.022	.153	-.126
344.6	1.017	.155	-.129
346.6	1.023	.149	-.128
348.7	.987	.148	-.119
352.0	.972	.137	-.098
356.7	.984	-.006	-.085
358.7	.979	-.019	-.078
359.3	.977	-.017	-.079

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
-2.0	.948	-.010	-.100
1.2	.994	-.078	-.106
5.1	.999	-.037	-.103
9.1	1.008	-.044	-.106
13.1	1.026	-.048	-.112
14.0	1.028	-.063	-.116
16.0	1.039	-.066	-.117
18.0	1.049	-.068	-.118
19.1	1.054	-.068	-.119
21.1	1.041	-.063	-.121
23.1	1.068	-.037	-.111
25.0	.966	-.046	-.116
27.1	.965	-.131	-.135
27.1	.981	-.131	-.134
29.0	1.048	-.134	-.145
31.1	1.065	-.112	-.142
31.1	1.071	-.111	-.141
32.0	1.074	-.108	-.137
36.0	1.080	-.110	-.137
37.1	1.067	-.120	-.136
38.0	1.065	-.124	-.127
39.1	1.054	-.125	-.129
39.1	1.068	-.126	-.127
40.0	1.061	-.130	-.124
42.0	1.078	-.135	-.117
45.0	1.053	-.143	-.117
47.0	1.054	-.148	-.112
50.0	1.050	-.157	-.102
55.1	1.074	-.166	-.091
59.0	1.060	-.175	-.082
59.2	1.072	-.175	-.079
67.1	1.070	-.190	-.058
74.0	1.074	-.199	-.036
78.0	1.085	-.208	-.025
83.0	1.086	-.205	-.010
90.0	1.080	-.208	.014
98.6	1.047	-.202	.030
99.0	1.064	-.205	.035
106.0	1.068	-.199	.059
115.2	1.074	-.196	.080
118.7	1.076	-.181	.088
122.0	1.077	-.177	.108
131.1	1.074	-.157	.118
138.0	1.054	-.140	.136
138.7	1.061	-.141	.136
147.0	1.071	-.113	.149
155.0	1.067	-.098	.160
158.7	1.064	-.079	.157
163.1	1.062	-.066	.160
171.0	1.068	-.038	.172
178.0	1.069	-.011	.176
178.6	1.076	-.012	.172
179.3	1.073	-.010	.172
185.3	1.076	.008	.173
189.6	1.076	.020	.171
191.0	1.076	.027	.171
194.9	1.072	.049	.166
198.2	1.075	.058	.166
199.6	1.072	.051	.164
207.0	1.077	.075	.155
211.5	1.058	.098	.151
213.2	1.039	.096	.152
215.5	1.054	.100	.150
217.0	1.056	.105	.143
219.0	1.066	.110	.141
219.1	1.067	.104	.139
221.5	1.057	.117	.134
223.0	1.059	.126	.131
227.0	1.065	.133	.125
231.0	1.069	.138	.112
239.0	1.063	.155	.096
239.0	1.069	.154	.097
247.0	1.074	.166	.073
255.6	1.066	.178	.053
259.2	1.068	.182	.046
263.6	1.062	.185	.032
271.6	1.063	.187	.011
275.0	1.068	.186	-.005
279.0	1.077	.181	-.021
287.7	1.066	.177	-.034
293.5	1.063	.170	-.044
295.9	1.056	.169	-.050
301.0	1.062	.158	-.077
304.6	1.058	.155	-.081
311.2	1.066	.162	-.096
313.5	1.061	.136	-.100
317.0	1.054	.125	-.110
319.0	1.061	.121	-.111
320.5	1.062	.120	-.113
321.4	1.058	.118	-.120
323.1	1.061	.118	-.121
325.2	1.060	.110	-.128
329.3	1.059	.108	-.129
327.0	1.062	.111	-.128
329.6	1.063	.130	-.131
331.7	.966	.141	-.130
333.3	.987	.096	-.122
335.2	1.031	.026	-.131
337.3	1.076	.059	-.163
339.0	1.072	.064	-.167
341.0	1.065	.063	-.167
344.1	1.079	.052	-.163
349.2	1.078	.033	-.139
352.0	1.070	.011	-.122
356.0	1.011	-.009	-.112
359.0	.998	-.010	-.106

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
0.0	.980	.060	-.165
0.0	.984	.037	-.141
.9	.988	.037	-.148
1.4	.962	.024	-.134
7.3	.957	.006	-.134
11.4	.942	-.022	-.135
15.4	.947	-.040	-.141
19.4	.957	-.057	-.146
21.1	.962	-.064	-.154
23.4	.982	-.067	-.158
25.4	1.007	-.068	-.156
27.4	.957	-.067	-.147
27.4	.979	-.067	-.151
29.4	.959	-.173	-.163
31.3	1.011	-.183	-.174
35.4	1.026	-.183	-.171
37.0	1.026	-.186	-.167
39.5	1.038	-.118	-.162
41.0	1.032	-.114	-.157
41.1	1.029	-.115	-.159
43.4	1.029	-.125	-.160
45.0	1.025	-.148	-.139
57.0	1.033	-.156	-.118
61.1	1.039	-.157	-.109
65.0	1.036	-.169	-.098
73.0	1.043	-.179	-.076
81.1	1.042	-.187	-.047
81.3	1.044	-.185	-.055
89.1	1.047	-.189	-.031
99.1	1.050	-.188	-.023
97.2	1.056	-.188	.002
100.0	1.046	-.187	.017
109.1	1.063	-.182	.024
113.1	1.047	-.176	.049
120.7	1.037	-.163	.072
121.0	1.052	-.168	.071
129.9	1.047	-.165	.093
135.0	1.046	-.127	.116
140.5	1.039	-.120	.119
144.9	1.037	-.109	.131
152.0	1.031	-.088	.144
160.0	1.038	-.064	.154
160.0	1.040	-.063	.157
169.0	1.036	-.039	.160
176.7	1.047	-.017	.163
178.0	1.042	-.006	.165
180.0	1.045	.002	.164
180.5	1.048	.000	.165
187.0	1.047	.009	.163
189.0	1.044	.014	.167
192.0	1.044	.036	.159
200.0	1.041	.041	.155
208.0	1.033	.063	.156
208.0	1.043	.063	.164
216.7	1.040	.104	.135
220.0	1.043	.116	.124
224.6	1.045	.126	.116
227.0	1.035	.162	.107
240.3	1.047	.157	.091
240.4	1.045	.171	.067
254.6	1.048	.178	.039
260.2	1.046	.181	.029
264.5	1.050	.183	.016
272.4	1.041	.194	-.009
280.1	1.042	.195	-.023
280.4	1.036	.195	-.021
284.7	1.049	.191	-.052
290.4	1.054	.172	-.074
299.0	1.079	.171	-.086
304.4	1.035	.167	-.094
309.0	1.042	.156	-.109
310.0	1.042	.151	-.110
312.7	1.030	.146	-.120
316.0	1.034	.141	-.125
316.6	1.032	.140	-.124
319.5	1.036	.135	-.131
320.2	1.031	.131	-.136
320.5	1.034	.129	-.135
327.0	1.035	.124	-.140
326.5	1.032	.119	-.144
330.5	1.037	.119	-.149
329.0	1.047	.126	-.151
332.6	1.019	.143	-.161
335.2	.987	.110	-.161
336.6	1.035	.071	-.160
340.3	1.032	.049	-.169
340.6	1.039	.046	-.166
344.7	1.040	.043	-.170
348.0	1.031	.077	-.170
352.0	1.017	.047	-.160
356.4	1.007	.053	-.150
360.0	.984	.037	-.141
360.0	.980	.040	-.149

TABLE A-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 2

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 2 WITHOUT PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.105	1.032	1.059	1.033	1.247	1.202	1.151	1.076	1.037	1.050	1.059	1.049	1.033
VTBAR =	-.010	.007	-.009	.004	-.055	-.041	-.025	-.002	.007	-.003	-.009	-.005	.004
VRBAR =	.009	-.007	.014	-.006	.055	.040	.023	.001	-.007	.007	.014	.007	-.006
1-WVX =	1.162	1.098	1.075	1.065	0.000	1.223	1.195	1.145	1.107	1.085	1.076	1.071	1.065
1-WX =	1.207	1.115	1.086	1.073	0.000	1.294	1.248	1.176	1.126	1.099	1.088	1.081	1.073
BBAR =	29.80	20.93	17.73	14.14	44.43	39.70	34.47	26.86	22.07	19.44	17.34	15.35	13.64
BPOS =	3.98	2.25	1.48	1.05	10.60	7.41	4.95	3.41	2.49	1.83	1.40	1.06	.99
THETA =	90.00	92.50	82.50	105.00	22.50	22.50	87.50	92.50	92.50	82.50	82.50	95.00	105.00
BNEG =	-4.06	-1.90	-1.87	-1.10	-11.10	-8.69	-6.16	-3.23	-2.22	-1.68	-1.85	-1.47	-1.07
THETA =	340.00	335.00	332.50	12.50	340.00	340.00	340.00	337.50	337.50	332.50	332.50	332.50	12.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE A-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 2

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 2 WITHOUT PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0381	.0358	.0254	.0197	.0158	.0108	.0052	.0025
PHASE ANGLE =	269.3	267.8	270.2	266.9	263.2	250.6	249.2	180.9
RADIUS = .633								
AMPLITUDE =	.0143	.0262	.0103	.0038	.0055	.0025	.0011	.0016
PHASE ANGLE =	308.9	258.9	262.4	291.4	248.4	284.6	198.6	133.2
RADIUS = .781								
AMPLITUDE =	.0182	.0143	.0093	.0017	.0052	.0016	.0040	.0013
PHASE ANGLE =	286.0	271.3	258.1	233.8	241.3	303.3	218.6	285.4
RADIUS = .963								
AMPLITUDE =	.0195	.0192	.0120	.0061	.0035	.0069	.0070	.0051
PHASE ANGLE =	260.8	246.9	219.3	202.4	204.3	168.5	175.2	155.1

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0058	.0071	.0042	.0083	.0072	.0052	.0030	.0018
PHASE ANGLE =	135.0	129.7	111.1	110.2	107.6	111.3	129.6	15.6
RADIUS = .633								
AMPLITUDE =	.0030	.0012	.0007	.0004	.0022	.0015	.0037	.0035
PHASE ANGLE =	111.9	140.9	84.7	302.5	256.3	231.3	272.7	281.7
RADIUS = .781								
AMPLITUDE =	.0032	.0022	.0041	.0027	.0048	.0024	.0032	.0022
PHASE ANGLE =	85.1	248.3	251.3	279.7	286.7	280.1	281.0	231.7
RADIUS = .963								
AMPLITUDE =	.0022	.0033	.0018	.0023	.0030	.0025	.0007	.0016
PHASE ANGLE =	186.0	133.7	154.6	241.2	242.8	296.2	295.0	125.9

TABLE A-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 2

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 2 WITHOUT PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0898	.0422	.0419	.0435	.0324	.0238	.0153	.0056
PHASE ANGLE =	257.4	283.4	272.3	260.6	266.3	244.7	250.0	237.5
RADIUS = .350								
AMPLITUDE =	.0734	.0404	.0418	.0369	.0273	.0198	.0121	.0043
PHASE ANGLE =	259.4	278.7	271.9	261.8	265.8	245.7	250.1	227.4
RADIUS = .400								
AMPLITUDE =	.0548	.0382	.0334	.0281	.0214	.0152	.0085	.0031
PHASE ANGLE =	263.0	273.2	271.3	263.8	264.8	247.5	250.1	203.2
RADIUS = .500								
AMPLITUDE =	.0281	.0338	.0202	.0143	.0122	.0079	.0033	.0024
PHASE ANGLE =	276.9	264.4	269.0	270.3	261.2	254.4	246.6	161.5
RADIUS = .600								
AMPLITUDE =	.0158	.0284	.0119	.0056	.0066	.0034	.0011	.0021
PHASE ANGLE =	302.3	259.4	264.5	284.1	252.6	273.0	213.5	136.8
RADIUS = .700								
AMPLITUDE =	.0164	.0190	.0097	.0023	.0052	.0025	.0026	.0005
PHASE ANGLE =	297.2	265.9	264.1	281.2	249.6	305.3	224.4	282.8
RADIUS = .800								
AMPLITUDE =	.0185	.0137	.0092	.0019	.0053	.0012	.0043	.0013
PHASE ANGLE =	283.5	271.2	255.3	222.7	237.9	293.4	215.5	278.5
RADIUS = .900								
AMPLITUDE =	.0194	.0147	.0100	.0041	.0066	.0032	.0056	.0020
PHASE ANGLE =	270.2	259.5	234.0	202.2	216.3	174.8	192.4	176.1
RADIUS = 1.000								
AMPLITUDE =	.0195	.0192	.0120	.0061	.0085	.0069	.0070	.0051
PHASE ANGLE =	260.8	248.9	219.3	202.4	204.3	168.5	175.2	155.1

TABLE A-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 2 WITHOUT PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0099	.0148	.0120	.0204	.0193	.0135	.0135	.0085
PHASE ANGLE =	139.0	134.6	127.4	112.2	98.8	98.7	111.1	81.6
RADIUS = .350								
AMPLITUDE =	.0087	.0125	.0103	.0168	.0157	.0110	.0102	.0061
PHASE ANGLE =	138.5	133.4	123.5	111.8	100.3	100.8	112.9	76.0
RADIUS = .400								
AMPLITUDE =	.0072	.0098	.0082	.0125	.0114	.0080	.0064	.0035
PHASE ANGLE =	137.4	131.7	117.9	111.1	102.9	104.5	117.0	61.7
RADIUS = .500								
AMPLITUDE =	.0048	.0053	.0047	.0056	.0044	.0033	.0012	.0020
PHASE ANGLE =	131.8	128.4	105.4	109.1	114.7	121.0	174.2	325.4
RADIUS = .600								
AMPLITUDE =	.0033	.0020	.0017	.0007	.0013	.0013	.0031	.0034
PHASE ANGLE =	118.5	130.7	91.2	89.3	228.4	200.6	268.5	287.7
RADIUS = .700								
AMPLITUDE =	.0033	.0014	.0024	.0018	.0038	.0019	.0036	.0028
PHASE ANGLE =	92.0	239.9	253.4	286.3	282.0	262.8	277.1	259.5
RADIUS = .800								
AMPLITUDE =	.0030	.0021	.0042	.0028	.0048	.0025	.0030	.0021
PHASE ANGLE =	85.7	245.9	250.2	277.9	286.3	282.5	281.9	224.9
RADIUS = .900								
AMPLITUDE =	.0016	.0016	.0027	.0027	.0039	.0027	.0018	.0015
PHASE ANGLE =	120.0	183.4	231.5	202.6	273.3	291.7	286.5	175.5
RADIUS = 1.000								
AMPLITUDE =	.0022	.0033	.0018	.0023	.0030	.0025	.0007	.0016
PHASE ANGLE =	186.0	133.7	154.6	241.2	242.8	296.2	295.0	125.9

TABLE A-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 2

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 2 WITHOUT PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2388	.0053	.0015	.0049	.0035	.0044	.0032	.0033
PHASE ANGLE =	179.5	110.2	135.1	158.9	141.4	144.9	101.5	75.7
RADIUS = .633								
AMPLITUDE =	.2093	.0038	.0043	.0040	.0033	.0030	.0026	.0017
PHASE ANGLE =	181.3	278.1	281.5	262.7	283.4	270.3	286.8	287.8
RADIUS = .781								
AMPLITUDE =	.1950	.0016	.0022	.0019	.0021	.0012	.0016	.0006
PHASE ANGLE =	179.5	153.9	302.9	266.2	273.5	271.6	304.4	249.3
RADIUS = .963								
AMPLITUDE =	.1881	.0083	.0048	.0037	.0028	.0029	.0016	.0017
PHASE ANGLE =	176.6	113.1	113.8	122.1	124.0	107.7	122.9	106.8

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0050	.0052	.0061	.0058	.0059	.0036	.0030	.0010
PHASE ANGLE =	38.5	30.2	26.0	25.2	22.8	22.1	11.0	297.5
RADIUS = .633								
AMPLITUDE =	.0018	.0004	.0038	.0012	.0024	.0030	.0029	.0025
PHASE ANGLE =	313.2	299.6	243.7	186.5	176.9	165.7	175.9	171.9
RADIUS = .781								
AMPLITUDE =	.0011	.0005	.0014	.0017	.0019	.0021	.0010	.0009
PHASE ANGLE =	256.3	263.3	208.3	185.2	197.1	192.4	218.2	224.2
RADIUS = .963								
AMPLITUDE =	.0010	.0011	.0010	.0009	.0013	.0014	.0012	.0007
PHASE ANGLE =	87.1	132.0	114.0	145.1	156.0	157.7	182.6	148.2

TABLE A-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 2

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 2 WITHOUT PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2737	.0245	.0124	.0168	.0148	.0163	.0138	.0119
PHASE ANGLE =	176.0	107.9	108.0	129.8	126.9	125.6	101.6	87.2
RADIUS = .350								
AMPLITUDE =	.2635	.0184	.0089	.0129	.0112	.0125	.0105	.0092
PHASE ANGLE =	177.0	108.0	109.6	133.4	128.3	127.8	101.7	85.8
RADIUS = .400								
AMPLITUDE =	.2512	.0115	.0050	.0086	.0072	.0082	.0067	.0061
PHASE ANGLE =	178.3	108.5	113.9	141.0	131.5	132.7	101.7	82.7
RADIUS = .500								
AMPLITUDE =	.2302	.0016	.0011	.0032	.0014	.0024	.0010	.0016
PHASE ANGLE =	180.3	118.9	247.4	188.5	174.0	171.0	99.5	60.2
RADIUS = .600								
AMPLITUDE =	.2137	.0033	.0039	.0037	.0028	.0026	.0021	.0013
PHASE ANGLE =	181.3	278.4	279.1	254.8	279.6	262.3	286.3	297.3
RADIUS = .700								
AMPLITUDE =	.2018	.0019	.0036	.0032	.0030	.0024	.0023	.0012
PHASE ANGLE =	180.5	259.7	291.2	267.8	280.7	272.8	295.8	275.8
RADIUS = .800								
AMPLITUDE =	.1937	.0022	.0018	.0015	.0018	.0009	.0014	.0005
PHASE ANGLE =	179.2	141.8	306.9	262.4	270.0	269.4	306.6	235.4
RADIUS = .900								
AMPLITUDE =	.1891	.0058	.0012	.0015	.0010	.0012	.0003	.0009
PHASE ANGLE =	177.6	122.7	96.7	133.7	153.9	111.0	89.5	125.4
RADIUS = 1.000								
AMPLITUDE =	.1881	.0083	.0036	.0037	.0028	.0029	.0016	.0017
PHASE ANGLE =	176.6	119.1	113.8	122.1	124.0	107.7	122.9	108.8

TABLE A-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5385 FROM EXP. 2 WITHOUT PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0125	.0133	.0163	.0164	.0192	.0144	.0144	.0080
PHASE ANGLE =	57.0	33.7	30.3	23.7	15.3	4.7	1.5	331.6
RADIUS = .350								
AMPLITUDE =	.0102	.0108	.0132	.0132	.0151	.0110	.0108	.0057
PHASE ANGLE =	53.9	33.2	29.6	23.9	16.3	6.7	2.5	329.9
RADIUS = .400								
AMPLITUDE =	.0075	.0079	.0095	.0094	.0103	.0071	.0067	.0031
PHASE ANGLE =	48.4	32.2	28.3	24.3	18.3	11.0	4.7	324.9
RADIUS = .500								
AMPLITUDE =	.0035	.0034	.0038	.0034	.0030	.0017	.0009	.0009
PHASE ANGLE =	25.9	27.4	22.5	27.1	31.7	51.0	39.3	201.2
RADIUS = .600								
AMPLITUDE =	.0019	.0007	.0005	.0005	.0017	.0025	.0025	.0024
PHASE ANGLE =	332.1	354.0	310.3	164.4	165.7	158.5	172.4	172.2
RADIUS = .700								
AMPLITUDE =	.0014	.0006	.0012	.0016	.0022	.0025	.0017	.0015
PHASE ANGLE =	285.4	283.3	222.1	187.4	189.5	180.5	191.1	191.4
RADIUS = .800								
AMPLITUDE =	.0010	.0004	.0014	.0017	.0018	.0021	.0010	.0008
PHASE ANGLE =	250.0	254.7	204.8	184.2	197.3	193.6	223.2	230.5
RADIUS = .900								
AMPLITUDE =	.0003	.0005	.0010	.0013	.0014	.0015	.0009	.0004
PHASE ANGLE =	166.1	155.6	166.4	172.0	183.6	184.8	213.0	219.6
RADIUS = 1.000								
AMPLITUDE =	.0010	.0011	.0010	.0009	.0013	.0014	.0012	.0007
PHASE ANGLE =	87.1	132.0	114.0	145.1	156.0	157.7	182.6	145.2

TABLE A-7

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 7

INPUT DATA

RADIUS = .456

ANGLE	VX/V	VT/V	VR/V
-1.1	1.002	.013	-.003
8.9	.970	-.010	-.033
18.0	.954	-.132	-.086
28.0	1.101	-.122	-.094
38.9	1.105	-.149	-.089
82.0	1.122	-.249	-.026
126.0	1.114	-.206	.056
179.4	1.109	-.016	.102
223.4	1.119	.144	.077
267.3	1.124	.217	.007
310.0	1.113	.166	-.067
319.2	1.104	.143	-.078
329.1	1.114	.114	-.084
338.0	.989	.111	-.070
349.1	1.013	.041	-.022
358.9	1.002	.013	-.003

RADIUS = .633

ANGLE	VX/V	VT/V	VR/V
1.0	1.003	-.020	-.069
45.4	1.042	-.131	-.109
91.2	1.067	-.196	-.006
136.0	1.038	-.129	.096
181.0	1.026	.016	.131
226.0	1.002	.166	.080
269.1	1.047	.220	-.021
270.0	1.047	.220	-.020
280.3	1.053	.215	-.045
304.3	1.040	.181	-.099
317.0	1.036	.155	-.113
338.0	.972	.039	-.120
352.0	.972	.017	-.098
359.3	.966	-.019	-.076
361.0	1.003	-.020	-.069

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
0.0	.991	-.002	-.097
46.6	1.037	-.133	-.109
90.0	1.052	-.196	.011
136.9	1.042	-.132	.127
179.3	1.043	-.005	.175
225.3	1.052	.127	.132
269.0	1.073	.185	.027
314.9	1.051	.139	-.092
360.0	.991	-.002	-.097

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
-1.0	1.006	.046	-.137
19.0	.961	-.053	-.144
39.3	1.026	-.108	-.160
59.3	1.041	-.151	-.112
91.1	1.053	-.184	-.017
135.1	1.048	-.128	.107
180.0	1.052	.003	.159
224.8	1.054	.125	.113
270.7	1.063	.184	-.003
291.1	1.057	.178	-.057
310.0	1.056	.150	-.109
331.1	1.025	.154	-.149
351.2	1.030	.074	-.159
356.8	1.007	.053	-.150
359.0	.991	.049	-.140
359.0	1.006	.046	-.137

TABLE A-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND THE INTERPOLATED RADII FOR EXPERIMENT 7

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 7
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.098	1.029	1.044	1.042	1.223	1.184	1.139	1.072	1.035	1.038	1.045	1.045	1.042
VTBAR =	-.011	.009	-.002	.009	-.054	-.041	-.025	-.003	.008	.002	-.002	.002	.009
VRBAR =	.005	-.006	.018	-.007	.045	.032	.017	-.001	-.007	.010	.018	.008	-.007
1-WVX =	1.149	1.091	1.067	1.058	0.000	1.203	1.178	1.134	1.099	1.077	1.067	1.062	1.058
1-WX =	1.190	1.107	1.077	1.065	0.000	1.268	1.227	1.163	1.118	1.090	1.077	1.070	1.064
BBAR =	29.66	20.86	17.45	14.24	43.87	39.28	34.21	26.79	22.02	19.20	17.08	15.26	13.74
BPOS =	3.94	2.29	1.14	.82	6.76	5.76	4.75	3.45	2.55	1.64	1.07	.84	.77
THETA =	87.50	90.00	90.00	92.50	82.50	82.50	82.50	90.00	90.00	90.00	90.00	92.50	92.50
BNEG =	-3.89	-1.55	-.84	-1.02	-10.86	-8.14	-5.63	-2.91	-1.67	-1.13	-.86	-.86	-.99
THETA =	340.00	227.50	0.00	10.00	7.50	7.50	340.00	340.00	230.00	357.50	0.00	5.00	10.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE A-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 7

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 7
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0343	.0361	.0230	.0164	.0103	.0057	.0036	.0061
PHASE ANGLE =	265.6	270.9	266.1	266.0	260.7	240.1	172.8	127.4
RADIUS = .633								
AMPLITUDE =	.0154	.0261	.0151	.0061	.0053	.0043	.0031	.0024
PHASE ANGLE =	337.8	262.5	298.6	7.3	328.0	352.1	12.8	24.5
RADIUS = .781								
AMPLITUDE =	.0152	.0191	.0075	.0022	.0026	.0018	.0011	.0009
PHASE ANGLE =	230.4	267.0	276.0	271.1	266.2	272.4	272.2	268.8
RADIUS = .963								
AMPLITUDE =	.0224	.0192	.0113	.0078	.0068	.0063	.0061	.0049
PHASE ANGLE =	246.8	248.7	227.9	196.1	187.0	164.3	152.4	152.5

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0089	.0100	.0096	.0077	.0050	.0019	.0010	.0029
PHASE ANGLE =	114.6	110.4	109.5	110.1	111.9	121.6	263.3	282.8
RADIUS = .633								
AMPLITUDE =	.0016	.0004	.0008	.0010	.0015	.0015	.0014	.0014
PHASE ANGLE =	41.1	45.4	295.2	326.1	321.1	337.3	346.6	350.1
RADIUS = .781								
AMPLITUDE =	.0007	.0006	.0005	.0003	.0004	.0003	.0002	.0002
PHASE ANGLE =	270.0	269.1	272.6	270.7	266.5	272.6	272.0	267.3
RADIUS = .963								
AMPLITUDE =	.0032	.0016	.0007	.0004	.0003	.0004	.0005	.0006
PHASE ANGLE =	156.6	170.2	196.5	200.6	201.4	159.1	134.0	124.5

TABLE A-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 7

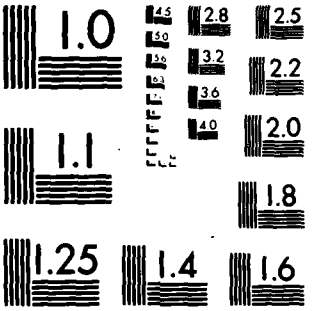
VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 7
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1008	.0470	.0396	.0503	.0272	.0227	.0172	.0180
PHASE ANGLE =	238.3	281.4	236.3	248.4	233.5	215.5	185.4	149.0
RADIUS = .350								
AMPLITUDE =	.0787	.0437	.0338	.0395	.0216	.0172	.0129	.0142
PHASE ANGLE =	242.3	278.5	242.9	250.9	237.8	218.2	184.0	145.7
RADIUS = .400								
AMPLITUDE =	.0544	.0399	.0278	.0272	.0154	.0110	.0080	.0099
PHASE ANGLE =	250.3	274.8	253.1	255.8	245.9	224.2	181.1	139.5
RADIUS = .500								
AMPLITUDE =	.0244	.0334	.0204	.0102	.0077	.0033	.0012	.0040
PHASE ANGLE =	284.8	268.0	276.5	281.9	277.9	272.6	139.8	110.1
RADIUS = .600								
AMPLITUDE =	.0170	.0278	.0164	.0059	.0056	.0041	.0028	.0024
PHASE ANGLE =	331.2	263.3	295.1	353.1	320.2	346.7	17.5	41.3
RADIUS = .700								
AMPLITUDE =	.0084	.0222	.0108	.0034	.0038	.0029	.0019	.0014
PHASE ANGLE =	274.8	266.1	293.7	345.0	310.9	327.6	340.8	345.5
RADIUS = .800								
AMPLITUDE =	.0168	.0187	.0071	.0025	.0026	.0017	.0011	.0009
PHASE ANGLE =	228.3	266.4	269.4	252.7	251.7	252.6	245.5	245.2
RADIUS = .900								
AMPLITUDE =	.0216	.0178	.0084	.0055	.0047	.0038	.0034	.0027
PHASE ANGLE =	233.2	257.7	236.6	208.4	200.3	181.6	167.6	169.5
RADIUS = 1.000								
AMPLITUDE =	.0224	.0192	.0113	.0078	.0068	.0063	.0061	.0049
PHASE ANGLE =	246.8	248.7	227.9	196.1	187.0	164.3	152.4	152.5

AD-A092 246 DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC F/G 20/4
ANALYSIS OF WAKE SURVEY EXPERIMENTAL DATA FOR MODEL 5365 REPRES--ETC(U)
OCT 80 R B HURWITZ, L B CROOK
UNCLASSIFIED DTNSRDC/SPD-0833-04 NL

2 OF 3
AD A
092246



MICROCOPY RESOLUTION TEST CHART

TABLE A-10 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 7
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0219	.0252	.0266	.0222	.0163	.0082	.0043	.0073
PHASE ANGLE =	125.7	112.8	110.2	114.4	119.0	138.7	209.6	256.0
RADIUS = .350								
AMPLITUDE =	.0179	.0206	.0214	.0177	.0128	.0062	.0031	.0059
PHASE ANGLE =	123.8	112.4	110.1	113.7	118.0	136.9	214.9	260.5
RADIUS = .400								
AMPLITUDE =	.0132	.0152	.0153	.0126	.0087	.0039	.0019	.0043
PHASE ANGLE =	120.3	111.7	109.9	112.5	116.1	132.7	227.9	268.8
RADIUS = .500								
AMPLITUDE =	.0061	.0067	.0059	.0047	.0027	.0008	.0010	.0022
PHASE ANGLE =	107.4	108.8	109.0	106.5	104.3	89.2	304.7	298.6
RADIUS = .600								
AMPLITUDE =	.0021	.0013	.0003	.0006	.0010	.0013	.0014	.0015
PHASE ANGLE =	67.1	94.7	91.8	20.7	337.1	343.5	343.1	340.1
RADIUS = .700								
AMPLITUDE =	.0008	.0004	.0007	.0006	.0008	.0008	.0007	.0007
PHASE ANGLE =	354.2	307.2	289.7	312.8	308.5	323.6	332.2	334.2
RADIUS = .800								
AMPLITUDE =	.0007	.0007	.0005	.0003	.0004	.0003	.0002	.0002
PHASE ANGLE =	250.3	260.3	265.9	256.2	251.4	252.2	245.2	239.6
RADIUS = .900								
AMPLITUDE =	.0018	.0009	.0005	.0003	.0004	.0004	.0004	.0004
PHASE ANGLE =	176.3	197.9	218.4	208.8	204.4	186.9	167.7	160.5
RADIUS = 1.000								
AMPLITUDE =	.0032	.0016	.0007	.0004	.0003	.0004	.0005	.0006
PHASE ANGLE =	156.6	170.2	196.5	200.6	201.4	159.1	134.0	124.5

TABLE A-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 7

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 7
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2328	.0054	.0027	.0050	.0052	.0045	.0036	.0031
PHASE ANGLE =	178.2	98.9	162.2	165.5	154.3	135.9	102.0	75.4
RADIUS = .633								
AMPLITUDE =	.2045	.0092	.0065	.0051	.0026	.0024	.0022	.0017
PHASE ANGLE =	182.8	300.5	308.9	303.2	347.4	29.1	55.7	106.5
RADIUS = .781								
AMPLITUDE =	.1885	.0030	.0020	.0016	.0011	.0004	.0005	.0004
PHASE ANGLE =	178.5	123.4	279.6	245.4	224.6	222.7	297.8	254.8
RADIUS = .963								
AMPLITUDE =	.1869	.0133	.0074	.0072	.0055	.0032	.0017	.0012
PHASE ANGLE =	175.3	130.4	162.0	173.1	191.1	212.6	265.8	329.3

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0032	.0043	.0051	.0054	.0052	.0047	.0040	.0031
PHASE ANGLE =	53.9	39.2	29.3	21.8	16.3	11.9	8.7	2.8
RADIUS = .633								
AMPLITUDE =	.0019	.0016	.0015	.0015	.0012	.0009	.0008	.0006
PHASE ANGLE =	143.4	170.1	201.2	228.5	247.5	268.4	288.1	290.0
RADIUS = .781								
AMPLITUDE =	.0003	.0001	.0002	.0002	.0001	.0001	.0001	.0001
PHASE ANGLE =	226.4	272.3	284.3	261.2	240.3	243.1	299.6	259.4
RADIUS = .963								
AMPLITUDE =	.0013	.0015	.0012	.0008	.0008	.0004	.0002	.0002
PHASE ANGLE =	27.0	56.9	81.5	107.7	128.2	132.3	126.1	127.2

TABLE A-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 7

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 7
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2678	.0401	.0216	.0241	.0207	.0149	.0064	.0046
PHASE ANGLE =	169.4	113.3	141.9	148.0	161.4	160.7	139.9	45.5
RADIUS = .350								
AMPLITUDE =	.2570	.0289	.0155	.0180	.0158	.0115	.0054	.0041
PHASE ANGLE =	172.0	112.3	143.0	149.6	160.5	157.4	131.6	53.2
RADIUS = .400								
AMPLITUDE =	.2446	.0163	.0087	.0111	.0102	.0077	.0043	.0036
PHASE ANGLE =	175.2	109.9	146.1	153.3	158.7	150.6	118.6	63.7
RADIUS = .500								
AMPLITUDE =	.2246	.0020	.0016	.0020	.0022	.0028	.0032	.0028
PHASE ANGLE =	180.2	342.2	277.0	209.6	143.4	112.4	88.7	84.0
RADIUS = .600								
AMPLITUDE =	.2090	.0090	.0060	.0046	.0022	.0023	.0025	.0020
PHASE ANGLE =	182.7	301.9	308.4	300.5	353.1	40.5	62.9	101.2
RADIUS = .700								
AMPLITUDE =	.1956	.0033	.0045	.0032	.0013	.0011	.0010	.0007
PHASE ANGLE =	180.8	302.3	305.5	296.0	328.3	26.5	44.0	124.7
RADIUS = .800								
AMPLITUDE =	.1874	.0043	.0016	.0017	.0015	.0007	.0006	.0005
PHASE ANGLE =	178.1	124.1	259.2	223.7	213.0	217.7	282.4	268.3
RADIUS = .900								
AMPLITUDE =	.1853	.0103	.0042	.0046	.0039	.0023	.0015	.0010
PHASE ANGLE =	176.1	127.7	169.6	177.8	194.4	213.2	265.4	304.7
RADIUS = 1.000								
AMPLITUDE =	.1869	.0133	.0074	.0072	.0055	.0032	.0017	.0012
PHASE ANGLE =	175.3	130.4	162.0	173.1	191.1	212.6	265.8	329.3

TABLE A-12 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 7
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0094	.0142	.0171	.0174	.0156	.0129	.0103	.0079
PHASE ANGLE =	21.9	25.9	27.0	27.0	24.5	21.7	18.9	12.6
RADIUS = .350								
AMPLITUDE =	.0073	.0111	.0133	.0136	.0123	.0104	.0084	.0064
PHASE ANGLE =	26.6	27.7	27.3	26.3	23.3	20.2	17.2	11.0
RADIUS = .400								
AMPLITUDE =	.0050	.0075	.0090	.0093	.0086	.0074	.0061	.0047
PHASE ANGLE =	35.8	31.3	27.9	24.9	21.0	17.3	14.2	8.0
RADIUS = .500								
AMPLITUDE =	.0023	.0023	.0026	.0029	.0031	.0030	.0027	.0021
PHASE ANGLE =	77.1	53.8	31.9	16.0	8.6	4.1	1.4	356.1
RADIUS = .600								
AMPLITUDE =	.0020	.0014	.0010	.0010	.0009	.0009	.0009	.0007
PHASE ANGLE =	132.7	155.5	195.7	242.7	275.6	299.9	314.8	315.4
RADIUS = .700								
AMPLITUDE =	.0010	.0008	.0007	.0008	.0006	.0005	.0004	.0003
PHASE ANGLE =	163.2	186.1	216.7	237.7	250.4	269.0	291.0	285.6
RADIUS = .800								
AMPLITUDE =	.0003	.0002	.0002	.0001	.0001	.0000	.0001	.0001
PHASE ANGLE =	254.6	330.9	333.9	290.4	211.9	168.2	308.7	232.8
RADIUS = .900								
AMPLITUDE =	.0007	.0009	.0007	.0005	.0004	.0003	.0002	.0002
PHASE ANGLE =	358.9	38.7	60.8	90.2	117.0	121.4	116.6	133.1
RADIUS = 1.000								
AMPLITUDE =	.0013	.0015	.0012	.0008	.0006	.0004	.0002	.0002
PHASE ANGLE =	27.0	56.9	81.5	107.7	128.2	132.3	126.1	127.2

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX B

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENTS 3 AND 9

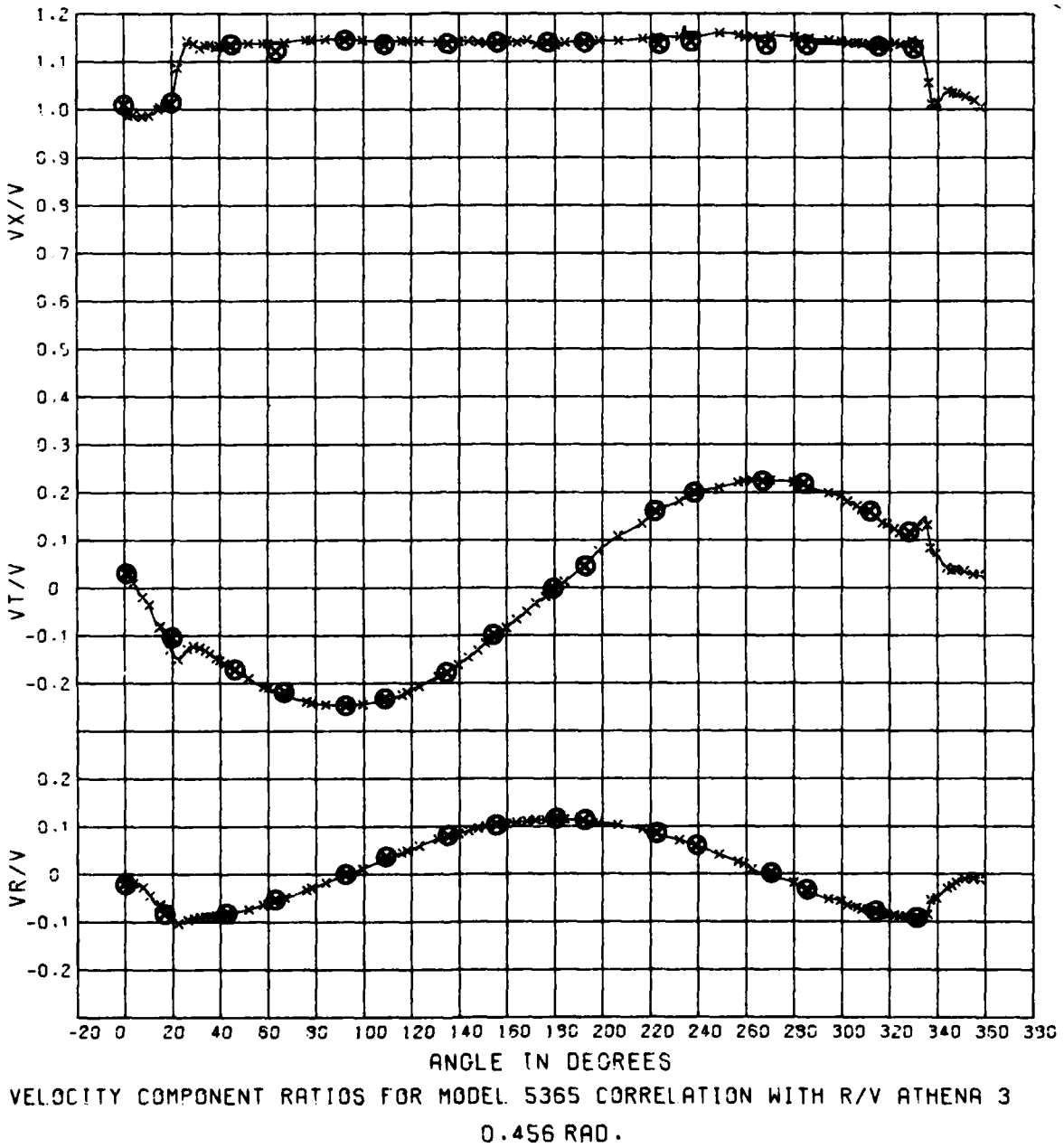


Figure B-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

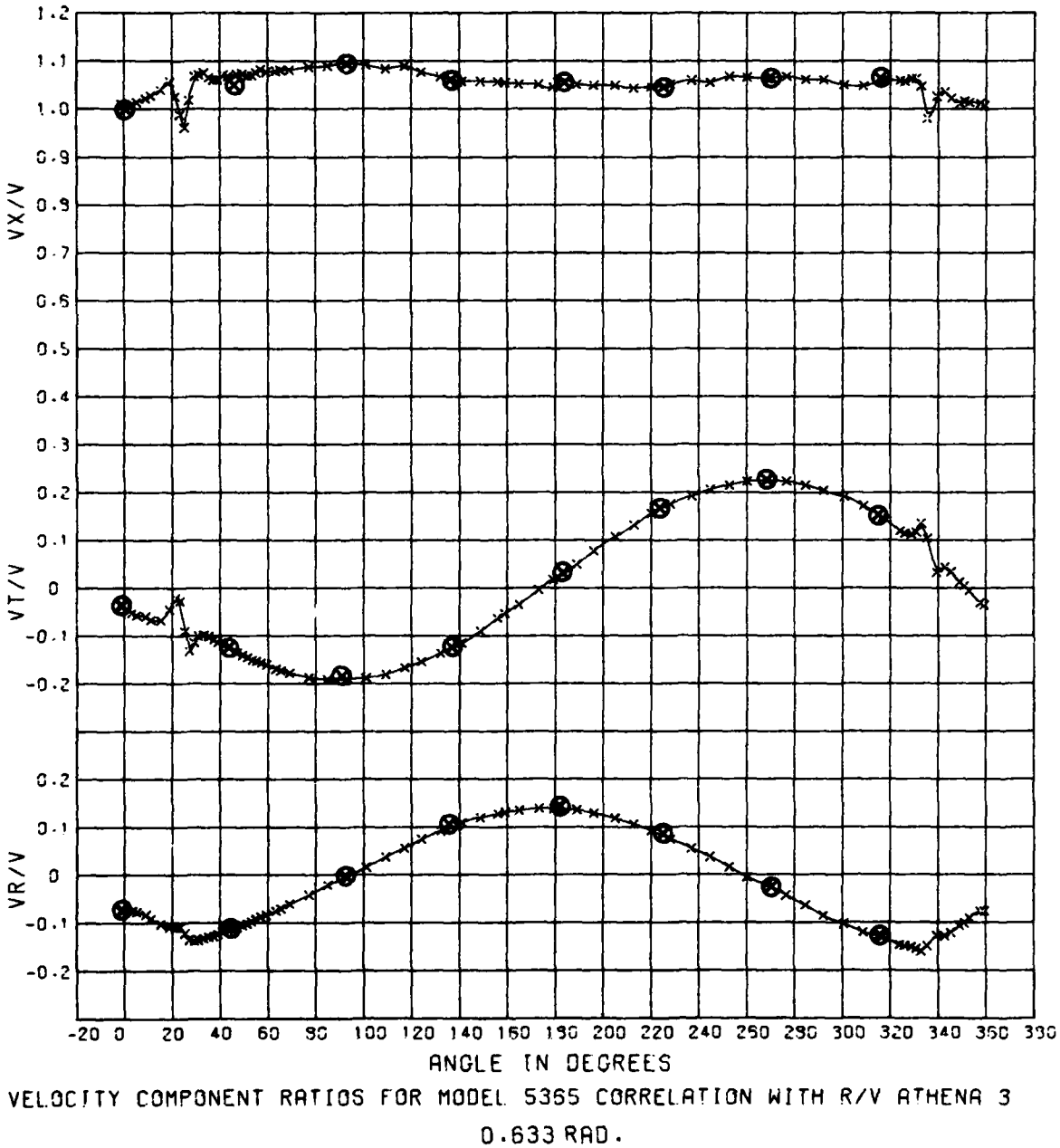


Figure B-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

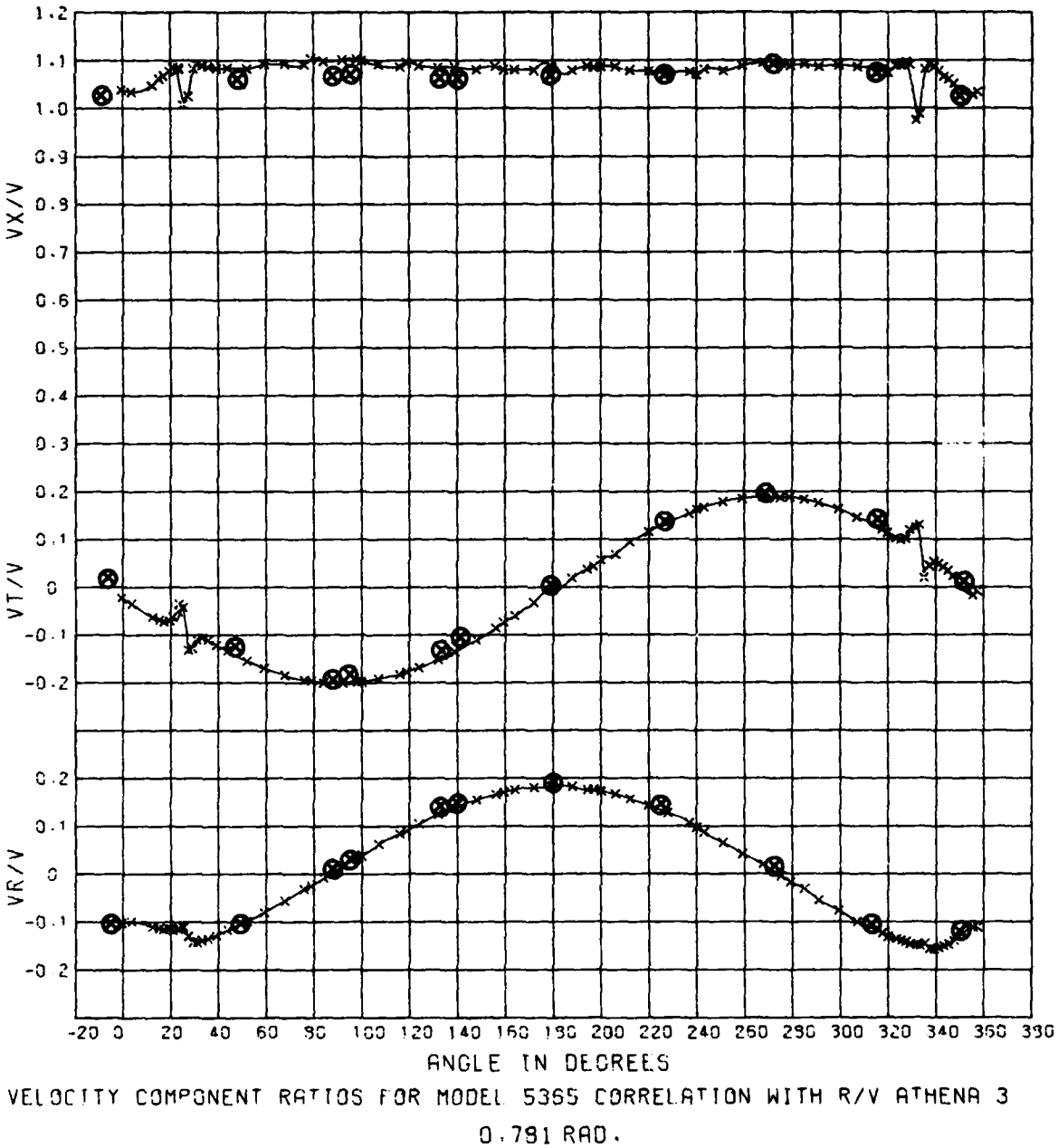


Figure B-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

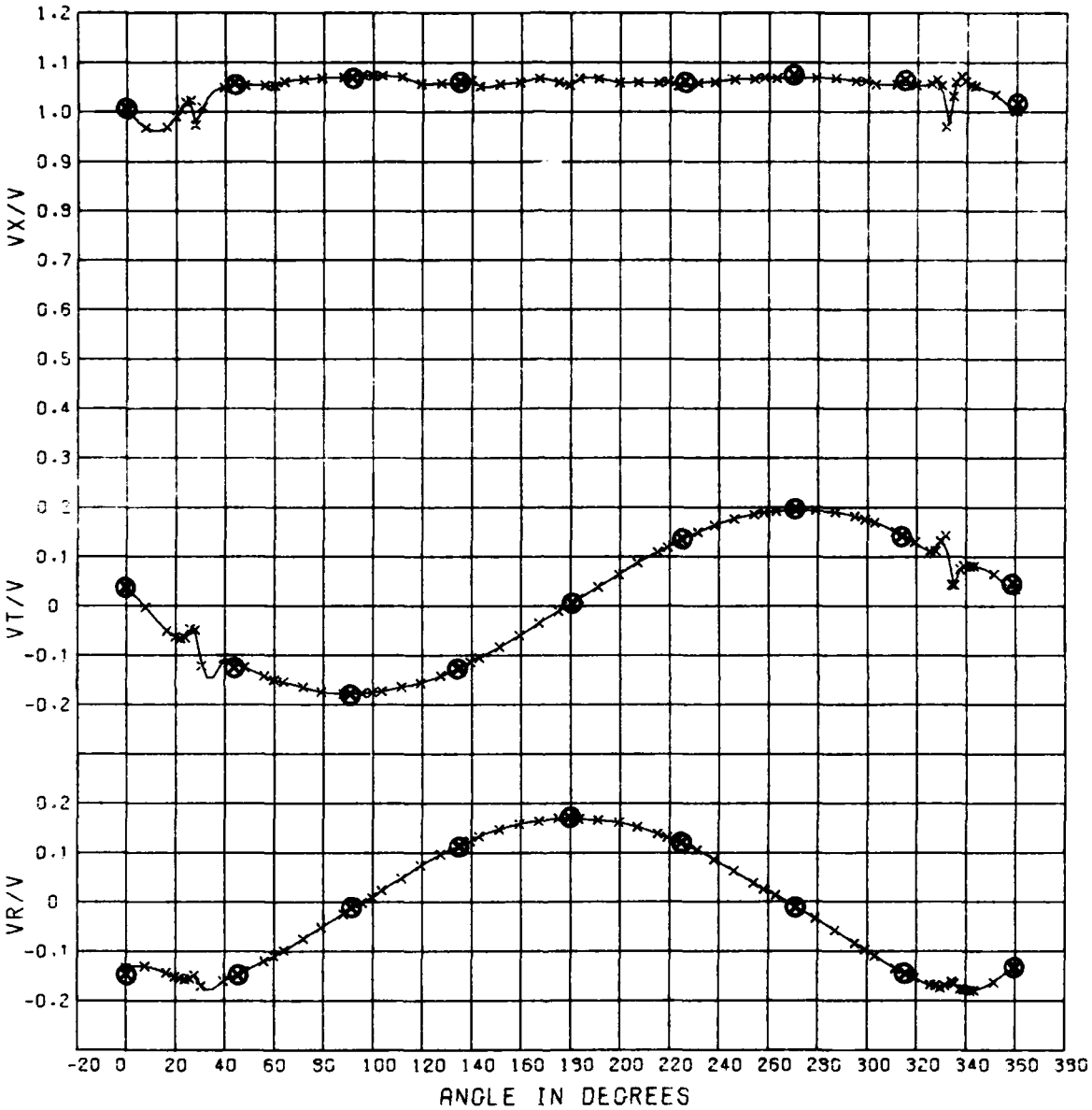


Figure B-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiments 3 and 9

x : Experiment 3
⊗ : Experiment 9

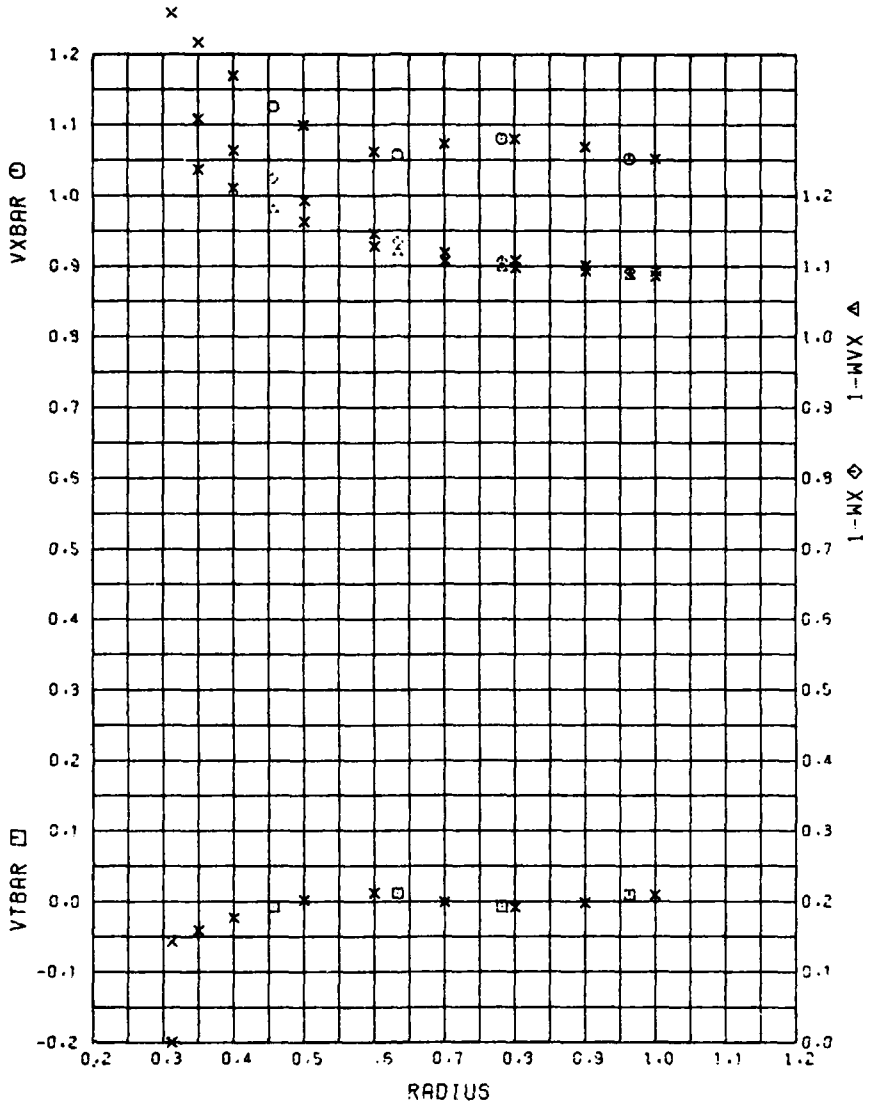


Figure B-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 3

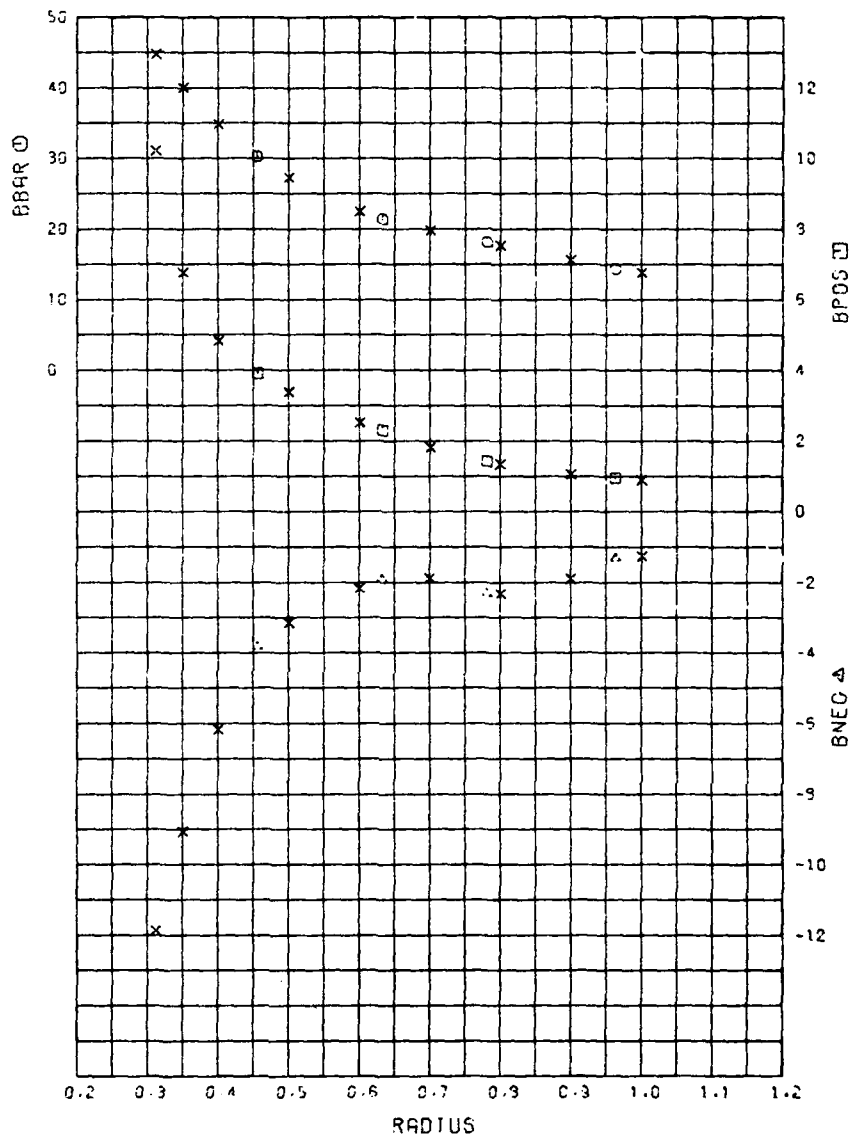


Figure B-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 3

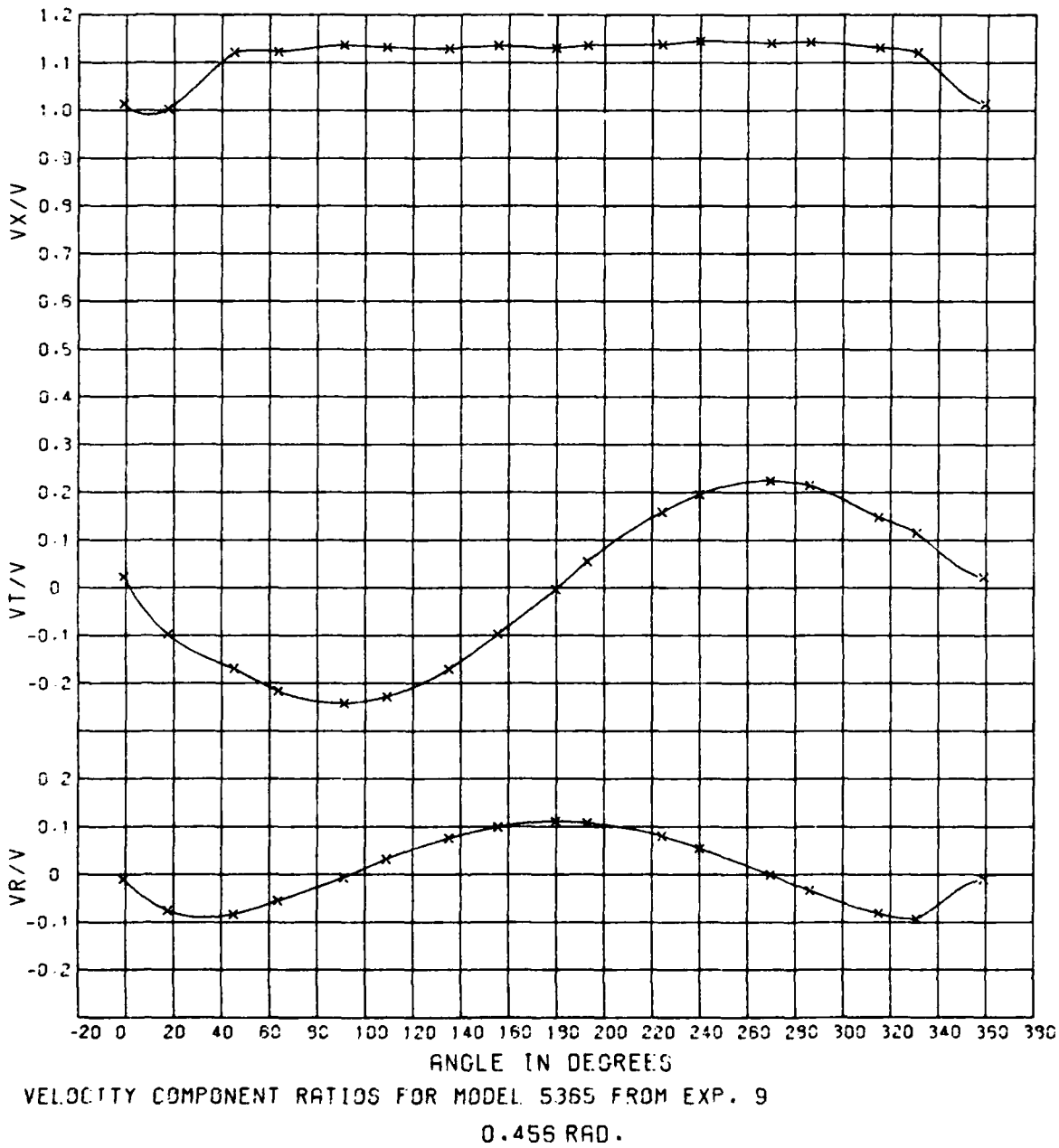


Figure B-7 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 9

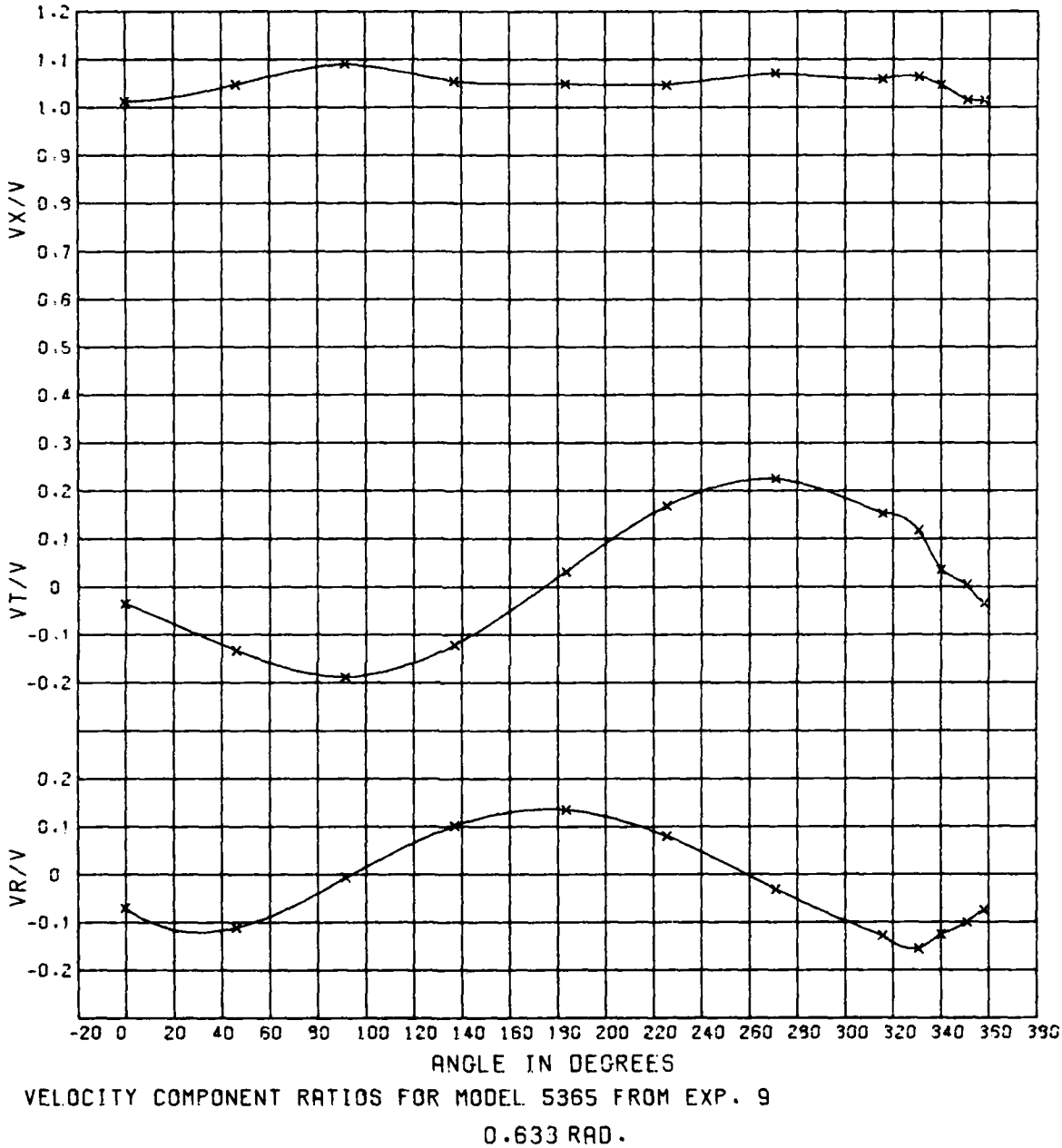


Figure B-8 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 9

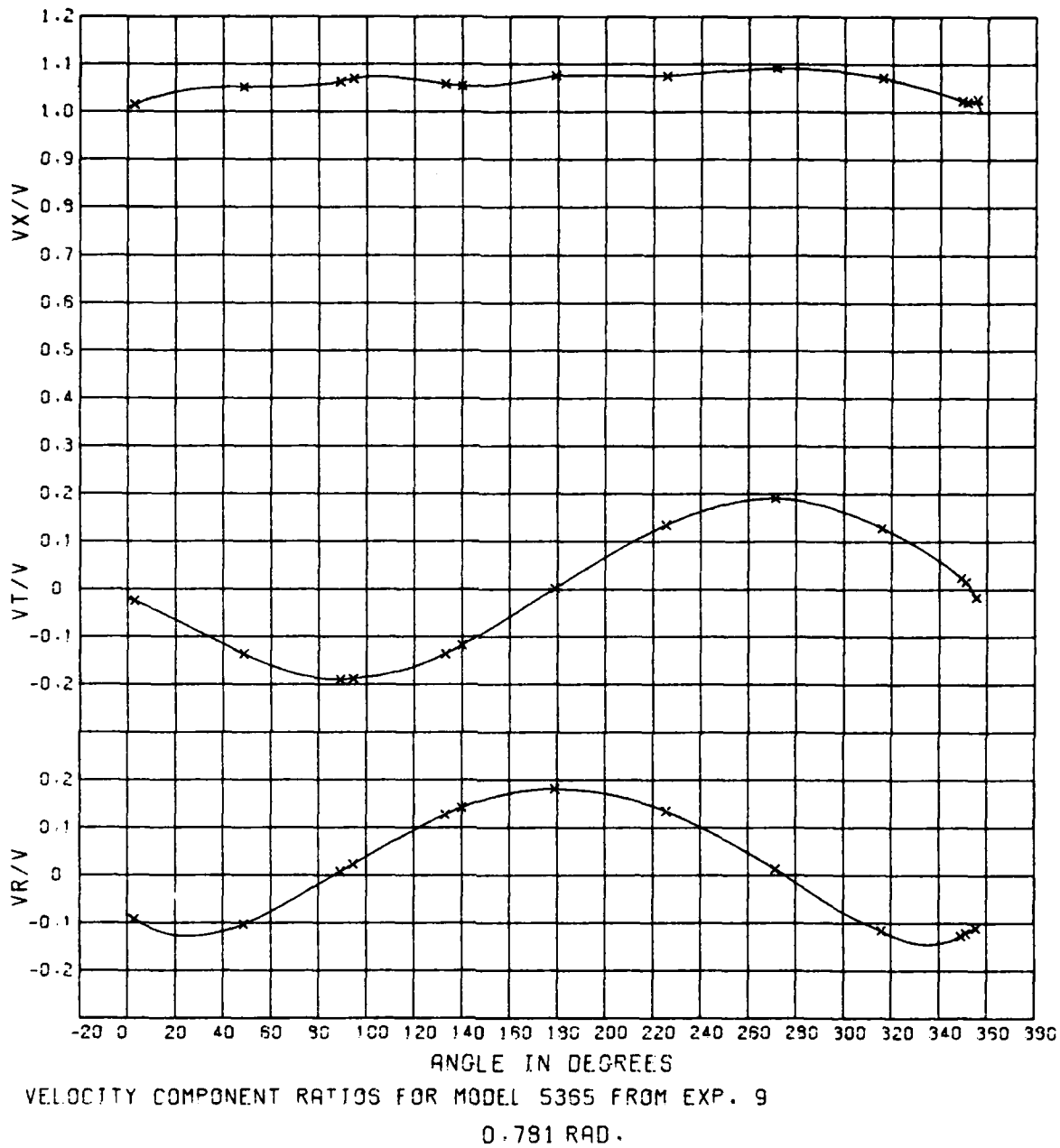


Figure B-9 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 9

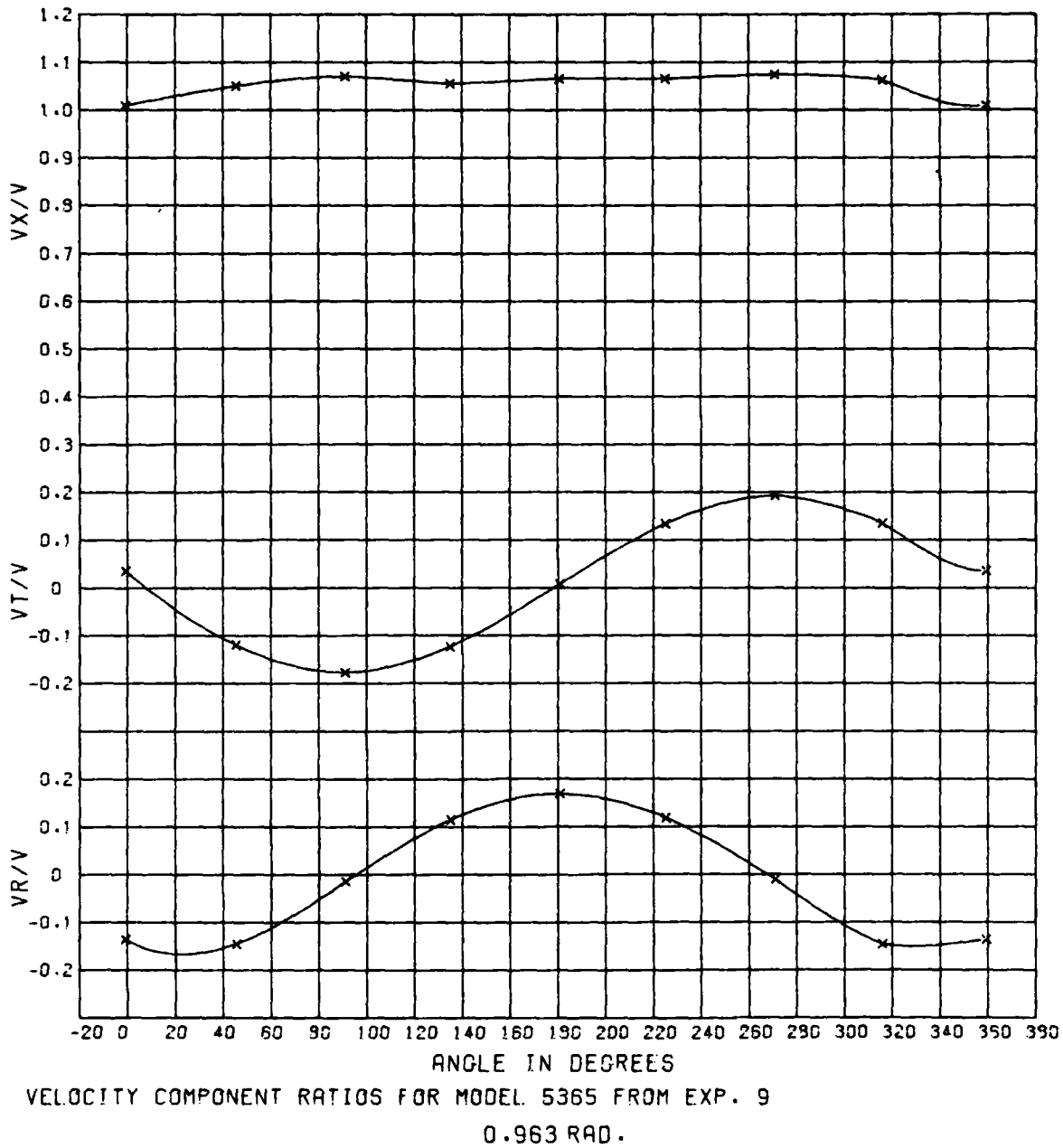


Figure B-10 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 9

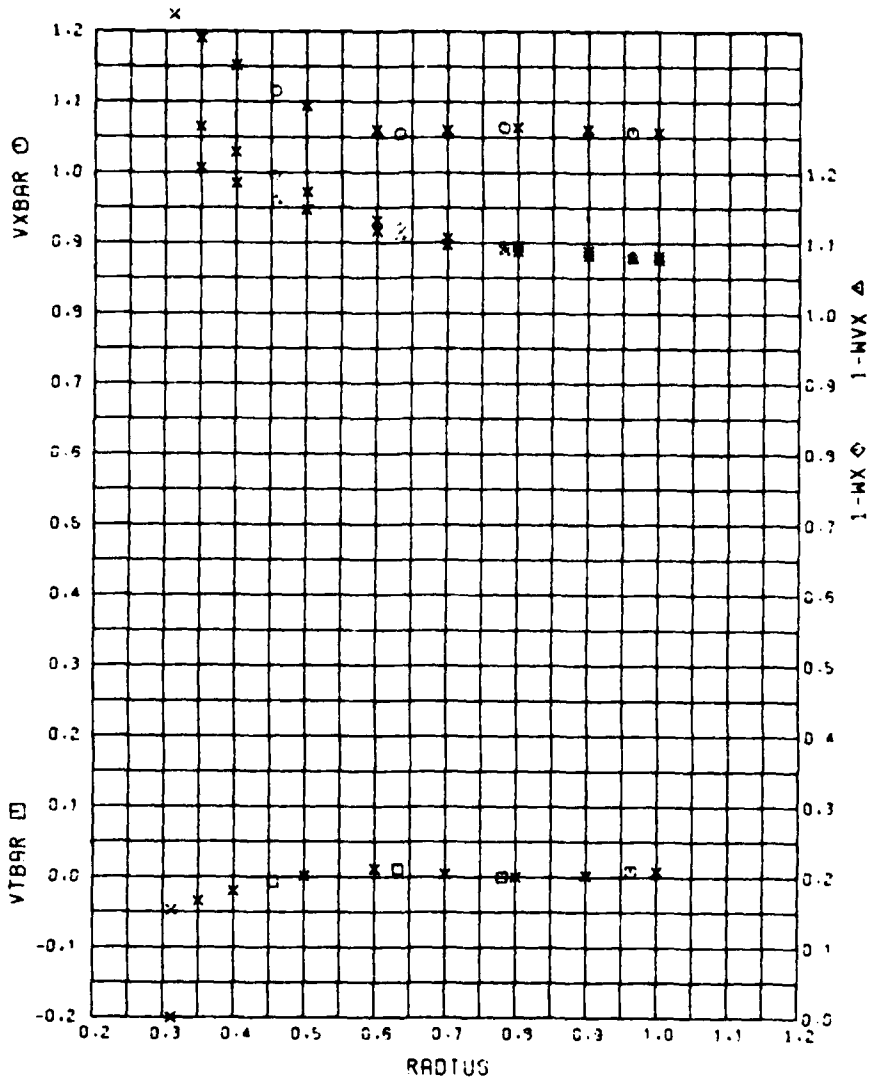


Figure B-11 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 9

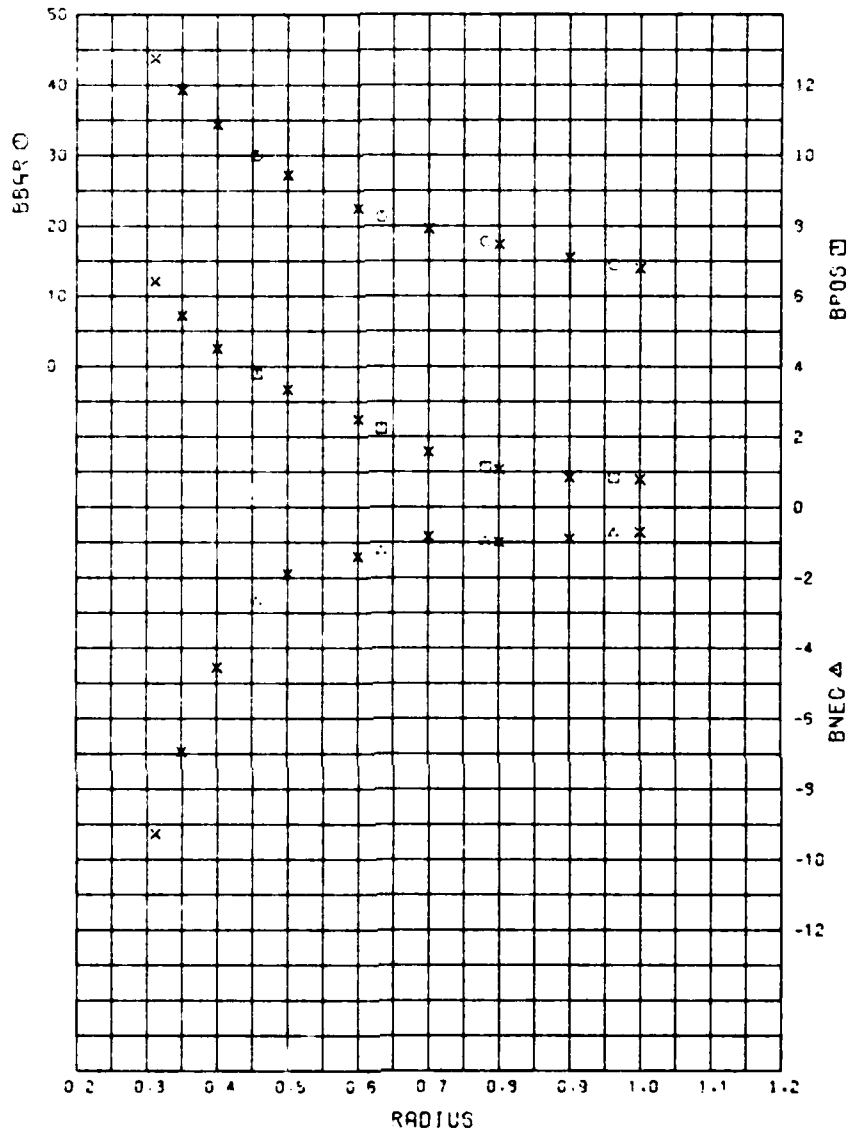


Figure B-12 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 9

TABLE B-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 3

RADIUS = .456

ANGLE	VR/V	VT/V	VP/V
1.7	.987	.877	-.017
3.6	.996	.817	-.014
5.6	.984	.883	-.021
7.6	.984	-.819	-.027
9.7	.983	-.827	-.048
11.8	.991	-.842	-.049
13.8	.998	-.845	-.055
15.8	1.002	-.102	-.076
15.8	1.004	-.848	-.063
17.9	1.006	-.847	-.074
19.8	1.008	-.174	-.091
19.8	1.017	-.132	-.093
21.7	1.058	-.148	-.102
23.8	1.114	-.150	-.104
25.7	1.144	-.132	-.097
27.8	1.141	-.123	-.096
29.8	1.137	-.122	-.092
31.5	1.127	-.126	-.091
33.8	1.136	-.131	-.090
35.7	1.135	-.134	-.089
37.7	1.137	-.145	-.088
39.8	1.127	-.152	-.088
39.8	1.132	-.152	-.087
41.8	1.128	-.159	-.086
43.8	1.136	-.164	-.083
51.9	1.138	-.190	-.076
55.8	1.158	-.208	-.065
59.9	1.178	-.218	-.062
67.8	1.141	-.227	-.049
71.9	1.165	-.238	-.035
73.8	1.166	-.241	-.029
83.9	1.147	-.265	-.017
91.9	1.148	-.247	-.002
99.8	1.168	-.245	.010
99.8	1.162	-.246	.013
107.9	1.166	-.237	.030
115.9	1.163	-.276	.045
119.8	1.166	-.219	.049
123.8	1.166	-.286	.060
131.8	1.148	-.286	.076
139.7	1.141	-.286	.086
139.9	1.142	-.168	.086
147.9	1.143	-.166	.098
147.8	1.148	-.131	.096
151.8	1.139	-.116	.100
155.7	1.148	-.108	.106
159.6	1.143	-.095	.106
163.9	1.148	-.086	.109
164.2	1.149	-.090	.111
171.9	1.134	-.077	.113
175.2	1.148	-.079	.114
179.7	1.136	-.096	.115
180.1	1.151	-.086	.116
184.8	1.148	.012	.115
187.8	1.161	.045	.113
194.4	1.164	.074	.109
200.4	1.163	.106	.103
210.9	1.148	.135	.096
220.5	1.149	.158	.086
232.8	1.153	.181	.071
239.9	1.151	.199	.056
240.6	1.161	.210	.042
254.6	1.156	.228	.026
254.8	1.151	.234	.021
262.9	1.152	.235	.010
270.8	1.155	.225	-.005
270.6	1.147	.221	-.017
278.5	1.156	.219	-.021
280.8	1.159	.211	-.037
286.1	1.165	.198	-.052
289.6	1.162	.192	-.056
302.3	1.139	.181	-.065
308.2	1.141	.174	-.068
306.7	1.138	.169	-.072
316.2	1.138	.164	-.075
311.9	1.134	.159	-.077
316.1	1.143	.152	-.078
319.8	1.135	.145	-.082
317.8	1.134	.138	-.084
317.8	1.134	.132	-.085
319.8	1.131	.133	-.085
327.1	1.140	.124	-.087
326.8	1.133	.119	-.088
329.8	1.139	.111	-.088
327.8	1.136	.108	-.089
339.8	1.140	.111	-.087
331.9	1.136	.128	-.087
338.8	1.046	.139	-.093
336.8	1.025	.125	-.077
337.8	1.011	.093	-.095
339.8	1.008	.094	-.063
340.2	1.028	.092	-.034
343.9	1.039	.062	-.029
344.9	1.034	.037	-.024
347.7	1.029	.039	-.015
347.7	1.034	.039	-.010
351.8	1.023	.039	-.011
351.7	1.030	.036	-.010
355.8	1.010	.028	-.010
357.8	1.004	.029	-.011
359.8	.998	.030	-.013

RADIUS = .631

ANGLE	VR/V	VT/V	VP/V
-7.8	1.014	-.035	-.074
-.7	1.007	-.034	-.076
-.7	1.007	-.037	-.076
3.1	1.009	-.042	-.075
6.2	1.014	-.046	-.077
9.8	1.021	-.049	-.083
11.2	1.027	-.047	-.092
14.3	1.039	-.048	-.103
19.8	1.054	-.046	-.106
19.8	1.065	-.046	-.108
21.4	1.076	-.021	-.108
23.3	.968	-.027	-.109
25.3	.961	-.091	-.122
27.8	1.018	-.131	-.135
29.3	1.064	-.116	-.130
31.8	1.071	-.108	-.134
33.2	1.075	-.094	-.132
35.1	1.069	-.101	-.124
37.3	1.061	-.108	-.128
39.8	1.049	-.114	-.123
39.8	1.063	-.116	-.126
41.1	1.071	-.118	-.119
43.3	1.064	-.126	-.115
47.8	1.072	-.139	-.109
49.3	1.073	-.140	-.105
51.4	1.069	-.145	-.102
53.3	1.070	-.151	-.098
55.8	1.076	-.153	-.093
57.8	1.082	-.157	-.086
59.8	1.074	-.161	-.086
59.5	1.079	-.161	-.084
63.3	1.079	-.169	-.075
65.3	1.081	-.173	-.070
69.8	1.081	-.178	-.061
77.2	1.087	-.187	-.041
85.8	1.089	-.191	-.021
93.2	1.094	-.198	-.004
101.8	1.091	-.198	.016
109.1	1.084	-.191	.030
117.8	1.089	-.187	.056
125.1	1.077	-.194	.075
132.8	1.060	-.196	.092
139.1	1.054	-.198	.103
139.2	1.055	-.198	.105
148.9	1.059	-.195	.108
149.8	1.058	-.198	.120
155.8	1.057	-.203	.129
159.8	1.055	-.203	.131
164.8	1.042	-.234	.135
173.8	1.052	-.084	.134
174.1	1.065	.019	.135
180.9	1.064	.022	.138
180.9	1.061	.058	.136
186.8	1.058	.078	.129
188.9	1.049	.107	.118
196.9	1.049	.130	.119
212.9	1.043	.132	.106
220.8	1.046	.156	.091
224.8	1.051	.176	.074
230.7	1.060	.192	.055
236.7	1.060	.192	.055
244.6	1.055	.206	.037
252.6	1.064	.219	.016
260.8	1.064	.223	-.006
264.5	1.063	.225	-.027
276.5	1.060	.223	-.043
284.5	1.062	.216	-.064
292.8	1.061	.204	-.084
300.6	1.058	.191	-.103
308.7	1.060	.172	-.120
316.7	1.059	.164	-.130
320.8	1.059	.158	-.144
324.8	1.058	.149	-.148
324.8	1.063	.143	-.151
330.8	1.064	.117	-.159
337.9	1.067	.136	-.160
336.8	.996	.143	-.157
339.8	.964	.076	-.148
338.9	1.064	.031	-.128
340.8	1.067	.029	-.126
342.9	1.036	.044	-.128
344.9	1.026	.039	-.126
349.8	1.018	.038	-.117
351.8	1.016	.035	-.107
353.8	1.014	-.008	-.098
357.1	1.010	-.027	-.079
358.8	1.016	-.039	-.074
359.3	1.007	-.034	-.074
359.3	1.007	-.037	-.074

RADIUS = .701

ANGLE	VR/V	VT/V	VP/V
-.7	1.038	-.021	-.101
3.5	1.034	-.034	-.099
11.6	1.043	-.061	-.109
13.8	1.051	-.065	-.111
15.8	1.052	-.069	-.112
15.5	1.061	-.067	-.115
17.8	1.068	-.072	-.115
19.4	1.070	-.070	-.115
21.8	1.065	-.062	-.116
23.8	1.068	-.063	-.115
23.3	1.074	-.038	-.113
25.4	1.081	-.035	-.113
25.8	1.012	-.063	-.109
25.3	1.083	-.061	-.113
27.8	1.022	-.127	-.127
27.7	1.024	-.139	-.132
29.3	1.063	-.128	-.142
31.8	1.092	-.118	-.142
33.2	1.089	-.106	-.138
35.7	1.086	-.111	-.134
37.2	1.084	-.121	-.128
43.8	1.086	-.133	-.117
51.9	1.092	-.154	-.099
59.8	1.092	-.149	-.081
59.6	1.098	-.171	-.079
67.8	1.092	-.186	-.055
75.9	1.091	-.195	-.032
75.9	1.106	-.196	-.025
83.9	1.098	-.200	-.008
91.9	1.101	-.208	.017
98.8	1.103	-.199	.035
99.9	1.099	-.198	.039
107.8	1.091	-.192	.062
115.9	1.087	-.183	.085
116.9	1.090	-.177	.098
123.3	1.089	-.169	.105
131.1	1.085	-.152	.125
139.8	1.086	-.135	.139
147.9	1.091	-.111	.156
155.9	1.088	-.087	.164
159.3	1.088	-.076	.172
163.8	1.081	-.068	.175
172.8	1.079	-.032	.181
175.8	1.080	-.029	.182
179.8	1.087	-.007	.187
179.7	1.084	-.006	.183
187.9	1.079	.019	.182
195.3	1.087	.038	.176
199.8	1.085	.046	.177
199.9	1.087	.057	.173
203.9	1.086	.069	.164
211.9	1.079	.094	.157
219.9	1.076	.115	.144
220.8	1.073	.127	.128
227.8	1.074	.154	.108
235.9	1.078	.163	.090
243.8	1.087	.187	.067
251.8	1.077	.179	.065
259.8	1.080	.189	.043
259.8	1.089	.189	.042
267.7	1.094	.188	.014
275.8	1.095	.187	-.006
279.8	1.088	.187	-.017
283.8	1.092	.184	-.031
291.8	1.086	.176	-.054
299.8	1.092	.161	-.075
299.9	1.087	.163	-.078
307.8	1.086	.147	-.100
315.8	1.081	.129	-.121
317.9	1.080	.118	-.126
319.7	1.076	.116	-.131
323.3	1.080	.103	-.136
325.3	1.089	.099	-.139
327.3	1.096	.091	-.142
329.8	1.091	.171	-.146
331.7	.979	.129	-.160
333.3	.988	.131	-.169
335.2	1.082	.019	-.169
337.3	1.091	.046	-.168
339.8	1.088	.056	-.156
339.7	1.091	.053	-.156
341.2	1.078	.041	-.156
341.7	1.079	.044	-.153
343.7	1.067	.042	-.151
345.2	1.061	.033	-.147
345.2	1.061	.037	-.147
347.8	1.068	.026	-.148
347.7	1.059	.022	-.139
349.6	1.027	-.017	-.111
347.6	1.036	-.018	-.111
349.3	1.030	-.022	-.101

RADIUS = .963

ANGLE	VR/V	VT/V	VP/V
-.1	1.003	.036	-.136
7.7	.966	-.003	-.138
15.6	.967	-.046	-.139
17.8	.971	-.054	-.140
19.8	.992	-.061	-.150
19.9	.988	-.066	-.157
21.8	1.005	-.066	-.156
23.8	1.019	-.066	-.159
23.8	1.019	-.065	-.157
25.8	1.023	-.066	-.158
27.8	.973	-.049	-.160
29.8	.972	-.138	-.166
31.8	1.046	-.113	-.175
33.8	1.052	-.107	-.160
35.8	1.046	-.107	-.159
37.8	1.054	-.125	-.160
39.9	1.054	-.142	-.170
39.9	1.053	-.158	-.118
43.8	1.061	-.156	-.099
51.7	1.065	-.160	-.075
59.8	1.068	-.175	-.051
59.8	1.069	-.176	-.051
67.9	1.078	-.178	-.024
69.6	1.075	-.177	-.002
99.7	1.073	-.176	.000
103.9	1.073	-.173	.025
111.9	1.078	-.165	.060
119.8	1.076	-.156	.075
119.8	1.076	-.156	.074
127.6	1.068	-.161	.096
135.6	1.068	-.176	.115
139.6	1.063	-.116	.126
147.8	1.061	-.185	.136
151.2	1.056	-.083	.147
159.2	1.058	-.066	.150
159.2	1.061	-.059	.156
167.2	1.067	-.036	.166
175.8	1.061	-.018	.170
179.3	1.056	.001	.171
183.3	1.060	.015	.169
191.8	1.067	.029	.166
199.3	1.058	.043	.162
199.4	1.060	.046	.162
207.8	1.060	.060	.153
215.2	1.059	.110	.139
219.2	1.062	.119	.132
223.2	1.062	.132	.125
231.1	1.058	.150	.105
239.8	1.049	.164	.085
239.8	1.062	.163	.080
246.8	1.046	.177	.063
254.8	1.067	.188	.040
258.8	1.078	.189	.026
262.9	1.068	.192	.014
270.9	1.069	.196	-.011
278.8	1.068	.196	-.023
278.9	1.060	.196	-.034
286.8	1.060	.198	-.050
290.8	1.063	.192	-.064
298.9	1.062	.175	-.087
302.9	1.058	.169	-.109
311.6	1.056	.151	-.135
319.1	1.056	.138	-.153
319.2	1.053	.138	-.154
325.8	1.055	.111	-.167
329.8	1.050	.112	-.169
327.7	1.065	.117	-.169
329.8	1.056	.131	-.175
331.6	.979	.143	-.178
333.7	.995	.079	-.154
335.8	1.068	.060	-.169
337.2	1.069	.063	-.166
337.6	1.072	.075	-.177
339.1	1.061	.062	-.170
341.6	1.055	.001	-.160
341.7	1.052	.001	-.170
343.3	1.035	.006	-.163
345.8	1.002	.036	-.135
345.3	1.004	.036	-.135
349.8	1.001	.036	-.136
349.9	1.003	.036	-.136

TABLE B-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.126	1.057	1.080	1.052	1.259	1.217	1.169	1.099	1.062	1.073	1.080	1.069	1.052
VTBAR	-.007	.012	-.008	.009	-.057	-.041	-.023	.002	.012	-.001	-.008	-.002	.009
VRBAR =	.008	-.008	.015	-.008	.056	.041	.023	-.000	-.009	.007	.015	.006	-.008
1-WVX =	1.180	1.119	1.097	1.086	0.000	1.237	1.210	1.163	1.128	1.107	1.098	1.093	1.086
1-WX =	1.224	1.135	1.107	1.093	0.000	1.308	1.263	1.195	1.146	1.119	1.108	1.101	1.093
BBAR =	30.23	21.36	18.05	14.38	44.74	40.05	34.87	27.31	22.51	19.82	17.65	15.61	13.87
BPOS =	3.91	2.29	1.42	.95	10.21	6.77	4.83	3.39	2.52	1.82	1.35	1.06	.90
THETA =	90.00	92.50	95.00	95.00	22.50	22.50	85.00	92.50	92.50	95.00	95.00	95.00	95.00
BNEG =	-3.83	-1.91	-2.31	-1.31	-11.67	-9.07	-6.17	-3.14	-2.17	-1.88	-2.32	-1.90	-1.26
THETA	0.00	335.00	332.50	332.50	0.00	0.00	0.00	337.50	335.00	332.50	332.50	332.50	332.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0367	.0358	.0234	.0190	.0143	.0099	.0050	.0026
PHASE ANGLE =	264.2	273.4	271.3	267.3	269.3	263.6	244.1	195.5
RADIUS = .633								
AMPLITUDE =	.0150	.0224	.0068	.0020	.0056	.0013	.0010	.0027
PHASE ANGLE =	323.3	268.9	255.5	266.1	202.2	288.8	13.9	31.2
RADIUS = .781								
AMPLITUDE =	.0103	.0147	.0093	.0025	.0029	.0040	.0007	.0012
PHASE ANGLE =	269.9	264.1	268.3	309.2	259.3	278.0	205.2	183.8
RADIUS = .963								
AMPLITUDE =	.0187	.0193	.0132	.0067	.0083	.0070	.0058	.0038
PHASE ANGLE =	261.6	254.1	234.9	191.4	213.7	193.4	175.5	174.1

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0044	.0058	.0068	.0057	.0054	.0030	.0009	.0019
PHASE ANGLE =	130.7	130.5	130.9	123.8	126.8	154.0	179.0	296.1
RADIUS = .633								
AMPLITUDE =	.0034	.0021	.0012	.0008	.0033	.0032	.0039	.0034
PHASE ANGLE =	73.2	40.2	146.1	288.0	279.1	261.3	252.6	271.8
RADIUS = .781								
AMPLITUDE =	.0007	.0027	.0019	.0016	.0038	.0027	.0028	.0003
PHASE ANGLE =	267.1	254.2	285.2	283.3	296.6	274.4	319.3	240.7
RADIUS = .963								
AMPLITUDE =	.0027	.0026	.0012	.0026	.0020	.0017	.0010	.0014
PHASE ANGLE =	165.9	169.4	196.8	260.4	205.3	298.0	133.4	43.5

TABLE B-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0900	.0499	.0535	.0462	.0258	.0265	.0155	.0146
PHASE ANGLE =	245.6	275.9	275.9	269.5	272.0	262.5	235.2	201.9
RADIUS = .350								
AMPLITUDE =	.0730	.0459	.0441	.0378	.0224	.0213	.0122	.0108
PHASE ANGLE =	248.7	275.3	275.1	269.0	271.4	262.6	236.5	201.4
RADIUS = .400								
AMPLITUDE =	.0537	.0409	.0333	.0281	.0183	.0153	.0085	.0064
PHASE ANGLE =	254.3	274.5	273.6	268.3	270.5	262.9	239.1	200.1
RADIUS = .500								
AMPLITUDE =	.0269	.0320	.0172	.0130	.0116	.0065	.0029	.0005
PHASE ANGLE =	276.0	272.4	268.5	266.4	268.0	264.9	252.4	154.0
RADIUS = .600								
AMPLITUDE =	.0162	.0246	.0082	.0038	.0068	.0019	.0008	.0025
PHASE ANGLE =	313.7	269.9	258.7	264.2	263.9	277.8	346.3	31.6
RADIUS = .700								
AMPLITUDE =	.0116	.0177	.0080	.0026	.0039	.0032	.0006	.0008
PHASE ANGLE =	312.2	267.7	268.3	307.6	268.6	291.2	348.1	41.7
RADIUS = .800								
AMPLITUDE =	.0106	.0144	.0095	.0023	.0029	.0040	.0010	.0015
PHASE ANGLE =	284.5	262.9	266.6	303.6	251.8	272.5	195.9	185.4
RADIUS = .900								
AMPLITUDE =	.0145	.0159	.0112	.0029	.0051	.0046	.0036	.0031
PHASE ANGLE =	265.7	256.7	249.5	213.3	220.8	223.6	179.6	180.9
RADIUS = 1.000								
AMPLITUDE =	.0187	.0193	.0132	.0067	.0083	.0070	.0058	.0038
PHASE ANGLE =	261.6	254.1	234.9	191.4	213.7	193.4	175.5	174.1

TABLE B-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0100	.0157	.0131	.0156	.0185	.0107	.0082	.0044
PHASE ANGLE =	192.6	158.9	130.7	128.5	116.5	122.3	71.5	65.5
RADIUS = .350								
AMPLITUDE =	.0078	.0125	.0113	.0126	.0145	.0082	.0055	.0026
PHASE ANGLE =	173.7	154.2	130.7	128.4	117.9	126.0	75.5	53.8
RADIUS = .400								
AMPLITUDE =	.0057	.0069	.0091	.0091	.0098	.0054	.0025	.0012
PHASE ANGLE =	156.6	145.5	130.7	128.5	120.6	134.1	88.2	.9
RADIUS = .500								
AMPLITUDE =	.0040	.0042	.0052	.0035	.0027	.0020	.0021	.0028
PHASE ANGLE =	110.0	113.0	131.5	129.8	140.7	188.2	226.7	282.9
RADIUS = .600								
AMPLITUDE =	.0037	.0024	.0021	.0002	.0025	.0028	.0038	.0036
PHASE ANGLE =	79.3	58.5	137.6	228.2	270.4	254.0	247.3	273.4
RADIUS = .700								
AMPLITUDE =	.0011	.0012	.0009	.0012	.0039	.0030	.0030	.0017
PHASE ANGLE =	53.8	290.5	268.4	289.2	292.8	267.2	288.6	265.6
RADIUS = .800								
AMPLITUDE =	.0009	.0029	.0020	.0017	.0036	.0026	.0027	.0001
PHASE ANGLE =	255.3	250.0	284.9	281.3	295.9	276.1	324.1	172.1
RADIUS = .900								
AMPLITUDE =	.0017	.0026	.0014	.0022	.0020	.0021	.0012	.0010
PHASE ANGLE =	201.1	217.8	264.6	268.9	270.9	287.4	349.4	64.1
RADIUS = 1.000								
AMPLITUDE =	.0027	.0026	.0012	.0026	.0020	.0017	.0010	.0014
PHASE ANGLE =	165.9	169.4	196.8	260.4	205.3	298.0	133.4	43.5

TABLE B-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2359	.0054	.0027	.0040	.0046	.0036	.0034	.0031
PHASE ANGLE =	160.6	66.7	131.0	150.6	141.6	146.5	106.7	84.2
RADIUS = .633								
AMPLITUDE =	.2069	.0088	.0072	.0059	.0047	.0041	.0037	.0026
PHASE ANGLE =	163.6	289.5	285.4	279.2	279.7	272.4	292.2	282.0
RADIUS = .781								
AMPLITUDE =	.1932	.0037	.0042	.0027	.0034	.0020	.0022	.0013
PHASE ANGLE =	180.5	283.4	296.2	263.2	279.0	256.9	294.7	312.0
RADIUS = .963								
AMPLITUDE =	.1868	.0031	.0026	.0042	.0044	.0044	.0027	.0012
PHASE ANGLE =	178.5	154.7	127.2	125.1	106.3	104.2	89.7	62.6

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0050	.0045	.0062	.0051	.0042	.0026	.0012	.0010
PHASE ANGLE =	62.1	43.5	46.2	49.6	43.0	69.2	60.2	164.8
RADIUS = .633								
AMPLITUDE =	.0025	.0024	.0008	.0008	.0016	.0030	.0030	.0034
PHASE ANGLE =	297.0	287.0	208.2	211.6	167.1	163.9	163.1	156.5
RADIUS = .781								
AMPLITUDE =	.0019	.0008	.0002	.0006	.0013	.0018	.0014	.0015
PHASE ANGLE =	330.4	31.0	48.6	129.8	135.3	158.7	147.9	168.7
RADIUS = .963								
AMPLITUDE =	.0002	.0008	.0014	.0023	.0025	.0022	.0016	.0014
PHASE ANGLE =	21.6	212.2	206.4	191.3	172.3	153.9	124.6	46.0

TABLE B-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 3

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER : 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2717	.0308	.0212	.0213	.0196	.0165	.0161	.0137
PHASE ANGLE =	174.5	92.2	111.6	124.0	124.1	122.3	108.9	88.8
RADIUS = .350								
AMPLITUDE =	.2610	.0226	.0154	.0157	.0149	.0124	.0121	.0104
PHASE ANGLE =	176.3	90.2	112.8	126.2	125.8	124.5	108.7	88.5
RADIUS = .400								
AMPLITUDE =	.2483	.0134	.0087	.0095	.0095	.0077	.0076	.0066
PHASE ANGLE =	178.5	85.2	115.9	131.5	129.8	129.9	108.2	87.5
RADIUS = .500								
AMPLITUDE =	.2273	.0027	.0016	.0021	.0020	.0019	.0008	.0010
PHASE ANGLE =	181.9	354.3	252.7	212.6	177.9	192.1	97.2	69.3
RADIUS = .600								
AMPLITUDE =	.2113	.0080	.0056	.0054	.0040	.0037	.0031	.0021
PHASE ANGLE =	183.6	292.5	283.6	276.5	275.2	268.4	292.6	283.0
RADIUS = .700								
AMPLITUDE =	.1997	.0065	.0061	.0047	.0047	.0034	.0033	.0020
PHASE ANGLE =	182.1	289.0	291.0	275.1	279.9	268.0	291.7	292.5
RADIUS = .800								
AMPLITUDE =	.1920	.0031	.0037	.0023	.0029	.0015	.0019	.0012
PHASE ANGLE =	180.2	280.0	297.1	256.8	278.3	250.4	296.8	318.9
RADIUS = .900								
AMPLITUDE =	.1878	.0014	.0002	.0019	.0010	.0019	.0008	.0008
PHASE ANGLE =	178.9	191.9	260.3	148.0	117.2	117.5	60.7	24.0
RADIUS = 1.000								
AMPLITUDE =	.1868	.0031	.0026	.0042	.0044	.0044	.0027	.0012
PHASE ANGLE =	178.5	154.7	127.2	125.1	106.3	104.2	89.7	62.6

TABLE B-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 3
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0169	.0162	.0180	.0154	.0136	.0096	.0079	.0047
PHASE ANGLE =	73.7	62.7	50.3	49.3	33.5	30.8	8.5	328.1
RADIUS = .350								
AMPLITUDE =	.0132	.0124	.0143	.0122	.0107	.0073	.0057	.0029
PHASE ANGLE =	72.4	60.4	49.7	49.3	34.6	35.0	11.6	326.4
RADIUS = .400								
AMPLITUDE =	.0089	.0082	.0101	.0085	.0073	.0047	.0031	.0009
PHASE ANGLE =	69.5	55.4	48.5	49.3	37.1	44.6	20.3	315.5
RADIUS = .500								
AMPLITUDE =	.0027	.0025	.0037	.0030	.0024	.0020	.0013	.0020
PHASE ANGLE =	46.4	20.5	42.5	50.4	54.5	106.1	129.8	158.0
RADIUS = .600								
AMPLITUDE =	.0020	.0022	.0005	.0003	.0013	.0028	.0028	.0033
PHASE ANGLE =	306.2	295.7	323.2	188.6	153.7	158.7	161.4	156.2
RADIUS = .700								
AMPLITUDE =	.0022	.0011	.0003	.0004	.0013	.0023	.0021	.0025
PHASE ANGLE =	314.3	321.7	324.7	154.9	146.1	162.1	159.0	164.1
RADIUS = .800								
AMPLITUDE =	.0018	.0009	.0002	.0006	.0013	.0018	.0013	.0013
PHASE ANGLE =	333.5	40.8	63.7	135.2	136.4	157.8	144.2	168.0
RADIUS = .900								
AMPLITUDE =	.0010	.0004	.0006	.0013	.0017	.0019	.0013	.0005
PHASE ANGLE =	348.9	94.4	190.3	176.1	157.3	154.4	127.1	84.8
RADIUS = 1.000								
AMPLITUDE =	.0002	.0008	.0014	.0023	.0025	.0022	.0016	.0014
PHASE ANGLE =	21.6	212.2	206.4	191.3	172.3	153.9	124.6	46.0

TABLE B-7

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 9

INPUT DATA

RADIUS = .456

ANGLE	VX/V	VT/V	VR/V
-1.0	1.014	.023	-.010
17.6	1.003	-.098	-.076
45.2	1.122	-.168	-.084
63.6	1.121	-.217	-.053
63.6	1.124	-.216	-.058
91.1	1.137	-.241	-.007
109.0	1.132	-.228	.031
135.0	1.129	-.170	.076
155.6	1.136	-.097	.099
179.7	1.131	-.003	.111
193.0	1.136	.055	.108
224.2	1.138	.159	.081
240.0	1.145	.196	.055
269.6	1.137	.225	.002
269.7	1.145	.224	-.002
286.1	1.143	.215	-.034
315.0	1.131	.148	-.081
331.0	1.121	.116	-.093
359.0	1.014	.023	-.010
361.0	1.014	.023	-.010

RADIUS = .633

ANGLE	VX/V	VT/V	VR/V
-.3	1.013	-.035	-.070
46.0	1.048	-.133	-.111
91.7	1.091	-.189	-.007
137.0	1.053	-.122	.102
137.0	1.056	-.121	.101
183.4	1.049	.032	.136
225.5	1.047	.168	.080
271.0	1.071	.225	-.032
315.7	1.059	.152	-.129
330.8	1.064	.117	-.155
340.0	1.047	.035	-.126
351.0	1.016	.005	-.101
358.0	1.014	-.035	-.074
359.7	1.013	-.035	-.070

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
2.9	1.015	-.025	-.092
48.7	1.052	-.137	-.104
89.1	1.063	-.190	.007
94.6	1.070	-.188	.023
133.2	1.058	-.136	.127
140.0	1.054	-.117	.142
179.0	1.075	.002	.182
179.0	1.076	.002	.182
225.5	1.075	.134	.135
271.4	1.092	.191	.013
316.0	1.072	.128	-.116
349.3	1.024	.025	-.127
351.3	1.020	.016	-.121
355.6	1.027	-.017	-.111
362.9	1.015	-.025	-.092

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
-.5	1.011	.036	-.135
-1.0	1.009	.036	-.137
45.5	1.050	-.120	-.145
91.2	1.071	-.177	-.014
135.1	1.056	-.124	.115
180.9	1.066	.009	.169
225.1	1.066	.133	.119
271.0	1.074	.193	-.011
316.0	1.063	.135	-.146
359.0	1.009	.036	-.137
359.5	1.011	.036	-.135
360.5	1.011	.036	-.135

TABLE B-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.116	1.055	1.064	1.057	1.224	1.191	1.152	1.094	1.060	1.060	1.064	1.061	1.057
VTBAR =	-.007	.011	-.000	.008	-.047	-.034	-.020	.001	.011	.004	-.000	.002	.008
VRBAR =	.006	-.009	.016	-.008	.054	.038	.021	-.002	-.010	.007	.016	.007	-.008
1-WVX =	1.160	1.109	1.088	1.077	0.000	1.207	1.185	1.147	1.117	1.097	1.088	1.082	1.077
1-WX =	1.196	1.122	1.095	1.082	0.000	1.265	1.229	1.172	1.132	1.107	1.095	1.088	1.082
BBAR =	30.01	21.31	17.76	14.44	43.73	39.31	34.42	27.20	22.48	19.58	17.37	15.49	13.93
BPOS =	3.79	2.23	1.13	.84	6.42	5.44	4.50	3.34	2.49	1.57	1.07	.84	.79
THETA =	90.00	92.50	102.50	90.00	105.00	102.50	95.00	90.00	92.50	97.50	102.50	100.00	90.00
BNEG =	-2.69	-1.26	-.98	-.74	-9.28	-6.94	-4.55	-1.89	-1.40	-.84	-.99	-.90	-.71
THETA =	0.00	242.50	357.50	352.50	357.50	357.50	357.50	267.50	247.50	245.00	357.50	357.50	352.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0379	.0328	.0226	.0159	.0098	.0063	.0031	.0006
PHASE ANGLE =	254.5	256.8	247.0	237.5	236.2	221.4	179.6	24.2
RADIUS = .633								
AMPLITUDE =	.0079	.0222	.0093	.0027	.0042	.0033	.0019	.0016
PHASE ANGLE =	298.9	252.9	219.8	161.2	257.3	270.6	302.0	329.7
RADIUS = .781								
AMPLITUDE =	.0196	.0151	.0069	.0056	.0063	.0014	.0014	.0012
PHASE ANGLE =	228.3	267.9	269.9	345.6	274.0	258.9	296.3	292.3
RADIUS = .963								
AMPLITUDE =	.0165	.0167	.0095	.0029	.0033	.0015	.0009	.0005
PHASE ANGLE =	256.5	273.1	269.1	325.0	319.7	344.8	19.9	39.5

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0021	.0014	.0006	.0005	.0007	.0008	.0008	.0004
PHASE ANGLE =	47.3	17.2	44.4	92.3	135.5	133.8	128.7	132.9
RADIUS = .633								
AMPLITUDE =	.0013	.0010	.0006	.0008	.0002	.0001	.0002	.0001
PHASE ANGLE =	350.1	353.7	29.4	60.0	68.2	105.1	87.1	68.8
RADIUS = .781								
AMPLITUDE =	.0013	.0007	.0007	.0005	.0008	.0004	.0005	.0004
PHASE ANGLE =	278.3	255.3	282.7	291.9	267.3	268.9	279.7	275.9
RADIUS = .963								
AMPLITUDE =	.0002	.0001	.0003	.0001	.0003	.0002	.0001	.0001
PHASE ANGLE =	77.8	200.9	242.7	318.7	310.6	340.6	25.4	44.0

TABLE B-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1039	.0435	.0460	.0400	.0203	.0132	.0106	.0022
PHASE ANGLE =	242.0	265.5	264.1	254.7	235.6	196.2	163.4	134.3
RADIUS = .350								
AMPLITUDE =	.0828	.0404	.0386	.0324	.0170	.0109	.0083	.0015
PHASE ANGLE =	244.1	263.0	260.6	251.5	235.4	200.9	165.3	125.8
RADIUS = .400								
AMPLITUDE =	.0590	.0367	.0302	.0238	.0133	.0084	.0056	.0007
PHASE ANGLE =	247.9	259.9	255.0	246.1	235.3	209.0	169.5	97.8
RADIUS = .500								
AMPLITUDE =	.0254	.0300	.0180	.0110	.0076	.0051	.0017	.0009
PHASE ANGLE =	262.8	254.7	239.5	227.7	238.0	233.8	200.4	356.1
RADIUS = .600								
AMPLITUDE =	.0101	.0240	.0109	.0040	.0046	.0036	.0016	.0015
PHASE ANGLE =	293.6	252.6	222.7	185.7	250.5	263.1	292.8	334.6
RADIUS = .700								
AMPLITUDE =	.0129	.0179	.0070	.0023	.0057	.0023	.0018	.0014
PHASE ANGLE =	239.7	259.4	243.6	350.2	266.6	262.7	296.4	307.4
RADIUS = .800								
AMPLITUDE =	.0204	.0147	.0071	.0060	.0063	.0012	.0013	.0012
PHASE ANGLE =	228.1	269.6	273.5	345.0	275.9	260.6	297.9	290.6
RADIUS = .900								
AMPLITUDE =	.0197	.0150	.0085	.0054	.0048	.0008	.0008	.0005
PHASE ANGLE =	237.0	274.3	276.8	339.5	291.6	317.4	330.6	304.0
RADIUS = 1.000								
AMPLITUDE =	.0165	.0167	.0095	.0029	.0033	.0015	.0009	.0005
PHASE ANGLE =	256.5	273.1	269.1	325.0	319.7	344.8	19.9	39.5

TABLE B-10 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0035	.0012	.0003	.0014	.0016	.0016	.0015	.0008
PHASE ANGLE =	77.5	37.5	258.2	230.6	179.7	149.1	148.3	176.8
RADIUS = .350								
AMPLITUDE =	.0031	.0013	.0001	.0009	.0013	.0014	.0013	.0007
PHASE ANGLE =	70.7	30.2	334.7	222.6	171.0	145.7	143.7	167.3
RADIUS = .400								
AMPLITUDE =	.0026	.0014	.0004	.0003	.0010	.0011	.0010	.0005
PHASE ANGLE =	60.6	23.3	38.5	181.1	156.1	140.5	137.0	152.2
RADIUS = .500								
AMPLITUDE =	.0018	.0014	.0007	.0007	.0006	.0006	.0006	.0003
PHASE ANGLE =	35.5	12.8	44.4	77.3	118.6	128.0	121.5	117.7
RADIUS = .600								
AMPLITUDE =	.0014	.0011	.0007	.0009	.0004	.0002	.0003	.0002
PHASE ANGLE =	3.1	.4	36.4	64.3	83.6	112.1	100.6	84.8
RADIUS = .700								
AMPLITUDE =	.0012	.0006	.0005	.0003	.0004	.0002	.0002	.0002
PHASE ANGLE =	304.5	301.3	318.5	357.5	269.7	259.5	280.4	281.4
RADIUS = .800								
AMPLITUDE =	.0013	.0007	.0008	.0006	.0008	.0004	.0005	.0004
PHASE ANGLE =	275.1	250.4	279.2	288.2	267.7	270.4	280.3	275.9
RADIUS = .900								
AMPLITUDE =	.0007	.0005	.0006	.0005	.0006	.0003	.0003	.0002
PHASE ANGLE =	265.9	235.5	265.5	282.7	275.8	286.5	292.9	283.9
RADIUS = 1.000								
AMPLITUDE =	.0002	.0001	.0003	.0001	.0003	.0002	.0001	.0001
PHASE ANGLE =	77.8	200.9	242.7	318.7	310.6	340.6	25.4	44.0

TABLE B-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2333	.0027	.0030	.0039	.0046	.0028	.0022	.0014
PHASE ANGLE =	181.0	95.4	170.2	161.9	161.4	166.2	127.5	69.0
RADIUS = .633								
AMPLITUDE =	.2047	.0105	.0074	.0063	.0048	.0039	.0037	.0024
PHASE ANGLE =	184.2	281.9	271.3	263.9	275.6	303.8	334.7	.8
RADIUS = .781								
AMPLITUDE =	.1873	.0015	.0044	.0021	.0022	.0020	.0011	.0012
PHASE ANGLE =	181.3	305.1	304.1	273.6	269.7	259.4	286.7	294.9
RADIUS = .963								
AMPLITUDE =	.1813	.0025	.0037	.0032	.0023	.0022	.0022	.0017
PHASE ANGLE =	178.8	39.5	26.5	51.8	53.6	58.4	60.3	82.4

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0022	.0016	.0014	.0011	.0011	.0010	.0009	.0006
PHASE ANGLE =	70.0	63.1	83.8	95.8	109.8	114.9	115.2	119.4
RADIUS = .633								
AMPLITUDE =	.0017	.0015	.0013	.0013	.0014	.0014	.0013	.0012
PHASE ANGLE =	39.3	65.1	102.0	143.2	175.7	205.6	237.0	255.4
RADIUS = .781								
AMPLITUDE =	.0010	.0008	.0008	.0006	.0006	.0005	.0005	.0005
PHASE ANGLE =	277.9	293.1	304.5	305.1	304.1	302.0	316.8	320.9
RADIUS = .963								
AMPLITUDE =	.0013	.0008	.0005	.0004	.0004	.0004	.0004	.0004
PHASE ANGLE =	103.3	101.2	98.6	93.3	88.0	78.8	71.7	89.7

TABLE B-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2652	.0329	.0179	.0191	.0190	.0154	.0139	.0050
PHASE ANGLE =	174.9	99.5	108.7	114.2	132.1	147.7	147.3	152.0
RADIUS = .350								
AMPLITUDE =	.2558	.0232	.0128	.0139	.0144	.0113	.0101	.0035
PHASE ANGLE =	176.8	99.4	112.9	118.2	135.1	149.0	145.8	143.6
RADIUS = .400								
AMPLITUDE =	.2446	.0124	.0071	.0082	.0091	.0068	.0059	.0020
PHASE ANGLE =	178.9	99.0	124.3	128.5	142.1	152.5	142.0	121.1
RADIUS = .500								
AMPLITUDE =	.2253	.0031	.0035	.0033	.0028	.0011	.0008	.0017
PHASE ANGLE =	182.3	284.2	232.2	215.3	201.5	232.4	36.6	35.7
RADIUS = .600								
AMPLITUDE =	.2094	.0101	.0070	.0060	.0044	.0035	.0034	.0024
PHASE ANGLE =	184.1	281.7	266.9	259.9	270.2	302.9	337.8	6.6
RADIUS = .700								
AMPLITUDE =	.1954	.0056	.0059	.0043	.0037	.0030	.0022	.0016
PHASE ANGLE =	182.8	283.7	283.5	264.9	271.2	281.8	315.2	327.9
RADIUS = .800								
AMPLITUDE =	.1859	.0010	.0041	.0016	.0019	.0018	.0009	.0011
PHASE ANGLE =	180.9	329.6	310.3	280.2	270.9	255.0	281.0	290.0
RADIUS = .900								
AMPLITUDE =	.1815	.0021	.0032	.0015	.0007	.0003	.0006	.0002
PHASE ANGLE =	179.5	53.7	355.4	39.6	25.8	79.8	65.6	71.5
RADIUS = 1.000								
AMPLITUDE =	.1813	.0025	.0037	.0032	.0023	.0022	.0022	.0017
PHASE ANGLE =	178.8	39.5	26.5	51.8	53.6	58.4	60.3	82.4

TABLE B-12 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 9
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0020	.0008	.0015	.0028	.0036	.0041	.0047	.0042
PHASE ANGLE =	130.7	320.3	350.3	6.3	33.8	55.9	76.0	84.8
RADIUS = .350								
AMPLITUDE =	.0019	.0007	.0011	.0019	.0025	.0030	.0034	.0030
PHASE ANGLE =	109.9	18.0	17.2	18.1	42.6	61.8	79.5	87.4
RADIUS = .400								
AMPLITUDE =	.0020	.0012	.0011	.0012	.0015	.0018	.0020	.0017
PHASE ANGLE =	87.0	52.6	58.6	48.5	64.6	76.3	88.0	93.8
RADIUS = .500								
AMPLITUDE =	.0022	.0019	.0016	.0013	.0012	.0010	.0006	.0004
PHASE ANGLE =	61.0	66.2	93.0	118.3	140.4	157.5	173.4	203.0
RADIUS = .600								
AMPLITUDE =	.0019	.0018	.0015	.0015	.0015	.0014	.0012	.0012
PHASE ANGLE =	45.2	66.8	101.3	139.2	170.0	199.0	230.9	250.9
RADIUS = .700								
AMPLITUDE =	.0008	.0005	.0002	.0002	.0005	.0007	.0007	.0008
PHASE ANGLE =	335.8	6.7	33.2	185.9	215.9	239.2	264.7	279.4
RADIUS = .800								
AMPLITUDE =	.0010	.0008	.0008	.0007	.0006	.0006	.0005	.0005
PHASE ANGLE =	272.4	288.7	303.0	308.3	311.6	312.3	328.0	331.3
RADIUS = .900								
AMPLITUDE =	.0003	.0003	.0004	.0004	.0004	.0004	.0004	.0004
PHASE ANGLE =	207.9	273.0	309.8	331.2	343.7	359.0	20.2	33.2
RADIUS = 1.000								
AMPLITUDE =	.0013	.0008	.0005	.0004	.0004	.0004	.0004	.0004
PHASE ANGLE =	103.3	101.2	98.6	93.3	88.0	78.8	71.7	89.7

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX C

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 4

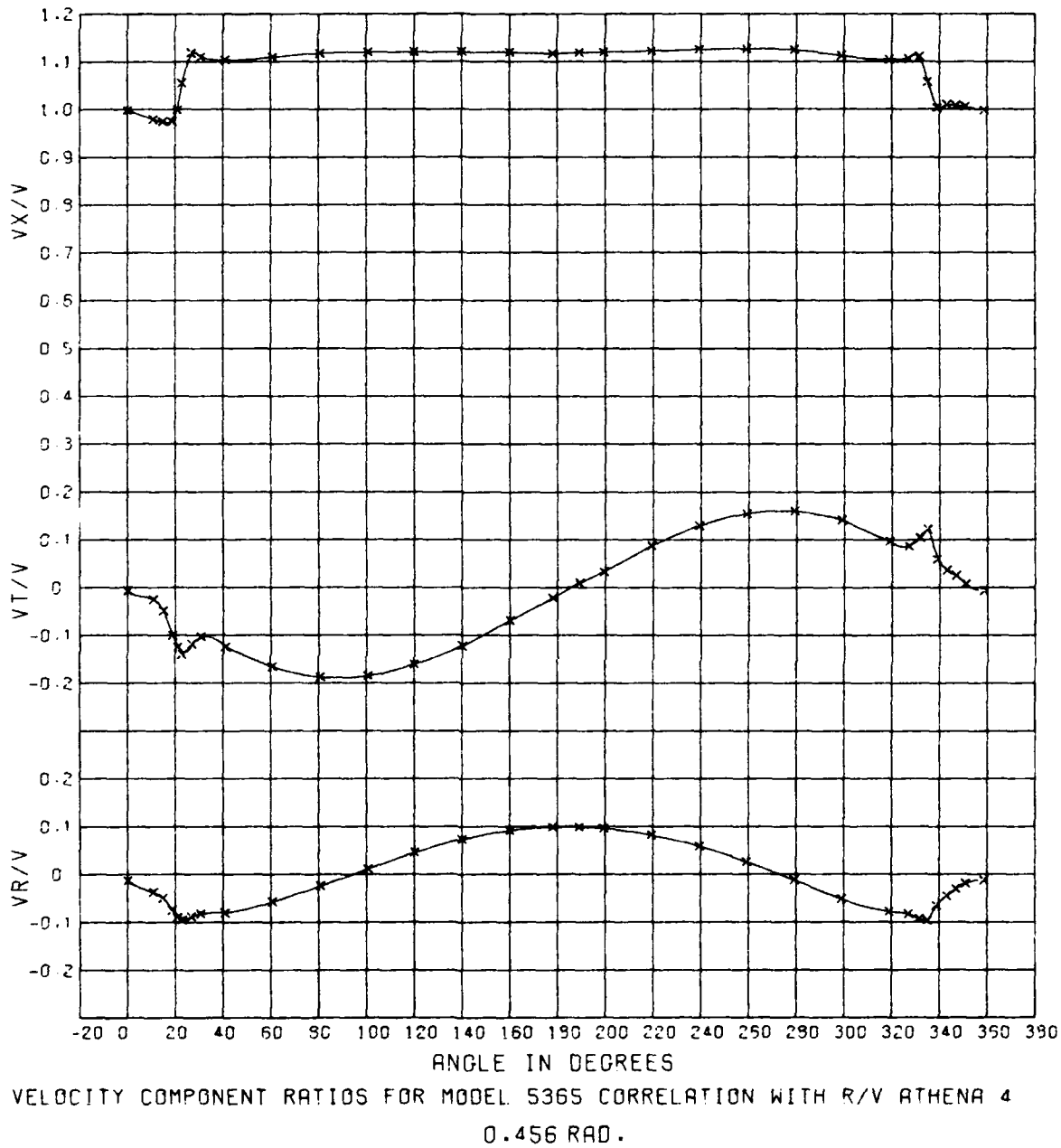


Figure C-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 4

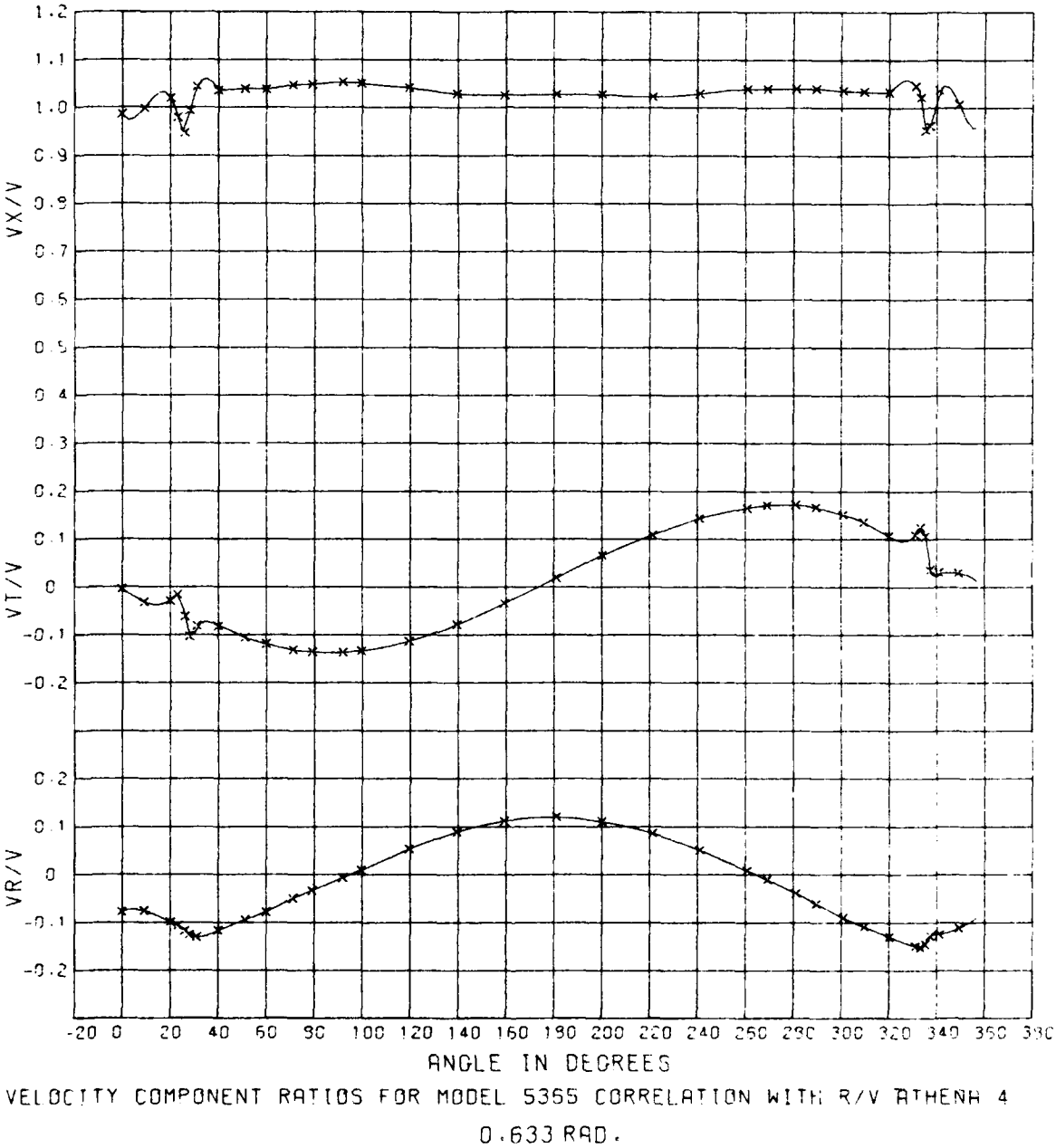


Figure C-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 4

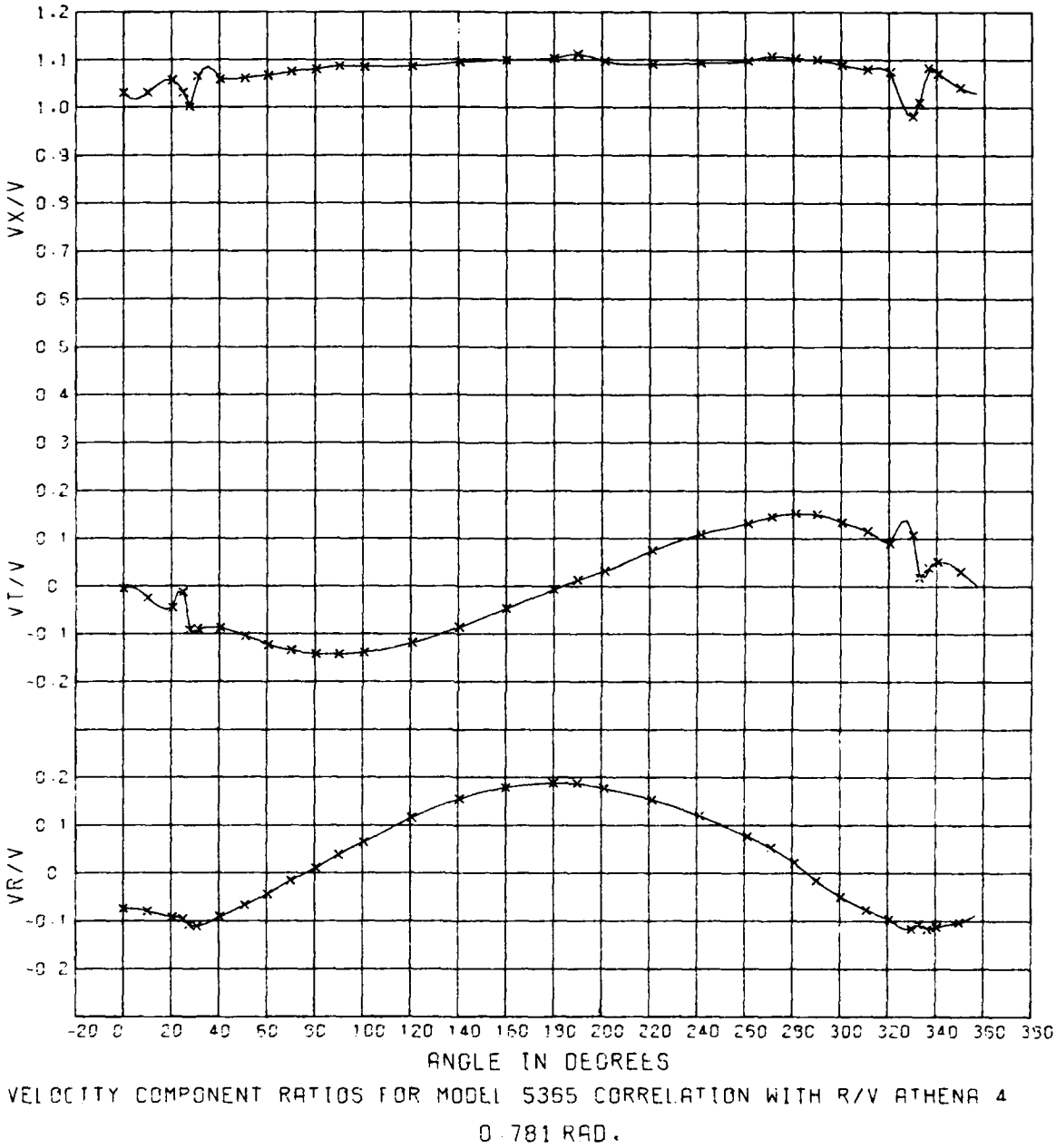


Figure C-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 4

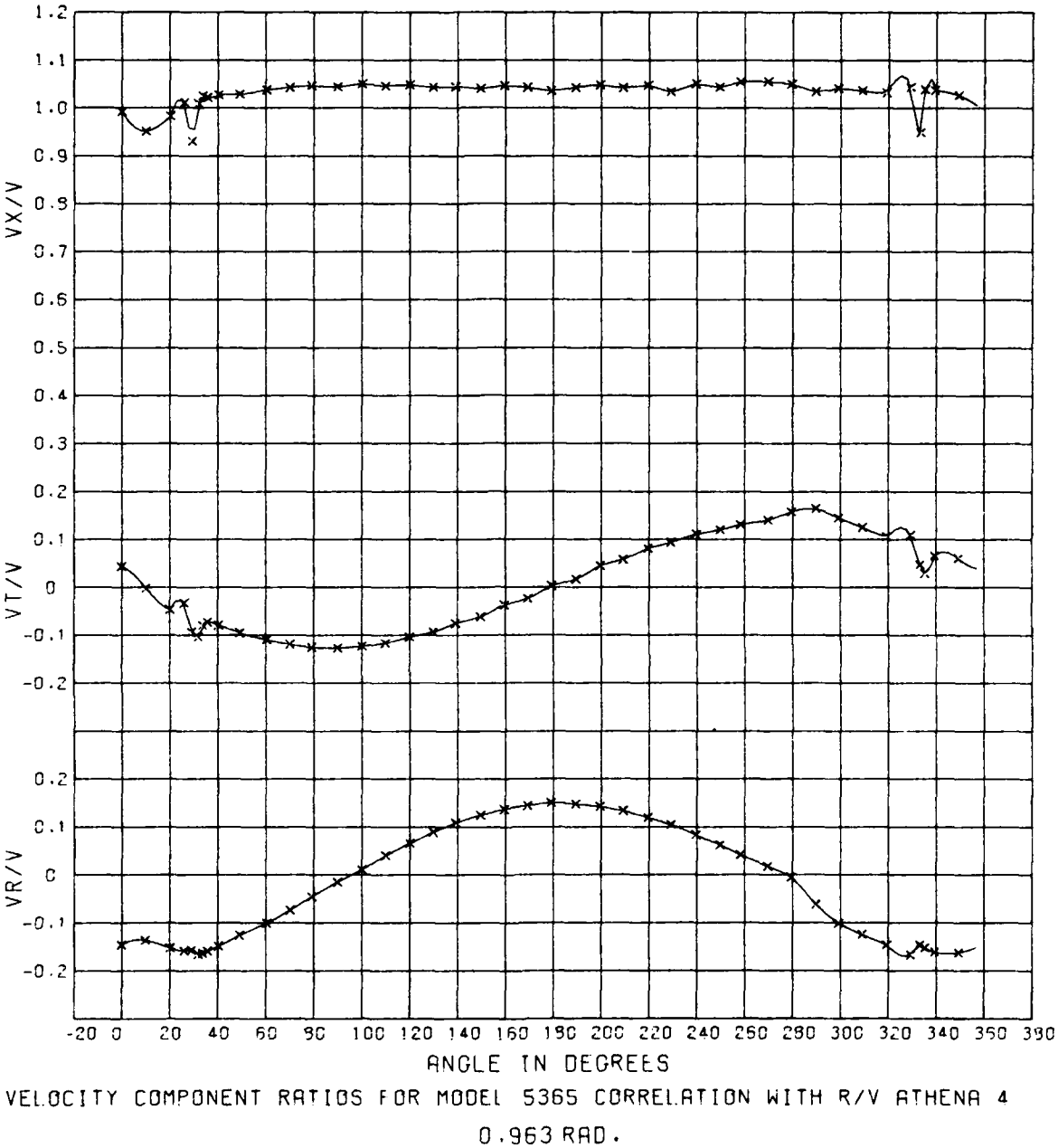


Figure C-4 – Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 4

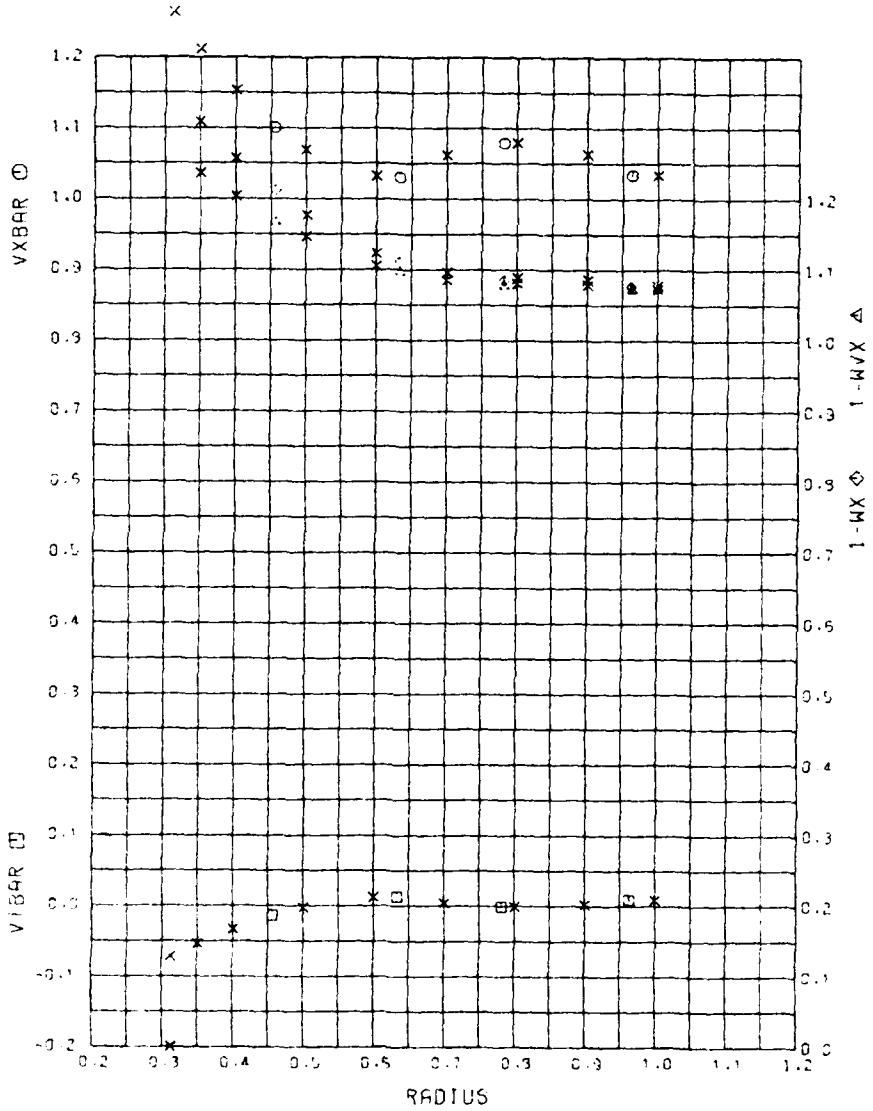


Figure C-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 4

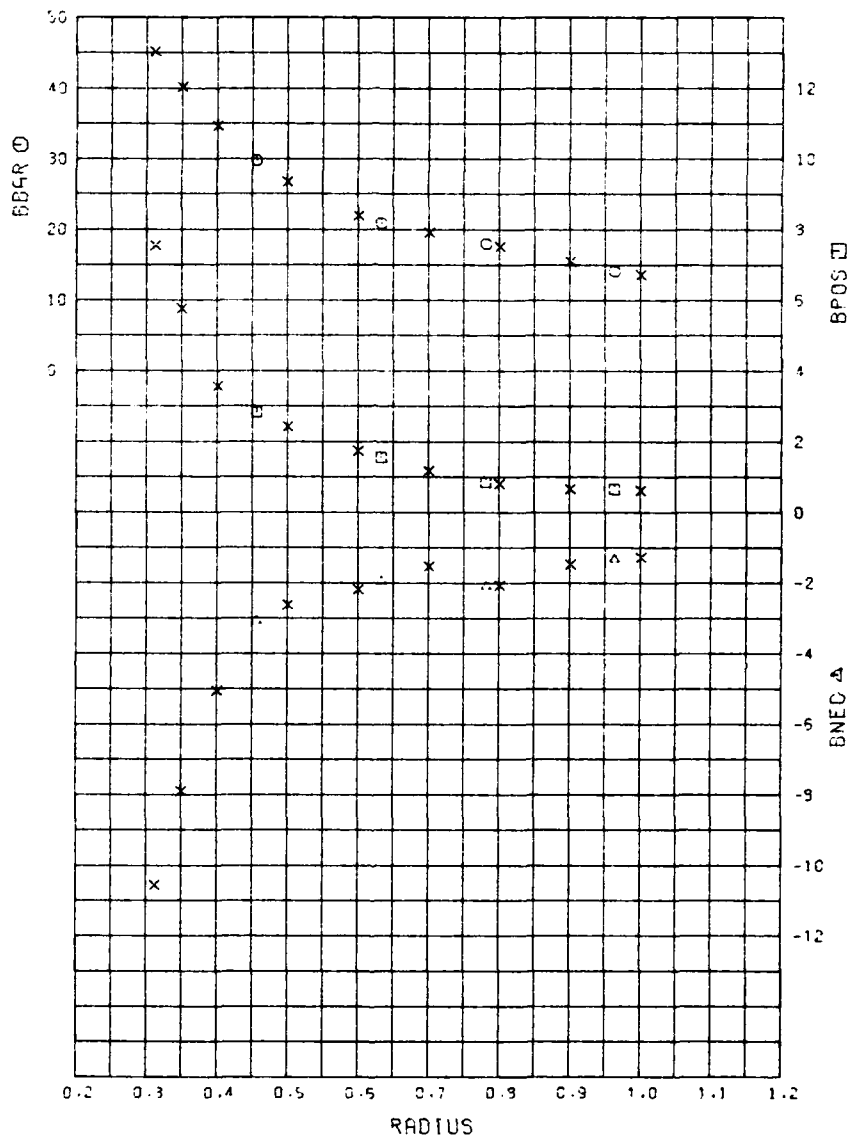


Figure C-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 4

TABLE C-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 4

RADIUS = .456

ANGLE	VX/V	VY/V	VP/V
8.8	.998	-.007	-.013
10.8	.979	-.025	-.037
14.8	.975	-.049	-.058
18.6	.975	-.100	-.074
20.7	.999	-.175	-.090
22.7	1.055	-.148	-.094
24.6	1.118	-.118	-.088
26.6	1.118	-.109	-.047
40.7	1.103	-.125	-.040
60.6	1.109	-.166	-.057
80.6	1.117	-.187	-.024
100.6	1.120	-.185	.011
120.8	1.120	-.161	.046
140.8	1.120	-.122	.074
160.8	1.120	-.069	.092
179.8	1.117	-.022	.099
189.8	1.119	.018	.099
199.3	1.120	.053	.097
219.3	1.122	.088	.092
239.3	1.125	.130	.059
259.1	1.127	.156	.026
279.1	1.125	.141	-.017
298.9	1.113	.141	-.052
318.9	1.104	.097	-.078
327.8	1.106	.087	-.092
337.8	1.115	.088	-.098
357.8	1.107	.111	-.095
336.9	1.057	.122	-.097
338.8	1.083	.059	-.065
347.9	1.018	.037	-.045
346.7	1.088	.074	-.038
358.7	1.006	.008	-.019
359.5	.998	-.008	-.017
360.0	.998	-.007	-.013

RADIUS = .633

ANGLE	VX/V	VY/V	VP/V
-.3	.995	-.006	-.078
9.8	.998	-.032	-.074
19.9	1.020	-.078	-.098
23.8	.979	-.016	-.107
25.9	.947	-.063	-.118
27.9	.993	-.106	-.126
31.0	1.044	-.081	-.131
39.8	1.036	-.082	-.117
51.8	1.019	-.107	-.096
59.8	1.038	-.119	-.078
71.8	1.046	-.131	-.058
79.0	1.049	-.135	-.036
91.8	1.051	-.137	-.007
99.6	1.058	-.134	.009
119.6	1.061	-.114	.053
139.4	1.029	-.079	.089
159.2	1.026	-.035	.111
181.8	1.028	.019	.120
200.0	1.024	.066	.110
221.1	1.023	.109	.086
221.1	1.022	.109	.086
240.7	1.029	.143	.058
260.6	1.039	.165	.008
269.0	1.039	.171	-.011
281.0	1.040	.172	-.039
289.4	1.040	.167	-.061
300.7	1.036	.152	-.090
309.6	1.034	.136	-.110
320.0	1.037	.107	-.138
331.8	1.046	.089	-.150
333.2	1.073	.125	-.153
335.2	.993	.106	-.146
337.2	.961	.075	-.128
337.2	.960	.036	-.129
341.0	1.037	.031	-.124
349.1	1.087	.038	-.112
359.7	.995	-.006	-.078

RADIUS = .791

ANGLE	VX/V	VY/V	VP/V
0.0	1.031	-.005	-.076
10.8	1.030	-.025	-.079
20.4	1.057	-.045	-.092
24.8	1.012	-.011	-.096
24.8	1.029	-.014	-.095
26.7	.986	-.049	-.102
28.8	1.033	-.114	-.114
30.9	1.066	-.149	-.111
40.3	1.058	-.048	-.091
50.8	1.061	-.105	-.067
60.4	1.067	-.123	-.046
70.0	1.074	-.136	-.016
80.6	1.080	-.142	.018
90.0	1.086	-.147	.038
100.5	1.085	-.139	.064
120.6	1.085	-.119	.115
140.5	1.093	-.087	.155
160.5	1.095	-.047	.155
160.0	1.100	-.047	.179
180.0	1.110	-.006	.189
180.0	1.096	-.009	.186
190.8	1.111	.017	.197
201.2	1.096	.031	.176
221.2	1.090	.075	.153
241.3	1.093	.109	.120
241.3	1.093	.110	.120
261.1	1.097	.131	.076
271.0	1.104	.146	.057
281.0	1.101	.152	.021
290.0	1.100	.151	-.014
300.0	1.090	.135	-.050
300.7	1.089	.133	-.058
311.0	1.079	.115	-.077
320.6	1.075	.090	-.096
330.0	.982	.107	-.117
330.0	.980	.109	-.117
332.8	1.010	.018	-.107
334.6	1.043	.039	-.118
340.5	1.071	.051	-.111
350.0	1.042	.031	-.103
360.0	1.031	-.005	-.076

RADIUS = .947

ANGLE	VX/V	VY/V	VP/V
-.2	.992	.043	-.146
9.8	.951	-.025	-.117
20.1	.982	-.047	-.151
25.9	1.011	-.036	-.159
29.0	.931	-.094	-.158
31.9	1.309	-.174	-.167
33.7	1.075	-.088	-.164
35.7	1.022	-.076	-.145
40.2	1.077	-.080	-.149
49.8	1.024	-.095	-.177
60.2	1.037	-.109	-.181
69.9	1.062	-.119	-.176
79.0	1.066	-.135	-.166
89.8	1.044	-.177	-.015
99.9	1.050	-.175	.016
109.7	1.046	-.117	.062
119.8	1.048	-.105	.066
129.7	1.043	-.096	.049
139.8	1.045	-.076	.138
149.5	1.038	-.062	.125
149.5	1.041	-.062	.126
159.4	1.046	-.078	.157
159.2	1.043	-.076	.146
179.0	1.073	.003	.152
179.0	1.048	.003	.148
189.1	1.043	.016	.147
199.4	1.048	.046	.147
209.0	1.047	.067	.133
219.4	1.047	.091	.119
229.8	1.036	.093	.126
239.4	1.050	.110	.083
249.4	1.046	.119	.047
259.0	1.055	.131	.041
269.5	1.055	.148	.017
279.3	1.050	.158	-.006
289.5	1.036	.166	-.043
299.0	1.041	.165	-.082
309.0	1.037	.125	-.125
319.1	1.037	.105	-.147
329.7	1.041	.109	-.148
337.1	.969	.047	-.147
339.1	1.039	.029	-.153
339.2	1.037	.066	-.162
339.3	1.037	.066	-.161
349.2	1.027	.061	-.165
359.8	.992	.043	-.146

TABLE C-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 4

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 4
PROPELLER DIAMETER = 6.00 FEET JA = .730

RADIUS =	.456	.533	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.101	1.0[illegible]0	1.079	1.034	1.204	1.212	1.1[illegible]	1.070	1.032	1.062	1.080	1.063	1.034
VTBAR =	-.014	.013	-.001	.009	-.072	-.054	-.033	-.003	.012	.004	-.001	.002	.009
VRBAR =	.007	-.009	.038	-.009	.016	.053	.028	-.005	-.012	.022	.039	.020	-.009
1-WX =	1.167	1.096	1.077	1.072	0.000	1.236	1.2[illegible]3	1.117	1.105	1.085	1.081	1.079	1.073
1-WX =	1.212	1.111	1.085	1.077	0.000	1.309	1.2[illegible]7	1.177	1.123	1.096	1.089	1.086	1.078
BBAR =	29.77	20.84	18.00	14.14	45.21	40.18	34.65	2[illegible].74	21.93	19.60	17.61	15.51	13.64
BPOS =	2.82	1.56	.86	.66	7.54	5.76	3.55	2.42	1.74	1.17	.81	.66	.62
THETA =	92.50	90.00	92.50	100.00	25.00	25.00	25.00	9[illegible].50	90.00	90.00	92.50	100.00	100.00
BNEG =	-2.07	-1.95	-2.09	-1.32	-10.56	-7.90	-5.06	-[illegible].62	-2.18	-1.53	-2.07	-1.47	-1.27
THETA =	337.50	335.00	327.50	332.50	342.50	342.50	342.50	33[illegible].00	335.00	327.50	327.50	330.00	332.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE C-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 4

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 4
PROPELLER DIAMETER 6.50 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0368	.0369	.0201	[illegible]	.0114	.0086	.0039	.0024
PHASE ANGLE =	265.8	270.3	272.5	267.6	264.2	259.9	239.8	162.7
RADIUS = .633								
AMPLITUDE =	.0071	.0167	.00[illegible]0	.0035	.0062	.0038	.0015	.0010
PHASE ANGLE =	303.3	283.4	25[illegible].1	272.1	261.3	271.5	266.3	341.3
RADIUS = .781								
AMPLITUDE =	.0270	.0122	.00[illegible]9	.0043	.0011	.0020	.0049	.0032
PHASE ANGLE =	256.8	262.8	2[illegible].3	42.7	106.9	154.2	179.4	170.4
RADIUS = .963								
AMPLITUDE =	.0184	.0169	.0095	.0076	.0080	.0047	.0030	.0038
PHASE ANGLE =	257.0	249.3	2[illegible].2	202.3	203.7	215.4	157.5	177.0

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0051	.0065	.0072	.0045	.0050	.0029	.0010	.0018
PHASE ANGLE =	122.0	112.8	1[illegible].2	104.8	101.8	92.4	51.0	320.4
RADIUS = .633								
AMPLITUDE =	.0019	.0017	.0017	.0043	.0052	.0043	.0046	.0058
PHASE ANGLE =	20.0	4.4	318.0	2[illegible].2	275.7	268.9	267.2	268.7
RADIUS = .781								
AMPLITUDE =	.0049	.0044	.0047	.0040	.0052	.0050	.0023	.0021
PHASE ANGLE =	198.9	249.7	2[illegible].3	2[illegible].9	308.1	320.8	4.0	85.5
RADIUS = .963								
AMPLITUDE =	.0036	.0031	.0019	.0026	.0035	.0031	.0007	.0005
PHASE ANGLE =	161.8	197.5	1[illegible].9	217.6	206.0	239.5	208.2	298.5

TABLE C-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 4

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R V ATHENA 4
PROPELLER DIAMETER 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1093	.0497	.0496	.0291	.0141	.0130	.0107	.0118
PHASE ANGLE =	257.7	274.5	288.6	271.9	265.9	242.9	207.4	164.3
RADIUS = .350								
AMPLITUDE =	.0860	.0441	.0340	.0252	.0137	.0117	.0083	.0087
PHASE ANGLE =	253.9	273.5	285.2	270.8	265.5	247.5	212.8	164.1
RADIUS = .400								
AMPLITUDE =	.0599	.0374	.0267	.0205	.0130	.0101	.0058	.0053
PHASE ANGLE =	261.2	272.1	279.8	269.3	264.9	253.5	223.0	163.7
RADIUS = .500								
AMPLITUDE =	.0234	.0264	.0162	.0122	.0108	.0074	.0030	.0007
PHASE ANGLE =	272.1	268.6	266.1	266.6	263.7	264.5	256.0	159.3
RADIUS = .600								
AMPLITUDE =	.0082	.0186	.0103	.0054	.0075	.0047	.0018	.0011
PHASE ANGLE =	301.0	264.6	254.8	267.5	262.1	271.5	275.8	343.6
RADIUS = .700								
AMPLITUDE =	.0188	.0138	.0092	.0028	.0017	.0011	.0031	.0013
PHASE ANGLE =	253.6	264.6	247.3	12.7	271.5	226.4	193.5	171.8
RADIUS = .800								
AMPLITUDE =	.0288	.0121	.0097	.0041	.0014	.0022	.0051	.0035
PHASE ANGLE =	256.1	261.7	245.8	47.0	116.9	154.3	177.7	170.7
RADIUS = .900								
AMPLITUDE =	.0264	.0139	.0077	.0020	.0040	.0032	.0046	.0041
PHASE ANGLE =	255.1	254.0	269.2	155.3	181.5	185.9	169.1	173.3
RADIUS = 1.000								
AMPLITUDE =	.0184	.0169	.0095	.0076	.0080	.0047	.0030	.0038
PHASE ANGLE =	257.0	249.3	226.2	202.3	203.7	215.4	157.6	177.0

TABLE C-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 4
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0180	.0168	.0187	.0200	.0223	.0211	.0197	.0147
PHASE ANGLE =	153.2	137.1	120.1	100.7	92.3	79.9	76.4	74.0
RADIUS = .350								
AMPLITUDE =	.0136	.0136	.0153	.0159	.0170	.0154	.0136	.0096
PHASE ANGLE =	148.9	132.6	118.1	101.5	93.6	81.2	76.1	70.5
RADIUS = .400								
AMPLITUDE =	.0089	.0099	.0112	.0111	.0108	.0088	.0069	.0042
PHASE ANGLE =	140.3	125.0	114.7	102.7	90.0	83.8	74.5	57.8
RADIUS = .500								
AMPLITUDE =	.0033	.0045	.0046	.0033	.0015	.0009	.0026	.0038
PHASE ANGLE =	96.2	98.7	102.1	107.9	123.3	229.9	269.5	282.1
RADIUS = .600								
AMPLITUDE =	.0023	.0019	.0010	.0021	.0043	.0057	.0065	.0061
PHASE ANGLE =	32.8	37.2	3.2	261.1	271.2	264.8	265.8	270.0
RADIUS = .700								
AMPLITUDE =	.0022	.0026	.0036	.0053	.0055	.0052	.0031	.0012
PHASE ANGLE =	203.7	269.7	281.6	298.4	298.5	299.8	296.9	271.5
RADIUS = .800								
AMPLITUDE =	.0053	.0046	.0047	.0058	.0050	.0048	.0023	.0024
PHASE ANGLE =	197.6	246.9	268.1	299.0	308.1	322.7	13.8	85.7
RADIUS = .900								
AMPLITUDE =	.0050	.0041	.0042	.0036	.0026	.0029	.0015	.0020
PHASE ANGLE =	185.7	228.2	248.8	279.7	276.4	303.3	39.5	83.2
RADIUS = 1.000								
AMPLITUDE =	.0036	.0031	.0019	.0026	.0035	.0031	.0007	.0005
PHASE ANGLE =	161.8	197.5	192.9	217.6	206.0	239.5	208.2	298.5

TABLE C-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 4

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH P/V ATHENA 4
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.1734	.0061	.0025	.0042	.0035	.0029	.0002	.0023
PHASE ANGLE =	179.2	180.9	165.6	174.3	179.9	173.7	220.2	17.3
RADIUS = .633								
AMPLITUDE =	.1521	.0060	.0047	.0020	.0011	.0012	.0011	.0015
PHASE ANGLE =	181.7	228.3	296.5	314.1	263.4	277.1	303.0	333.0
RADIUS = .781								
AMPLITUDE =	.1404	.0094	.0049	.0010	.0006	.0008	.0018	.0027
PHASE ANGLE =	176.9	193.0	311.7	319.5	47.1	174.3	325.3	13.0
RADIUS = .963								
AMPLITUDE =	.1365	.0108	.0011	.0033	.0055	.0042	.0017	.0024
PHASE ANGLE =	175.8	177.9	264.1	11.6	97.7	116.3	90.6	49.0

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0042	.0059	[illegible]	[illegible]	.0075	.0020	.0064	.0019
PHASE ANGLE =	16.2	15.8	[illegible]	11.7	[illegible]	255.4	283.8	232.4
RADIUS = .633								
AMPLITUDE =	.0014	.0009	[illegible]	[illegible]	[illegible]	[illegible]	.0042	[illegible]
PHASE ANGLE =	2.1	8.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	170.3
RADIUS = .781								
AMPLITUDE =	.0015	.0009	[illegible]	[illegible]	.0039	.0032	.0018	.0016
PHASE ANGLE =	43.3	110.3	[illegible]	[illegible]	191.0	206.7	[illegible]	307.9
RADIUS = .963								
AMPLITUDE =	.0031	.0026	[illegible]	.0020	.0024	.0020	.0014	.0012
PHASE ANGLE =	64.5	107.3	[illegible]	[illegible]	216.1	222.5	258.1	338.1

TABLE C-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 4

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 4
PROPELLER DIAMETER - 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1980	.0171	.0083	.0145	.0091	.0096	.0011	.0064
PHASE ANGLE =	172.7	147.2	11[illegible].6	16[illegible].4	160.0	155.0	109.8	40.8
RADIUS = .350								
AMPLITUDE =	.1906	.0132	.0058	.0113	.0073	.0075	.0008	.0050
PHASE ANGLE =	174.7	151.5	118.6	164.7	163.4	157.5	115.5	37.5
RADIUS = .400								
AMPLITUDE =	.1819	.0091	.0030	.0076	.0053	.0050	.0004	.0035
PHASE ANGLE =	177.0	161.2	124.1	1[illegible].6	169.4	162.5	130.2	30.6
RADIUS = .500								
AMPLITUDE =	.1673	.0051	.0016	.0022	.0024	.0018	.0004	.0018
PHASE ANGLE =	180.5	202.1	27[illegible].3	16[illegible].4	192.7	192.4	272.9	1.7
RADIUS = .600								
AMPLITUDE =	.1555	.0057	.0042	.0016	.0012	.0012	.0009	.0015
PHASE ANGLE =	181.8	229.0	241.1	3[illegible].8	244.2	266.5	297.7	33[illegible].1
RADIUS = .700								
AMPLITUDE =	.1457	.0075	.0052	.0016	.0007	.0009	.0017	.0021
PHASE ANGLE =	179.2	206.5	30[illegible].5	30[illegible].3	291.0	251.0	315.3	358.0
RADIUS = .800								
AMPLITUDE =	.1395	.0097	.0047	.0009	.0008	.0010	.0017	.0027
PHASE ANGLE =	176.5	190.8	312.1	3[illegible]	95.4	158.5	328.6	15.9
RADIUS = .900								
AMPLITUDE =	.1366	.0108	.0028	.0017	.0033	.0027	.0009	.0027
PHASE ANGLE =	175.5	182.2	3[illegible].1	[illegible]	92.3	124.0	24.1	32.8
RADIUS = 1.000								
AMPLITUDE =	.1365	.0108	.0011	.0033	.0055	.0042	.0017	.0024
PHASE ANGLE =	175.8	177.9	2[illegible].1	[illegible].6	97.7	116.3	96.6	49.0

TABLE C-6 (Continued)

VELOCITY COMPONENT RATIOS [illegible] MODEL 5365 CORRELATION WITH [illegible] V ATHENA [illegible]
PROPELLER DIA[illegible] [illegible] 20 FEET JA = [illegible]

HARMONIC ANALYSES OF TANGENTIAL VE[illegible] COMPONENT RATIOS (V1/V1)

HARMONIC =	9	10	[illegible]	[illegible]	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0090	.0130	[illegible]	[illegible]	.0121	.0129	.0116	[illegible]
PHASE ANGLE =	26.0	21.1	[illegible]	[illegible]	352.8	338.7	329.7	318.3
RADIUS = .350								
AMPLITUDE =	.0075	.0108	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PHASE ANGLE =	24.0	19.9	[illegible]	[illegible]	355.5	340.3	[illegible]	312.3
RADIUS = .400								
AMPLITUDE =	.0058	.0083	.0077	.0081	.0063	.0055	.0041	[illegible]
PHASE ANGLE =	20.8	18.2	17.0	[illegible]	[illegible]	343.8	324.6	[illegible]
RADIUS = .500								
AMPLITUDE =	.0032	.0043	[illegible]	[illegible]	[illegible]	.0066	[illegible]	[illegible]
PHASE ANGLE =	11.3	13.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	191.0
RADIUS = .600								
AMPLITUDE =	.0016	.0016	.0011	[illegible]	[illegible]	.0034	.0041	[illegible]
PHASE ANGLE =	2.3	7.8	35.0	112.7	147.0	158.6	[illegible]	171.3
RADIUS = .700								
AMPLITUDE =	.0013	.0005	.0012	[illegible]	.0035	.0023	[illegible]	[illegible]
PHASE ANGLE =	21.0	54.9	[illegible]	172.1	178.0	185.5	198.3	205.4
RADIUS = .800								
AMPLITUDE =	.0016	.0011	[illegible]	.0032	.0039	.0031	.0019	[illegible]
PHASE ANGLE =	47.4	113.1	[illegible]	[illegible]	193.2	210.3	[illegible]	314.
RADIUS = .900								
AMPLITUDE =	.0024	.0020	.0026	[illegible]	.0023	.0027	[illegible]	[illegible]
PHASE ANGLE =	60.7	112.3	[illegible]	[illegible]	204.7	221.8	[illegible]	327.7
RADIUS = 1.000								
AMPLITUDE =	.0031	.0020	[illegible]	.0028	.0024	.0020	.0014	[illegible]
PHASE ANGLE =	64.5	107.3	[illegible]	[illegible]	216.1	222.5	258.1	338.1

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX D

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS

EXPERIMENT 5

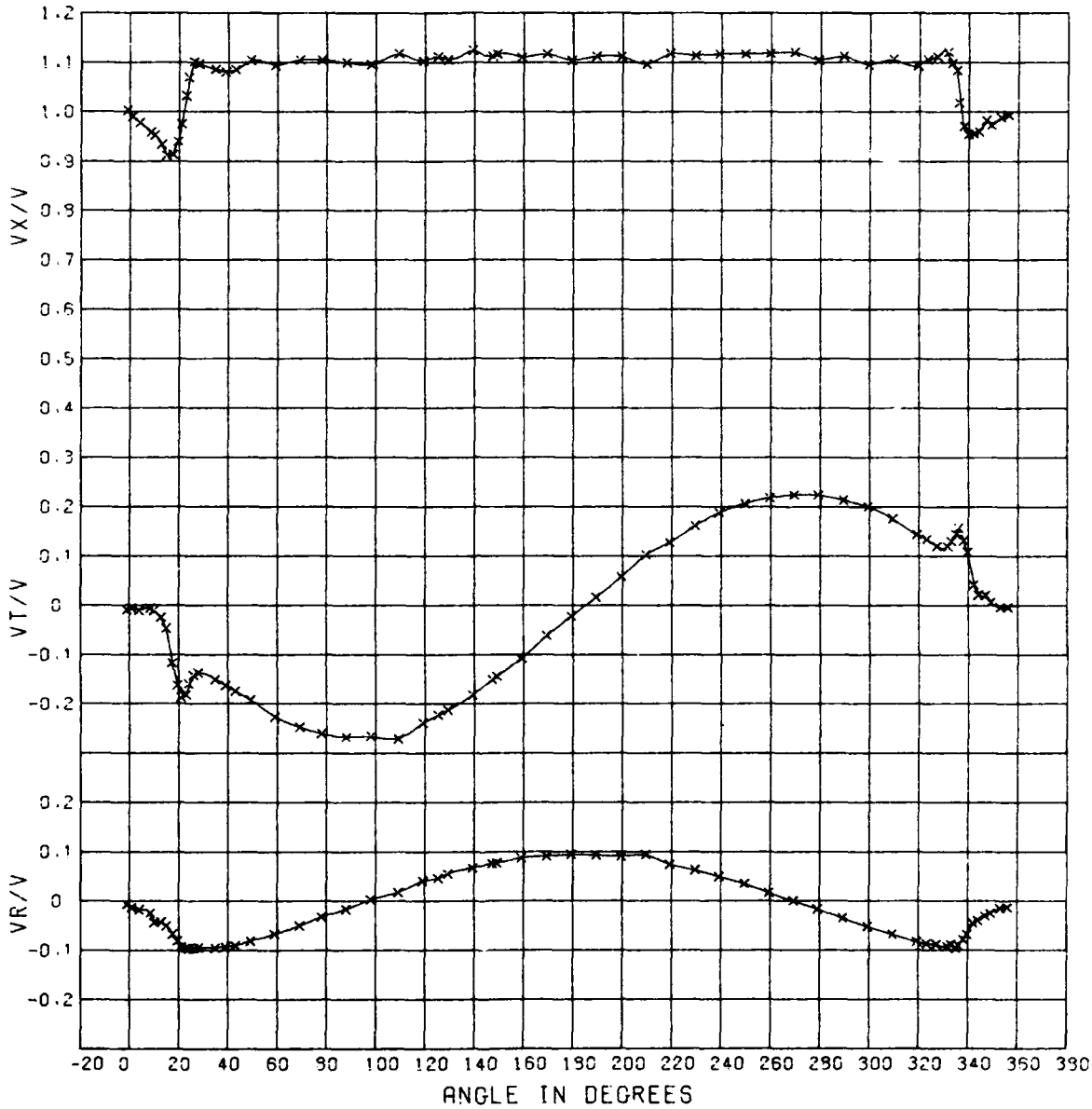


Figure D-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 5

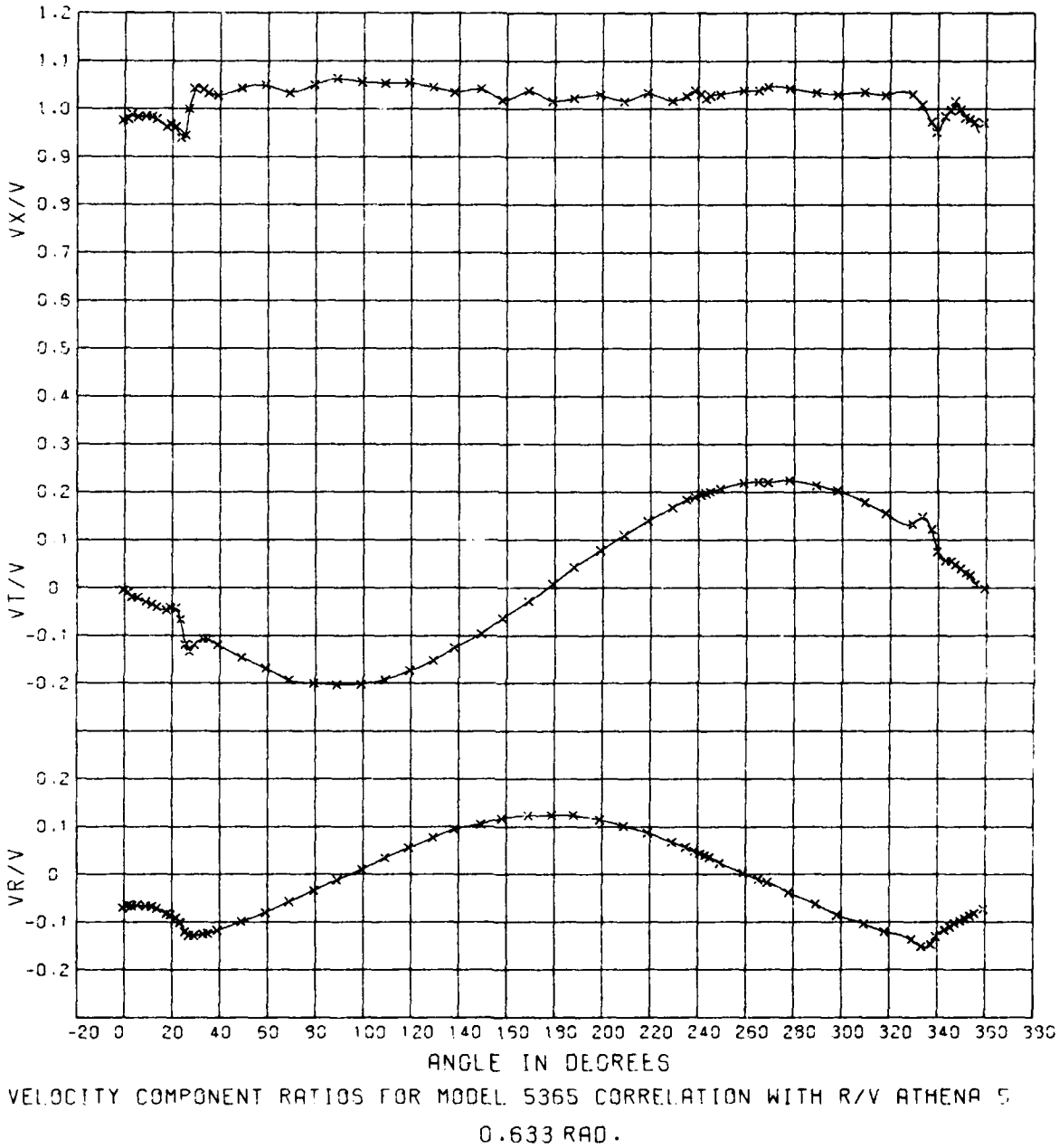


Figure D-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 5

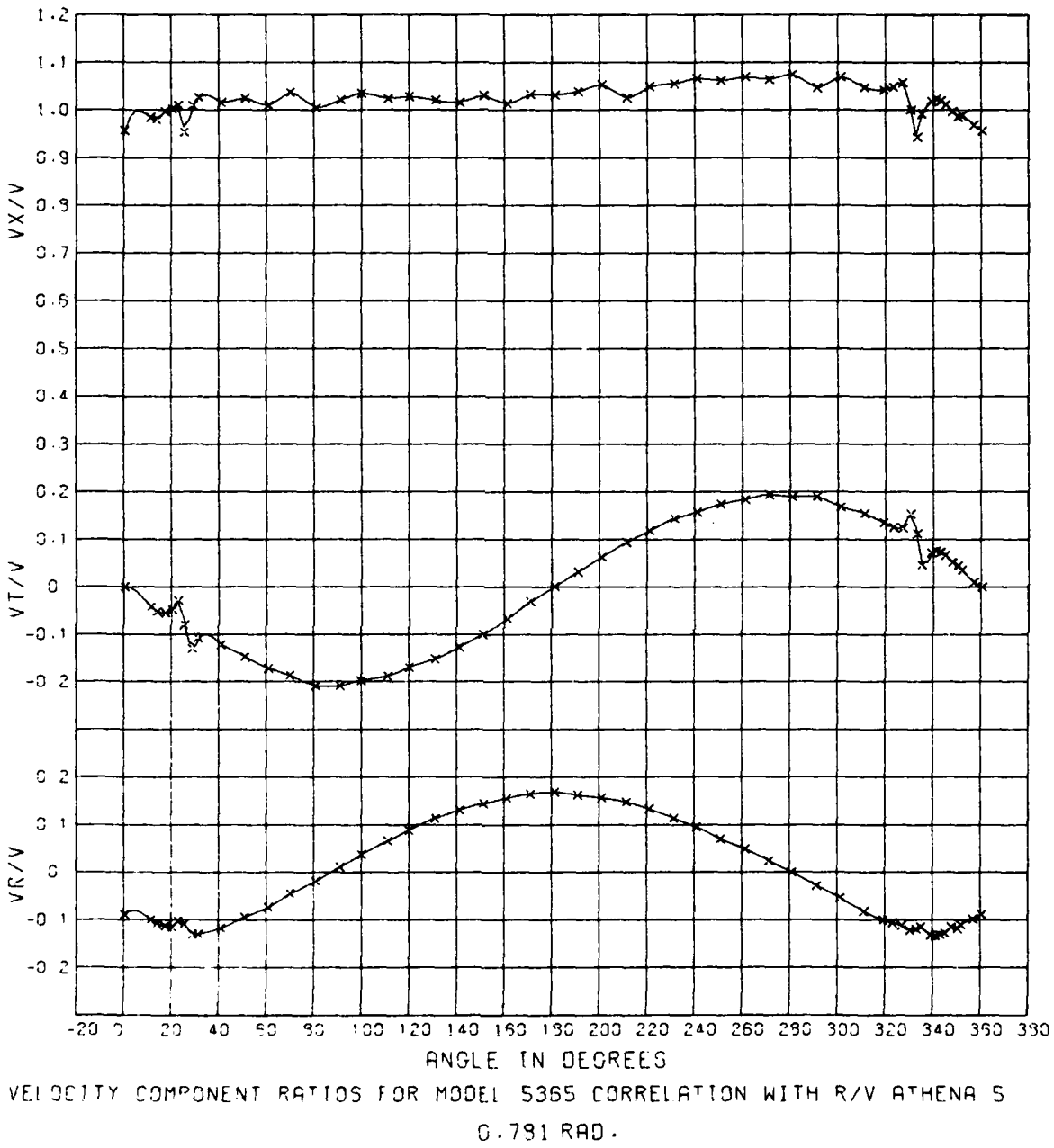


Figure D-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 5

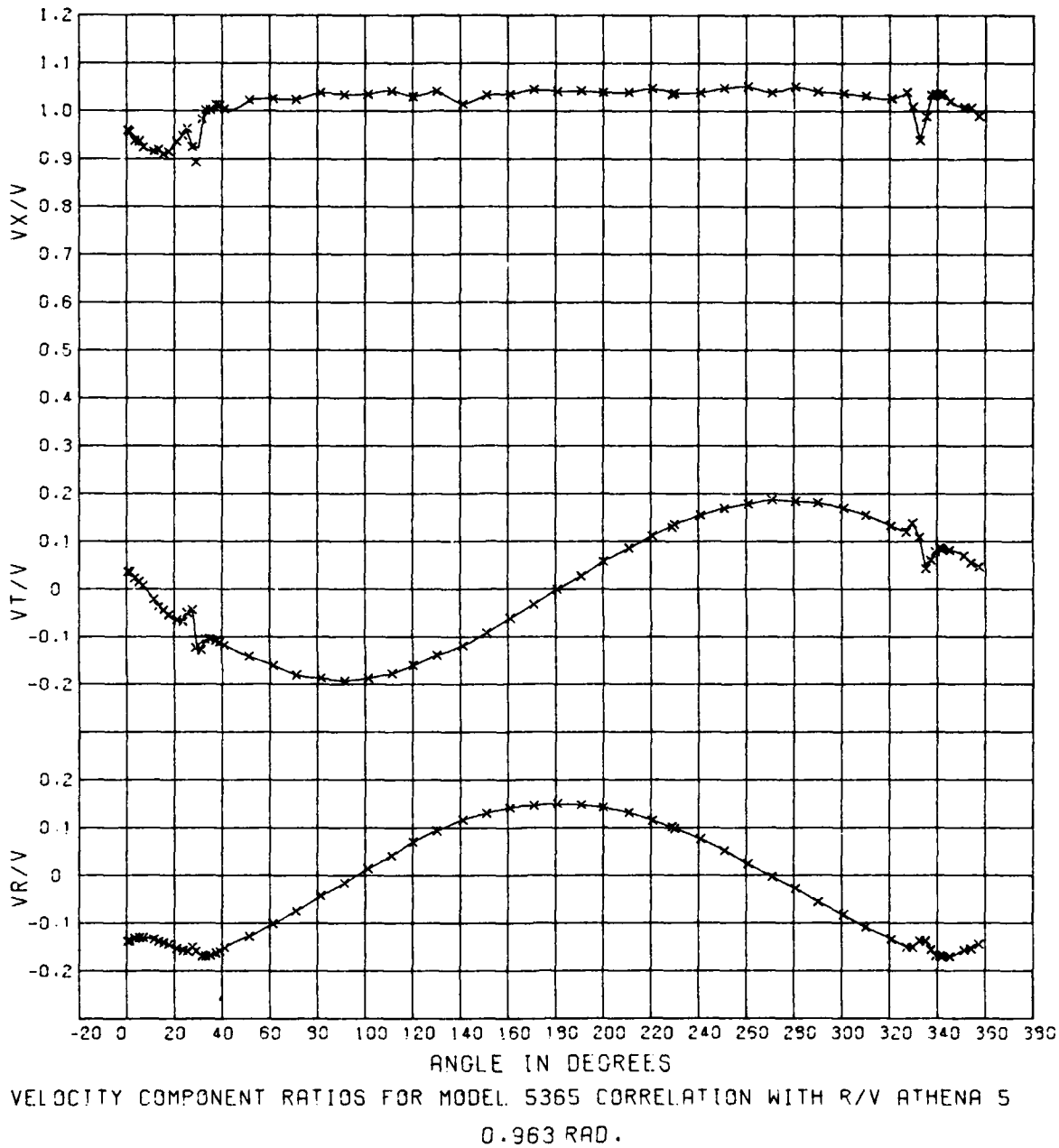


Figure D-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 5

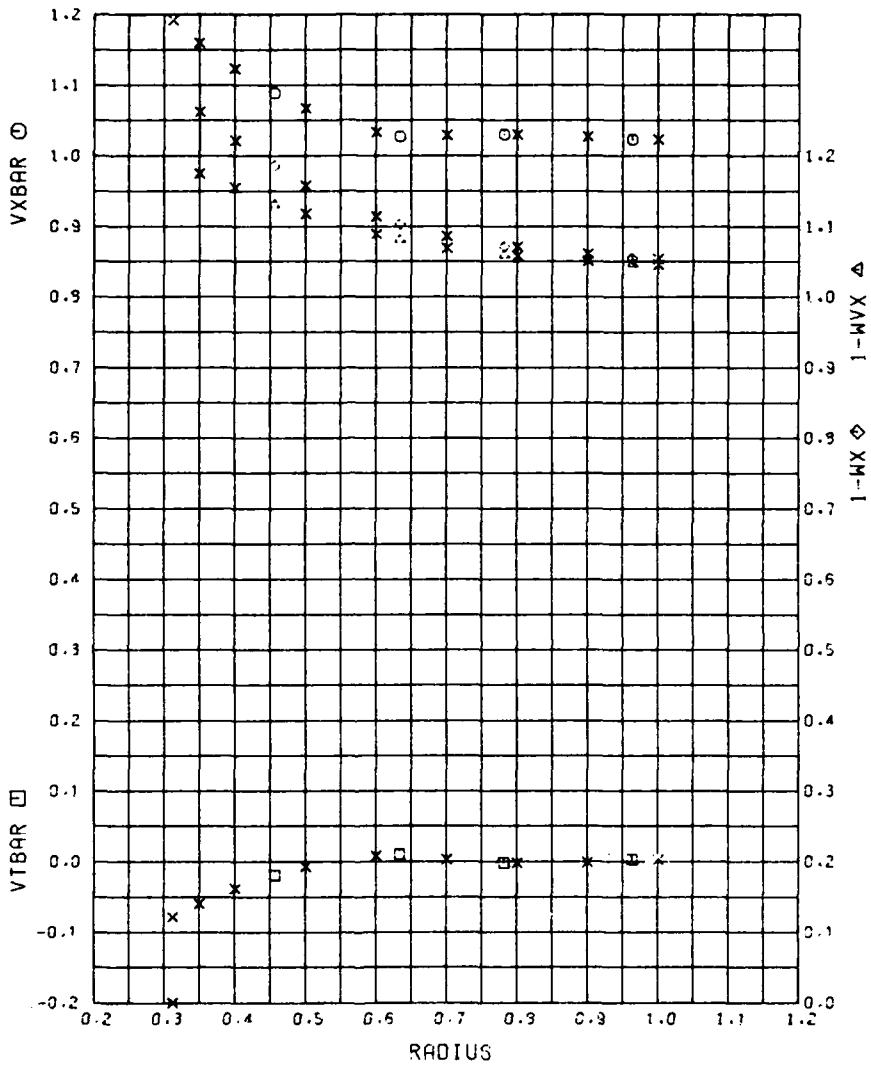


Figure D-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 5

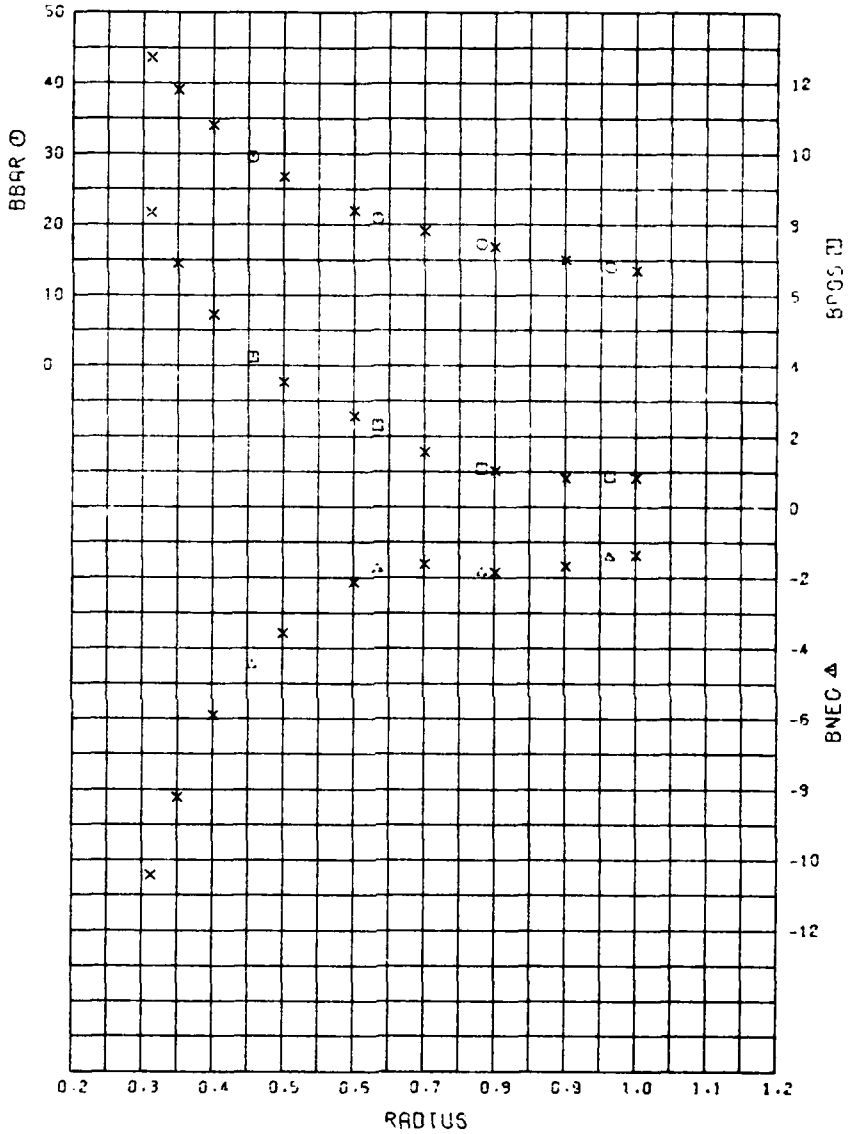


Figure D-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 5

TABLE D-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 5

RADIUS = .456

ANGLE	VX/V	VY/V	VZ/V
-1.0	1.083	-.089	-.037
.0	.990	-.085	-.014
1.0	.974	-.010	-.019
2.0	.963	-.083	-.010
4.0	.956	-.080	-.032
10.0	.953	-.010	-.044
12.0	.974	-.025	-.063
14.0	.912	-.047	-.051
16.0	.892	-.086	-.059
18.0	.935	-.158	-.080
18.0	.974	-.166	-.077
20.0	.957	-.170	-.090
20.0	.975	-.166	-.093
22.0	1.089	-.181	-.090
22.0	1.056	-.181	-.102
24.0	1.051	-.154	-.096
24.0	1.087	-.162	-.098
26.0	1.101	-.143	-.095
26.0	1.093	-.138	-.095
28.0	1.100	-.137	-.095
28.0	1.096	-.141	-.095
30.0	1.074	-.163	-.095
30.0	1.086	-.143	-.098
32.0	1.085	-.174	-.091
34.0	1.104	-.192	-.093
36.0	1.096	-.227	-.068
38.0	1.105	-.247	-.051
38.0	1.105	-.248	-.033
40.0	1.108	-.248	-.017
40.0	1.096	-.246	.033
100.1	1.114	-.271	.017
110.0	1.103	-.279	.048
120.2	1.112	-.223	.066
130.2	1.124	-.217	.059
138.1	1.124	-.182	.047
147.2	1.113	-.151	.074
149.0	1.117	-.146	.077
150.0	1.118	-.168	.087
160.1	1.127	-.140	.091
160.3	1.107	-.163	.090
170.3	1.102	-.177	.099
170.3	1.107	-.171	.096
180.3	1.113	.016	.093
180.4	1.112	.059	.091
200.4	1.097	.103	.093
210.0	1.118	.127	.076
220.4	1.116	.167	.062
230.0	1.117	.188	.049
240.4	1.117	.206	.036
250.4	1.118	.218	.017
260.3	1.120	.274	-.000
270.0	1.105	.276	-.017
280.2	1.112	.213	-.034
290.2	1.094	.208	-.053
300.2	1.107	.175	-.068
310.1	1.095	.144	-.083
320.1	1.105	.136	-.087
327.1	1.111	.178	-.084
331.1	1.171	.116	-.091
332.0	1.171	.176	-.096
333.0	1.098	.170	-.089
334.0	1.077	.168	-.093
335.0	1.091	.167	-.100
336.0	1.014	.155	-.086
338.0	1.021	.159	-.095
338.0	.964	.176	-.093
339.0	.974	.136	-.076
339.0	.966	.139	-.077
340.0	.957	.081	-.050
342.0	.966	.062	-.045
344.0	.968	.071	-.060
346.0	.987	.078	-.071
348.0	.966	.087	-.027
349.0	.968	.086	-.026
357.0	.988	-.086	-.015
358.0	.997	-.086	-.016
359.0	1.053	-.089	-.107

RADIUS = .633

ANGLE	VX/V	VY/V	VZ/V
-.7	.976	-.095	-.071
1.6	.979	-.089	-.066
3.0	.989	-.098	-.066
4.5	.983	-.070	-.064
6.0	.985	-.038	-.067
11.5	.986	-.034	-.069
15.5	.979	-.061	-.077
17.5	.982	-.067	-.083
19.0	.971	-.066	-.086
19.5	.965	-.068	-.086
21.5	.986	-.062	-.091
23.5	.979	-.067	-.101
25.5	.965	-.119	-.120
27.0	1.008	-.134	-.128
29.0	1.046	-.119	-.129
29.5	1.048	-.119	-.128
31.0	1.048	-.107	-.129
33.0	1.072	-.107	-.123
35.0	1.028	-.170	-.117
40.0	1.042	-.146	-.090
50.0	1.050	-.169	-.080
60.0	1.032	-.193	-.058
70.4	1.050	-.208	-.034
80.0	1.042	-.203	-.017
90.3	1.054	-.202	.010
100.0	1.051	-.197	.036
110.2	1.054	-.174	.059
120.2	1.045	-.152	.077
130.0	1.034	-.176	.096
140.1	1.041	-.094	.105
150.0	1.017	-.084	.117
160.0	1.037	-.079	.127
170.4	1.014	.024	.126
180.0	1.022	.062	.123
190.4	1.029	.074	.116
200.4	1.015	.110	.101
210.4	1.013	.140	.087
220.0	1.017	.168	.068
230.4	1.024	.196	.057
238.0	1.031	.189	.049
240.0	1.041	.199	.046
250.0	1.038	.196	.043
260.0	1.071	.197	.036
264.0	1.077	.208	.035
265.0	1.070	.206	.023
266.0	1.037	.219	.007
267.0	1.079	.221	-.011
268.0	1.066	.228	-.017
269.0	1.043	.225	-.030
270.1	1.034	.216	-.063
280.0	1.038	.203	-.084
290.2	1.035	.178	-.106
300.0	1.024	.146	-.121
310.2	1.030	.117	-.136
311.2	1.009	.108	-.151
312.2	.973	.122	-.147
320.2	.967	.077	-.131
330.3	.955	.071	-.129
340.3	.994	.054	-.117
345.3	.997	.054	-.110
347.0	1.017	.064	-.107
349.3	.995	.048	-.098
351.3	.992	.038	-.093
353.3	.974	.026	-.087
355.3	.971	.017	-.083
358.0	.969	-.001	-.074
359.3	.972	-.016	-.071
359.3	.974	-.009	-.071

RADIUS = .761

ANGLE	VX/V	VY/V	VZ/V
0.0	.956	.000	-.006
1.0	.967	.001	-.001
11.0	.978	-.042	-.100
12.0	.991	-.043	-.100
16.0	.982	-.053	-.100
17.0	.996	-.051	-.111
19.0	.998	-.058	-.116
20.0	.996	-.060	-.118
21.0	1.009	-.067	-.133
23.0	1.010	-.074	-.137
25.0	.965	-.066	-.103
26.0	.963	-.115	-.115
29.0	1.010	-.131	-.131
31.0	1.073	-.111	-.129
32.0	1.038	-.105	-.129
40.9	1.016	-.122	-.116
41.1	1.016	-.173	-.119
51.0	1.024	-.166	-.096
60.9	1.018	-.172	-.074
70.0	1.036	-.167	-.066
80.9	1.085	-.204	-.019
91.1	1.021	-.204	.012
100.0	1.035	-.196	.037
111.2	1.024	-.196	.066
120.0	1.074	-.178	.099
121.0	1.020	-.142	.112
131.1	1.014	-.128	.130
141.3	1.035	-.108	.144
151.2	1.014	-.067	.164
171.0	1.532	-.031	.164
181.3	1.031	.001	.169
191.0	1.038	.032	.163
201.0	1.053	.043	.157
211.4	1.075	.096	.148
221.0	1.049	.118	.133
231.4	1.059	.146	.116
241.0	1.044	.158	.099
251.0	1.041	.175	.078
261.3	1.069	.186	.064
271.3	1.064	.194	.024
281.0	1.075	.199	-.000
291.3	1.066	.198	-.029
301.2	1.064	.188	-.054
311.2	1.047	.179	-.083
314.2	1.062	.136	-.100
321.2	1.068	.176	-.106
327.1	1.057	.176	-.112
330.0	.983	.153	-.122
331.0	1.084	.155	-.121
333.1	.966	.112	-.114
335.1	.982	.067	-.115
337.1	1.019	.073	-.132
341.1	1.074	.077	-.133
343.1	1.019	.074	-.132
345.1	1.012	.047	-.124
348.0	.987	.052	-.115
350.0	.983	.049	-.119
352.0	.989	.041	-.117
357.0	.964	.034	-.099
358.0	.966	.010	-.086
361.0	.987	.001	-.091

RADIUS = .963

ANGLE	VX/V	VY/V	VZ/V
0.0	.966	.034	-.179
1.0	.966	.075	-.167
1.3	.956	.036	-.137
3.4	.938	.022	-.132
5.4	.937	.015	-.130
7.0	.924	.007	-.130
11.4	.977	-.010	-.137
11.5	.989	-.025	-.135
13.4	.919	-.037	-.138
15.5	.989	-.044	-.141
17.5	.915	-.059	-.144
21.0	.937	-.095	-.152
23.5	.949	-.064	-.157
25.4	.964	-.090	-.160
27.5	.975	-.144	-.160
29.0	.993	-.171	-.154
31.4	.976	-.138	-.170
31.4	.990	-.127	-.164
33.0	.999	-.105	-.169
33.0	1.004	-.195	-.170
35.0	1.002	-.184	-.164
37.4	1.013	-.189	-.167
39.0	1.012	-.112	-.159
41.0	1.004	-.116	-.151
51.4	1.027	-.162	-.128
61.4	1.024	-.148	-.101
71.0	1.023	-.100	-.075
81.3	1.038	-.107	-.063
91.3	1.034	-.103	-.016
101.2	1.034	-.107	.014
111.2	1.042	-.177	.051
120.0	1.038	-.140	.078
130.0	1.041	-.139	.094
141.0	1.014	-.119	.114
151.0	1.033	-.091	.130
160.9	1.035	-.062	.141
170.4	1.049	-.032	.147
180.0	1.041	-.008	.150
190.0	1.042	.027	.148
200.0	1.039	.058	.142
210.0	1.039	.086	.131
220.0	1.047	.111	.115
230.0	1.034	.135	.098
230.0	1.036	.136	.099
240.7	1.038	.155	.077
250.0	1.046	.169	.051
260.7	1.051	.170	.025
270.4	1.038	.167	-.003
280.4	1.051	.146	-.030
290.0	1.041	.141	-.055
300.7	1.037	.178	-.063
310.0	1.032	.155	-.100
320.0	1.026	.132	-.136
327.0	1.039	.120	-.151
329.0	1.023	.131	.107
330.0	1.038	.129	.027
331.0	1.035	.127	-.154
332.0	.983	.150	-.168
333.0	.958	.112	-.135
337.0	.970	.106	-.130
339.0	.989	.083	-.130
357.1	1.035	.061	-.156
358.1	1.036	.075	-.168
361.0	1.033	.087	-.168
361.1	1.036	.084	-.170
362.0	1.036	.082	-.170
364.1	1.031	.082	-.170
365.1	1.008	.071	-.157
366.0	1.007	.055	-.153
367.1	.989	.047	-.144
368.0	.986	.036	-.135

TABLE D-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 5

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 5
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.089	1.027	1.030	1.023	1.192	1.160	1.123	1.067	1.033	1.029	1.030	1.027	1.023
VTBAR =	-.019	.010	-.002	.003	-.078	-.059	-.038	-.007	.008	.003	-.002	-.001	.003
VRBAR =	.001	-.007	.018	-.009	.039	.027	.013	-.005	-.009	.009	.018	.008	-.009
1-WVX =	1.131	1.081	1.059	1.047	0.000	1.175	1.155	1.118	1.089	1.069	1.058	1.051	1.046
1-WX =	1.186	1.103	1.071	1.055	0.000	1.262	1.221	1.158	1.114	1.086	1.071	1.061	1.054
BBAR =	29.55	20.81	17.24	14.02	43.65	39.06	34.03	26.72	21.97	19.06	16.85	15.02	13.52
BPOS =	4.24	2.31	1.10	.88	8.33	6.90	5.44	3.53	2.58	1.55	1.03	.82	.83
THETA =	107.50	90.00	100.00	110.00	107.50	107.50	107.50	107.50	90.00	100.00	100.00	100.00	110.00
BNEG =	-4.47	-1.76	-1.85	-1.41	-10.43	-8.22	-5.90	-3.58	-2.13	-1.62	-1.85	-1.68	-1.36
THETA =	340.00	337.50	332.50	332.50	12.50	15.00	340.00	340.00	337.50	332.50	332.50	332.50	332.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE D-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 5

VELOCITY COMPONENT RATIOS TO MODEL 5365 CORRELATION WITH R V ATHENA 5
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0421	.0330	.0235	.0200	.0134	.0070	.0016	.0031
PHASE ANGLE =	264.1	265.5	271.1	256.2	260.1	261.7	254.6	99.6
RADIUS = .633								
AMPLITUDE =	.0157	.0241	.0004	.0055	.0058	.0030	.0026	.0049
PHASE ANGLE =	297.7	260.2	258.8	267.6	241.8	231.0	97.7	86.1
RADIUS = .781								
AMPLITUDE =	.0248	.0185	.0079	.0047	.0059	.0004	.0010	.0013
PHASE ANGLE =	213.0	271.4	280.6	294.7	266.2	66.4	151.9	356.2
RADIUS = .963								
AMPLITUDE =	.0293	.0218	.0156	.0088	.0096	.0095	.0058	.0073
PHASE ANGLE =	249.1	250.2	227.7	192.2	196.2	166.5	157.1	161.4

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0076	.0104	.0113	.0092	.0109	.0057	.0040	.0007
PHASE ANGLE =	114.3	93.7	99.0	111.8	103.5	98.3	79.3	213.1
RADIUS = .633								
AMPLITUDE =	.0042	.0018	.0018	.0022	.0027	.0041	.0038	.0067
PHASE ANGLE =	79.1	91.3	100.0	91.9	29.2	280.7	313.0	267.6
RADIUS = .781								
AMPLITUDE =	.0035	.0011	.0019	.0030	.0042	.0040	.0039	.0038
PHASE ANGLE =	165.0	214.2	11.1	303.4	294.3	221.5	316.7	305.9
RADIUS = .963								
AMPLITUDE =	.0035	.0027	.0039	.0027	.0015	.0015	.0032	.0015
PHASE ANGLE =	146.7	159.8	169.2	256.5	259.7	300.2	289.8	232.2

TABLE D-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 5

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 5
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1003	.0429	.0456	.0420	.0271	.0121	.0107	.0047
PHASE ANGLE =	240.1	275.7	279.1	256.3	271.4	281.1	263.2	258.6
RADIUS = .350								
AMPLITUDE =	.0810	.0400	.0388	.0353	.0223	.0106	.0079	.0022
PHASE ANGLE =	244.5	272.9	277.4	258.1	269.1	276.6	262.7	247.4
RADIUS = .400								
AMPLITUDE =	.0599	.0365	.0309	.0275	.0179	.0087	.0047	.0010
PHASE ANGLE =	252.3	269.2	274.7	256.0	265.4	270.0	291.2	133.4
RADIUS = .500								
AMPLITUDE =	.0323	.0305	.0197	.0151	.0106	.0059	.0004	.0043
PHASE ANGLE =	275.6	263.1	267.7	256.8	255.1	254.6	181.8	94.6
RADIUS = .600								
AMPLITUDE =	.0190	.0256	.0111	.0071	.0086	.0036	.0023	.0052
PHASE ANGLE =	297.8	260.1	260.0	262.6	243.6	237.0	97.5	88.4
RADIUS = .700								
AMPLITUDE =	.0157	.0206	.0081	.0051	.0059	.0010	.0012	.0025
PHASE ANGLE =	232.6	267.7	277.8	291.3	264.0	277.6	102.2	48.5
RADIUS = .800								
AMPLITUDE =	.0263	.0183	.0079	.0044	.0058	.0007	.0013	.0010
PHASE ANGLE =	212.8	271.0	277.5	290.9	263.0	107.7	159.1	344.1
RADIUS = .900								
AMPLITUDE =	.0286	.0190	.0104	.0043	.0064	.0048	.0035	.0029
PHASE ANGLE =	226.6	260.9	215.4	270.8	222.4	158.7	161.7	171.5
RADIUS = 1.000								
AMPLITUDE =	.0293	.0218	.0156	.0088	.0036	.0095	.0058	.0073
PHASE ANGLE =	249.1	250.2	2[illegible].7	192.2	196.2	166.5	157.1	161.4

TABLE D-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 5
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0159	.0221	.0252	.0160	.0235	.0237	.0148	.0133
PHASE ANGLE =	148.3	96.6	94.7	116.6	117.9	107.1	97.5	84.4
RADIUS = .350								
AMPLITUDE =	.0130	.0186	.0210	.0141	.0197	.0180	.0115	.0089
PHASE ANGLE =	141.5	95.9	95.6	115.5	115.1	105.9	95.7	86.1
RADIUS = .400								
AMPLITUDE =	.0099	.0144	.0161	.0117	.0153	.0116	.0075	.0040
PHASE ANGLE =	130.2	95.0	97.1	113.9	110.5	103.5	91.3	91.3
RADIUS = .500								
AMPLITUDE =	.0065	.0076	.0062	.0073	.0080	.0021	.0021	.0031
PHASE ANGLE =	101.1	92.6	100.7	109.6	95.5	85.1	49.3	255.3
RADIUS = .600								
AMPLITUDE =	.0048	.0029	.0030	.0034	.0033	.0033	.0031	.0064
PHASE ANGLE =	80.4	90.4	103.2	100.1	56.0	287.1	318.7	265.0
RADIUS = .700								
AMPLITUDE =	.0028	.0005	.0018	.0012	.0028	.0036	.0040	.0051
PHASE ANGLE =	125.8	143.9	37.3	337.3	320.0	243.3	317.1	286.5
RADIUS = .800								
AMPLITUDE =	.0037	.0012	.0017	.0033	.0044	.0039	.0039	.0036
PHASE ANGLE =	168.3	213.2	7.4	300.4	291.5	219.4	315.7	308.9
RADIUS = .900								
AMPLITUDE =	.0039	.0019	.0039	.0034	.0034	.0023	.0035	.0018
PHASE ANGLE =	166.1	185.1	204.4	284.0	280.0	227.1	304.5	302.5
RADIUS = 1.000								
AMPLITUDE =	.0035	.0027	.0039	.0027	.0015	.0015	.0032	.0015
PHASE ANGLE =	146.7	159.8	189.2	258.5	259.7	300.2	289.8	232.2

TABLE D-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 5

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 5
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2469	.0040	[illegible]	[illegible]	.0021	.0008	.0017	.0012
PHASE ANGLE =	178.8	116.1	[illegible]	[illegible]	136.7	87.3	52.0	35.4
RADIUS = .633								
AMPLITUDE =	.2132	.0035	.0029	[illegible]	.0021	.0013	.0017	.0030
PHASE ANGLE =	180.2	189.2	[illegible]	240.5	240.5	272.1	291.8	339.0
RADIUS = .781								
AMPLITUDE =	.1966	.0054	.0021	.0022	.0023	.0013	.0016	.0011
PHASE ANGLE =	177.9	130.5	[illegible]	[illegible]	222.8	157.0	349.7	347.1
RADIUS = .963								
AMPLITUDE =	.1877	.0082	.0025	.0022	.0032	.0036	.0022	.0022
PHASE ANGLE =	176.5	132.5	99.1	124.0	116.6	97.3	87.3	99.7

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0078	.0070	.0081	.0073	.0062	.0036	.0023	.0018
PHASE ANGLE =	16.9	9.4	10.1	18.0	.1	9.7	5.0	304.8
RADIUS = .633								
AMPLITUDE =	.0034	.0035	.0020	.0010	.0005	.0014	.0031	.0031
PHASE ANGLE =	341.2	335.8	338.0	345.3	110.8	154.6	173.7	171.3
RADIUS = .781								
AMPLITUDE =	.0007	.0005	.0007	.0013	.0021	.0027	.0016	.0009
PHASE ANGLE =	348.8	112.4	114.2	157.0	214.6	196.0	179.8	195.8
RADIUS = .963								
AMPLITUDE =	.0019	.0012	.0018	.0019	.0017	.0013	.0011	.0007
PHASE ANGLE =	101.8	156.8	149.7	161.2	186.4	186.6	264.6	294.3

TABLE D-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 5

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 5
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2862	.0148	.0011	.0060	.0075	.0060	.0077	.0093
PHASE ANGLE =	175.4	86.7	207.8	147.4	113.6	101.1	70.7	72.2
RADIUS = .350								
AMPLITUDE =	.2747	.0112	.0014	.0051	.0057	.0043	.0053	.0076
PHASE ANGLE =	176.4	89.8	231.9	186.7	115.9	99.9	69.3	65.7
RADIUS = .400								
AMPLITUDE =	.2608	.0072	.0029	.0043	.0038	.0024	.0036	.0057
PHASE ANGLE =	177.6	97.1	247.5	171.0	121.4	97.1	65.5	53.9
RADIUS = .500								
AMPLITUDE =	.2371	.0028	.0027	.0034	.0013	.0003	.0008	.0036
PHASE ANGLE =	179.5	145.9	260.8	203.0	167.7	319.0	9.3	18.0
RADIUS = .600								
AMPLITUDE =	.2183	.0033	.0030	.0031	.0018	.0013	.0015	.0031
PHASE ANGLE =	180.3	190.2	268.4	231.8	235.9	277.5	292.3	345.4
RADIUS = .700								
AMPLITUDE =	.2046	.0038	.0028	.0027	.0025	.0009	.0017	.0021
PHASE ANGLE =	179.1	150.1	279.6	269.9	235.4	218.6	320.4	337.0
RADIUS = .800								
AMPLITUDE =	.1951	.0058	.0018	.0020	.0022	.0014	.0016	.0009
PHASE ANGLE =	177.7	128.8	290.6	294.5	217.6	147.5	357.3	355.9
RADIUS = .900								
AMPLITUDE =	.1894	.0075	.0006	.0001	.0018	.0026	.0016	.0012
PHASE ANGLE =	176.8	128.2	70.3	28.0	154.8	112.3	52.2	88.4
RADIUS = 1.000								
AMPLITUDE =	.1877	.0082	.0025	.0022	.0032	.0036	.0022	.0022
PHASE ANGLE =	176.5	132.5	99.1	124.0	116.6	97.3	87.3	99.7

TABLE D-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R V ATHENA 5
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0108	.0119	.0170	.0170	.0153	.0101	.0124	.0111
PHASE ANGLE =	[illegible]	36.4	[illegible]	[illegible]	351.0	356.1	358.4	351.1
RADIUS = .350								
AMPLITUDE =	.0125	.0163	[illegible]	[illegible]	.0126	.0081	.0041	.0081
PHASE ANGLE =	31.8	30.1	[illegible]	[illegible]	352.7	356.4	358.9	324.2
RADIUS = .400								
AMPLITUDE =	.0101	.0045	[illegible]	.0110	[illegible]	.0008	.0019	.0017
PHASE ANGLE =	[illegible]	26.8	[illegible]	[illegible]	[illegible]	2.4	[illegible]	324.3
RADIUS = .500								
AMPLITUDE =	[illegible]	.0060	[illegible]	[illegible]	.0042	.0022	.0013	.0010
PHASE ANGLE =	[illegible]	[illegible]	[illegible]	15.3	5.3	20.9	53.0	226.8
RADIUS = .600								
AMPLITUDE =	.0042	.0041	[illegible]	.0018	.0023	.0010	.0027	.0028
PHASE ANGLE =	[illegible]	340.9	[illegible]	1.2	43.4	131.0	172.4	173.4
RADIUS = .700								
AMPLITUDE =	.0025	.0014	[illegible]	[illegible]	.0012	.0021	.0024	.0019
PHASE ANGLE =	[illegible]	244.2	[illegible]	[illegible]	207.5	185.6	173.9	176.8
RADIUS = .800								
AMPLITUDE =	.0009	.0007	[illegible]	.0015	.0022	.0027	.0014	.0007
PHASE ANGLE =	[illegible]	128.7	[illegible]	143.4	214.3	197.1	183.0	205.5
RADIUS = .900								
AMPLITUDE =	.0011	.0014	.0016	[illegible]	.0022	.0022	.0009	.0006
PHASE ANGLE =	103.0	148.1	142.3	[illegible]	205.3	196.9	227.9	280.1
RADIUS = 1.000								
AMPLITUDE =	.0014	.0012	.0018	.0014	.0017	.0013	.0011	.0007
PHASE ANGLE =	151.6	156.8	149.7	161.2	186.4	186.6	264.6	294.3

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX E

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 6

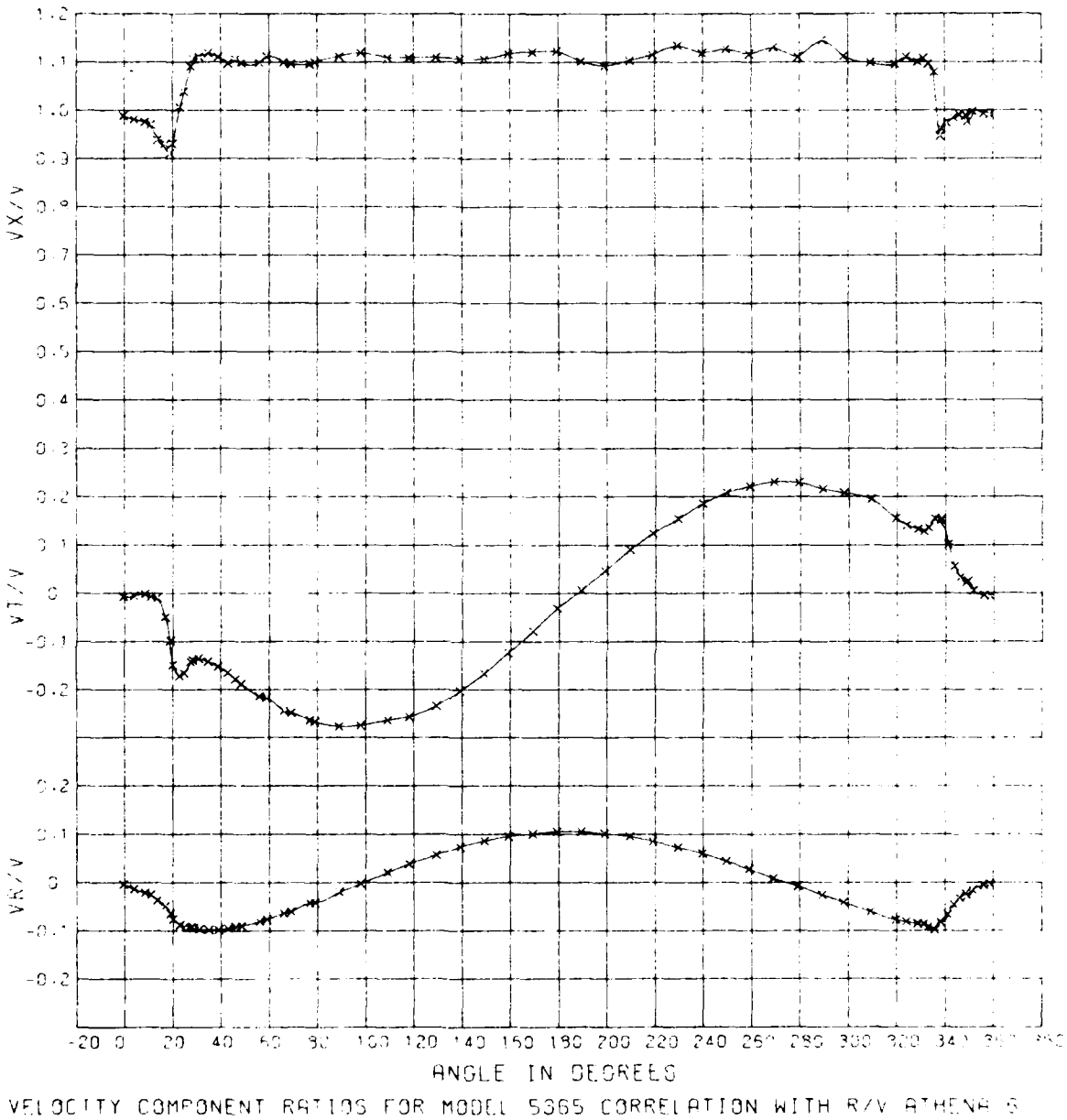


Figure E-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 6

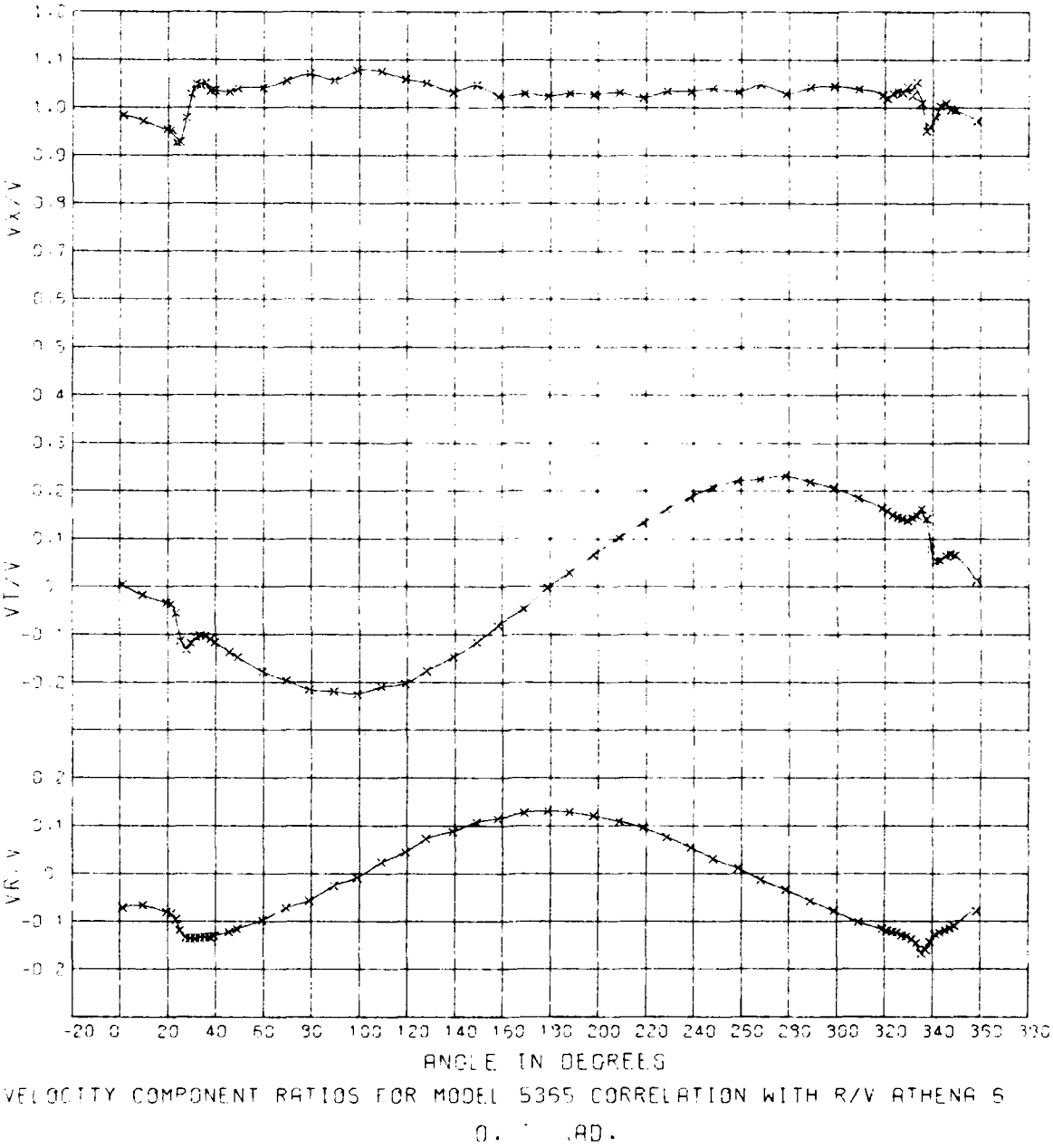


Figure E-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 6

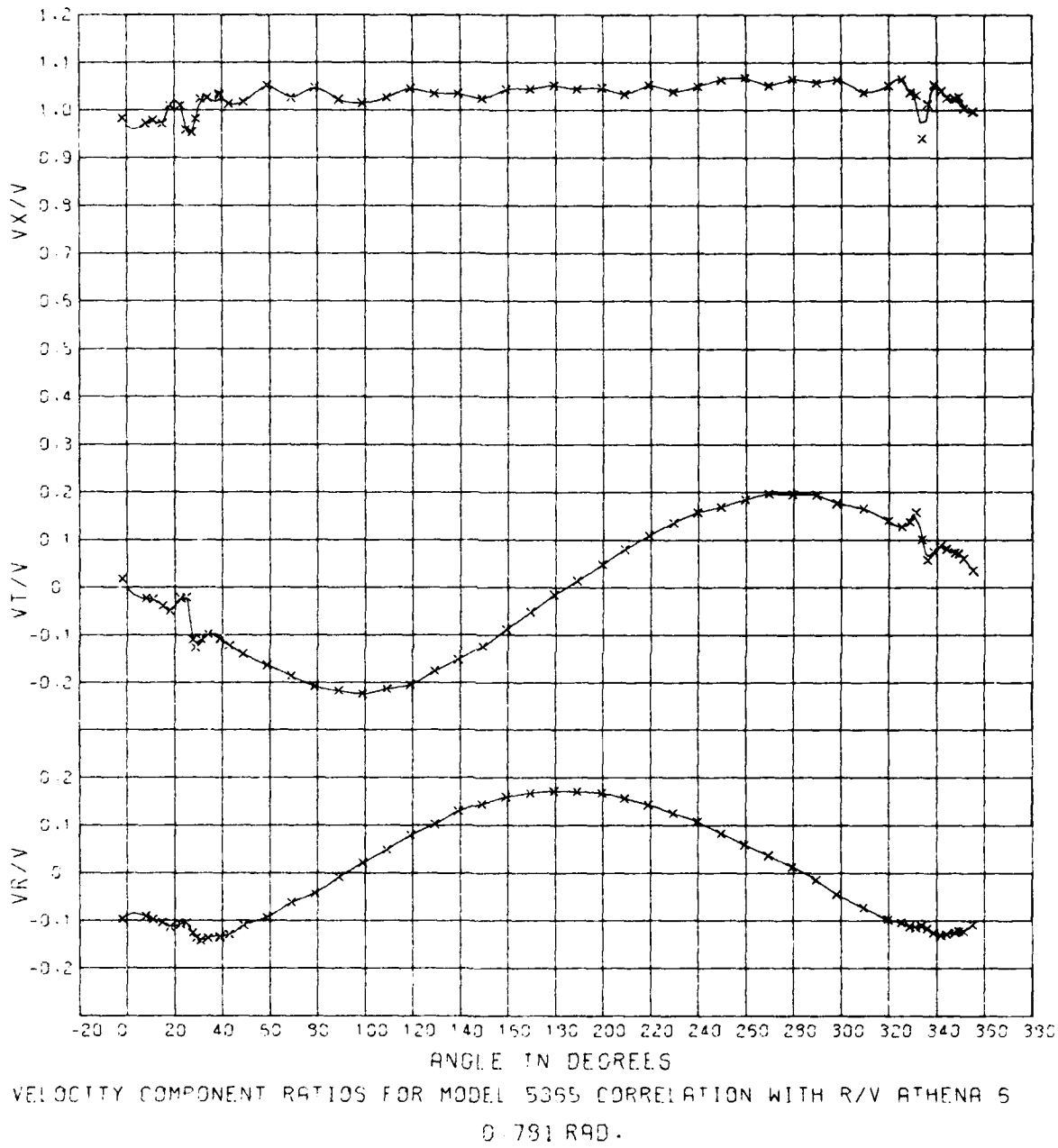


Figure E-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 6

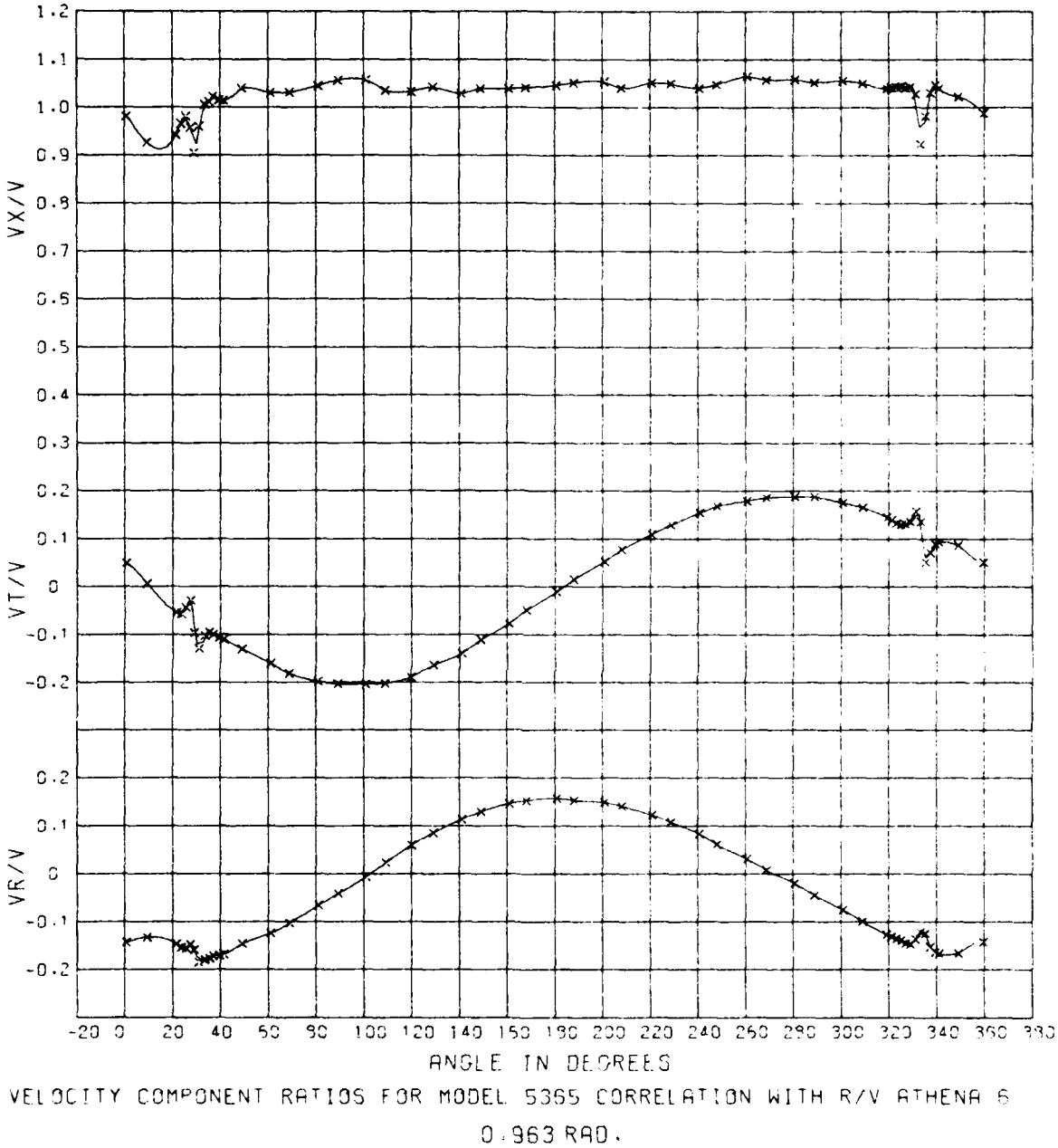


Figure E-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 6

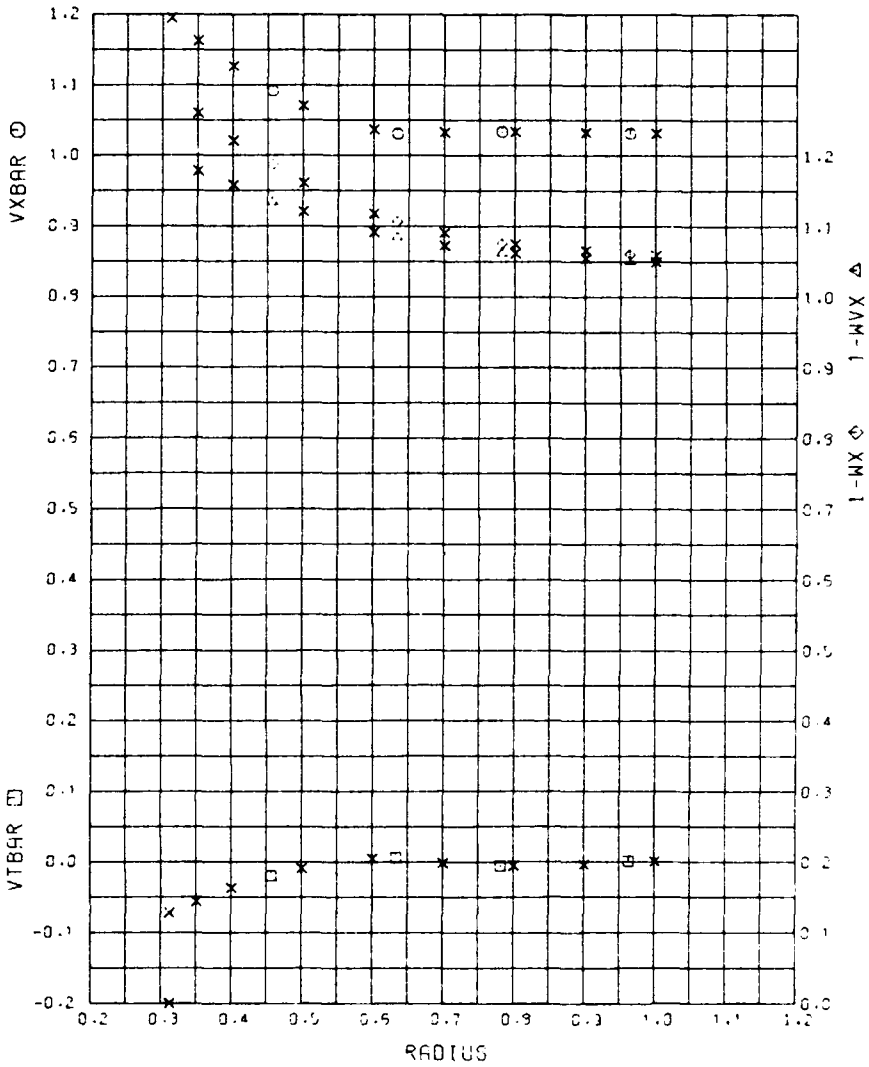


Figure E-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 6

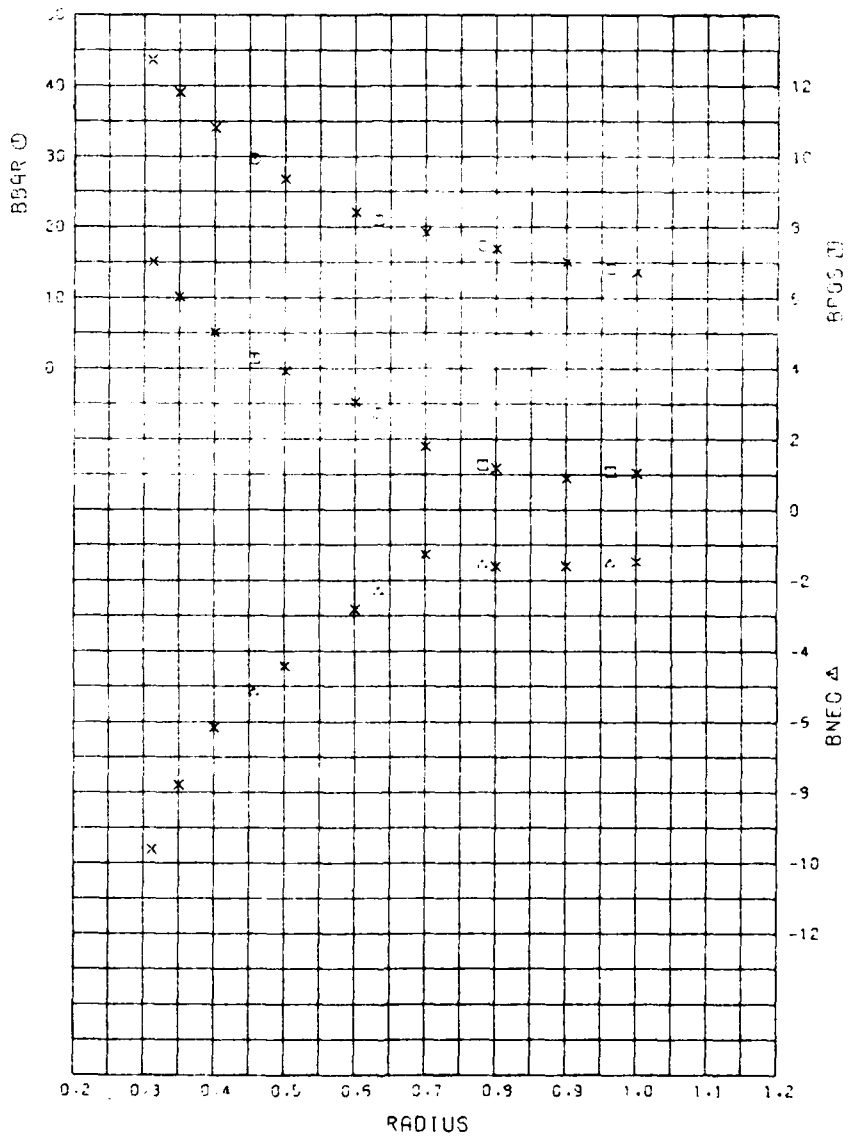


Figure E-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 6

TABLE E-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 6

RADIUS = .656

ANGLE	VX/V	VT/V	VR/V
-1.0	.995	-.011	-.006
0.0	.993	-.006	-.005
4.0	.991	-.005	-.014
8.0	.978	-.007	-.025
9.0	.973	-.002	-.019
11.0	.978	-.008	-.025
13.0	.961	-.006	-.015
14.0	.955	-.017	-.040
15.9	.930	-.050	-.049
18.9	.907	-.091	-.064
19.0	.914	-.105	-.064
20.0	.931	-.150	-.074
22.9	1.067	-.171	-.049
24.0	1.039	-.166	-.093
26.9	1.042	-.165	-.092
28.0	1.100	-.140	-.095
28.0	1.109	-.139	-.096
28.9	1.106	-.161	-.095
30.9	1.110	-.136	-.097
34.0	1.119	-.142	-.098
34.9	1.110	-.153	-.098
42.9	1.097	-.166	-.096
46.0	1.105	-.179	-.092
48.0	1.095	-.190	-.090
49.0	1.101	-.197	-.090
50.0	1.098	-.215	-.081
55.9	1.112	-.217	-.077
56.0	1.099	-.245	-.066
59.0	1.096	-.249	-.061
64.9	1.096	-.263	-.047
70.4	1.107	-.265	-.042
70.0	1.097	-.269	-.047
80.0	1.112	-.277	-.020
90.0	1.119	-.275	-.033
109.1	1.109	-.256	.021
109.1	1.109	-.272	.019
110.0	1.109	-.257	.039
120.2	1.119	-.234	.057
119.2	1.104	-.207	.074
129.2	1.101	-.168	.087
129.2	1.112	-.165	.086
139.1	1.117	-.133	.095
139.0	1.119	-.077	.090
139.1	1.123	-.079	.101
139.1	1.121	-.031	.105
139.1	1.101	.005	.105
139.0	1.092	.047	.101
239.4	1.103	.090	.096
249.0	1.115	.124	.085
249.4	1.134	.156	.073
259.4	1.119	.186	.060
269.4	1.177	.209	.046
269.0	1.116	.221	.027
269.0	1.130	.230	.019
279.1	1.110	.229	-.000
289.2	1.146	.215	-.026
289.0	1.112	.208	-.062
309.2	1.099	.195	-.067
319.1	1.089	.158	-.076
320.0	1.103	.154	-.079
329.0	1.111	.141	-.082
329.0	1.097	.134	-.088
339.1	1.103	.132	-.086
339.1	1.108	.126	-.087
339.1	1.108	.119	-.087
339.0	1.096	.134	-.092
339.0	1.093	.149	-.090
339.0	1.086	.148	-.089
339.0	.968	.153	-.085
339.0	.967	.149	-.080
339.0	.957	.159	-.088
339.0	.966	.168	-.086
341.0	.971	.121	-.068
343.0	.971	.087	-.063
344.0	.997	.044	-.048
346.0	.990	.033	-.032
348.0	.997	.074	-.021
349.0	.987	.021	-.023
349.1	.976	.075	-.028
350.7	1.006	.008	-.019
352.0	.989	.002	-.013
354.0	.993	-.005	-.004
354.0	.993	-.011	-.006
354.0	.986	-.011	-.003
354.0	.995	-.011	-.006
360.0	.993	-.006	-.005

RADIUS = .638

ANGLE	VX/V	VT/V	VR/V
1.1	.993	.003	-.073
9.5	.971	-.018	-.067
10.6	.954	-.036	-.081
21.4	.960	-.039	-.083
21.5	.965	-.035	-.085
21.5	.976	-.057	-.097
25.0	.978	-.114	-.120
27.5	.978	-.131	-.136
29.4	1.040	-.118	-.136
29.5	1.016	-.120	-.139
31.5	1.049	-.106	-.137
33.5	1.045	-.103	-.136
39.5	1.051	-.105	-.136
37.5	1.036	-.118	-.137
38.4	1.076	-.120	-.133
38.5	1.044	-.114	-.129
45.5	1.032	-.137	-.123
49.0	1.040	-.144	-.116
50.5	1.061	-.179	-.098
60.4	1.056	-.196	-.072
70.0	1.071	-.216	-.057
80.3	1.056	-.219	-.025
90.0	1.078	-.226	-.009
100.2	1.075	-.209	.026
110.2	1.059	-.203	.065
120.0	1.051	-.176	.073
119.1	1.037	-.148	.088
129.0	1.044	-.116	.107
130.0	1.072	-.081	.114
139.0	1.079	-.047	.127
139.9	1.073	-.003	.131
140.0	1.078	.029	.128
149.0	1.077	.057	.121
150.0	1.031	.102	.109
159.7	1.020	.133	.094
159.8	1.034	.162	.076
159.7	1.033	.187	.055
160.0	1.041	.207	.031
169.6	1.032	.221	.011
169.0	1.044	.224	-.017
179.6	1.079	.231	-.036
180.9	1.062	.219	-.059
189.7	1.045	.206	-.078
189.8	1.034	.195	-.102
189.8	1.021	.165	-.117
199.7	1.030	.152	-.115
201.0	1.018	.150	-.120
209.7	1.029	.150	-.123
209.3	1.033	.145	-.126
209.0	1.022	.142	-.133
209.3	1.041	.142	-.128
209.3	1.037	.140	-.132
209.3	1.047	.136	-.137
219.3	1.025	.144	-.139
219.3	1.053	.150	-.145
219.3	1.051	.148	-.147
219.3	1.010	.143	-.148
219.3	.957	.142	-.150
219.0	.959	.078	-.144
219.0	.980	.053	-.129
219.0	1.003	.055	-.126
219.4	1.010	.045	-.119
219.4	.996	.046	-.115
219.4	.995	.065	-.109
219.4	.992	.066	-.113
219.0	.971	.014	-.079
219.0	.969	.009	-.081

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
-2.0	.983	.018	-.098
4.0	.971	-.022	-.091
10.9	.979	-.024	-.098
14.9	.971	-.039	-.104
18.0	1.027	-.049	-.116
18.0	.993	-.051	-.116
22.0	1.008	-.076	-.108
22.9	1.012	-.072	-.107
24.9	.959	-.021	-.105
25.9	.918	-.091	-.171
28.0	.996	-.129	-.133
28.9	.982	-.127	-.138
28.9	1.024	-.189	-.143
30.9	1.024	-.098	-.138
30.9	1.034	-.106	-.133
30.9	1.079	-.107	-.140
30.9	1.038	-.109	-.136
42.9	1.013	-.122	-.130
49.0	1.017	-.148	-.118
50.9	1.052	-.154	-.096
59.0	1.025	-.187	-.062
59.8	1.064	-.208	-.043
69.0	1.071	-.218	-.008
70.9	1.014	-.229	.021
79.9	1.024	-.214	.049
79.9	1.045	-.205	.079
79.2	1.034	-.176	.103
89.9	1.035	-.152	.130
89.2	1.023	-.124	.144
99.9	1.043	-.098	.150
99.3	1.044	-.052	.167
109.0	1.051	-.016	.171
109.3	1.044	.014	.178
109.4	1.047	.049	.168
109.8	1.032	.081	.156
119.8	1.057	.109	.143
119.9	1.039	.137	.125
119.9	1.049	.158	.107
129.9	1.058	.182	.088
129.9	1.065	.196	.068
129.9	1.068	.185	.048
129.9	1.051	.196	.036
139.9	1.065	.196	.017
139.9	1.056	.193	-.015
139.9	1.059	.195	-.014
139.9	1.046	.177	-.045
139.9	1.037	.166	-.073
139.9	1.058	.161	-.095
139.9	1.051	.139	-.108
139.9	1.065	.124	-.104
139.9	1.035	.136	-.114
139.9	1.040	.138	-.112
139.9	1.031	.158	-.115
139.9	.930	.143	-.112
139.9	.958	.058	-.111
139.9	1.012	.057	-.116
139.9	1.052	.076	-.125
139.9	1.056	.076	-.127
139.9	1.044	.087	-.131
139.9	1.037	.089	-.132
139.9	1.076	.091	-.129
139.9	1.033	.078	-.124
139.9	1.015	.068	-.126
139.9	1.077	.071	-.127
139.9	1.083	.061	-.123
139.9	.997	.036	-.108
139.9	.983	.018	-.098

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
0.0	.986	.047	-.139
1.3	.974	.051	-.144
4.4	.974	.056	-.134
21.5	.961	-.054	-.147
23.5	.965	-.057	-.154
25.5	.983	-.063	-.154
27.5	.957	-.079	-.168
29.0	.984	-.087	-.159
29.0	.984	-.097	-.168
31.0	.948	-.129	-.185
33.5	1.006	-.187	-.180
35.4	1.011	-.096	-.178
37.0	1.022	-.108	-.173
39.5	1.015	-.106	-.171
41.4	1.017	-.118	-.168
49.0	1.040	-.131	-.147
51.0	1.079	-.161	-.125
59.0	1.031	-.182	-.103
61.0	1.063	-.187	-.084
61.0	1.046	-.199	-.064
69.5	1.056	-.203	-.042
101.0	1.057	-.205	-.007
109.2	1.035	-.202	.023
120.0	1.033	-.190	.060
129.1	1.062	-.166	.085
141.0	1.028	-.140	.111
149.0	1.038	-.111	.129
150.9	1.038	-.078	.146
159.0	1.040	-.049	.157
160.9	1.046	-.011	.157
169.0	1.047	.015	.156
169.0	1.056	.016	.152
180.7	1.054	.053	.149
189.0	1.039	.074	.141
189.6	1.052	.109	.123
189.7	1.049	.129	.108
199.0	1.063	.155	.084
199.0	1.067	.168	.061
199.6	1.065	.179	.031
199.9	1.057	.186	.008
199.9	1.058	.188	-.020
199.9	1.051	.188	-.045
199.7	1.056	.176	-.075
209.0	1.050	.166	-.099
219.2	1.048	.164	-.127
221.2	1.041	.140	-.132
223.2	1.043	.133	-.134
225.2	1.044	.130	-.139
227.0	1.046	.129	-.144
229.0	1.042	.135	-.148
231.3	1.027	.148	-.137
233.3	.923	.137	-.171
235.3	.982	.067	-.175
237.3	1.031	.071	-.159
239.4	1.047	.098	-.144
240.9	1.037	.092	-.149
241.0	1.041	.093	-.165
249.1	1.072	.086	-.167
250.1	.989	.055	-.167
250.9	.986	.047	-.139
251.7	.979	.051	-.144

TABLE E-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 6

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 6
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.092	1.031	1.034	1.032	1.195	1.163	1.127	1.071	1.037	1.033	1.034	1.033	1.032
VTBAR =	-.020	.006	-.005	.001	-.072	-.056	-.037	-.009	.005	-.001	-.005	-.004	.001
VRBAR =	.005	-.009	.017	-.010	.055	.039	.021	-.003	-.010	.008	.017	.007	-.010
1-WVX =	1.134	1.085	1.062	1.051	0.000	1.178	1.158	1.121	1.092	1.073	1.062	1.055	1.050
1-WX =	1.187	1.107	1.076	1.061	0.000	1.260	1.221	1.161	1.118	1.091	1.075	1.066	1.059
BBAR =	29.65	20.91	17.31	14.14	43.61	39.07	34.10	2[illegible].82	22.08	19.14	16.93	15.12	13.64
BPOS =	4.28	2.71	1.27	1.10	7.01	6.03	5.02	3.92	3.05	1.79	1.18	.90	1.04
THETA =	97.50	100.00	80.00	95.00	90.00	90.00	90.00	100.00	100.00	80.00	80.00	90.00	95.00
BNEG =	-5.17	-2.32	-1.56	-1.52	-9.11	-7.79	-6.17	-3.42	-2.82	-1.28	-1.60	-1.59	-1.47
THETA =	337.50	337.50	352.50	15.00	340.00	340.00	337.50	337.50	337.50	335.00	332.50	332.50	15.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETPIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE E-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 6

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 6
PROPELLER DIAMETER 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0398	.0362	[illegible]	[illegible]	.0135	.0105	.0043	.0062
PHASE ANGLE =	[illegible]	267.7	[illegible]	[illegible]	272.2	205.9	229.4	109.7
RADIUS = .633								
AMPLITUDE =	.0140	.0281	[illegible]	.0053	.0058	.0033	.0041	.0025
PHASE ANGLE =	300.3	257.6	[illegible]	[illegible]	242.1	176.0	135.1	121.4
RADIUS = .781								
AMPLITUDE =	[illegible]	.0153	[illegible]	[illegible]	.0054	.0020	.0034	.0048
PHASE ANGLE =	[illegible]	255.7	[illegible]	[illegible]	[illegible]	96.3	272.3	210.3
RADIUS = .963								
AMPLITUDE =	[illegible]	.0238	.0179	[illegible]	.0091	.0080	.0097	.0079
PHASE ANGLE =	[illegible]	250.4	[illegible]	[illegible]	[illegible]	179.9	146.8	124.9

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 6
PROPELLER DIAMETER 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	[illegible]	.0115	[illegible]	[illegible]	.0041	.0025	.0021	.0018
PHASE ANGLE =	[illegible]	94.6	[illegible]	[illegible]	68.6	38.2	319.7	209.5
RADIUS = .633								
AMPLITUDE =	[illegible]	.0059	[illegible]	[illegible]	.0010	.0011	.0007	.0010
PHASE ANGLE =	[illegible]	68.3	[illegible]	[illegible]	301.5	244.5	308.5	258.7
RADIUS = .781								
AMPLITUDE =	.0002	.0004	[illegible]	[illegible]	.0015	.0050	.0054	.0031
PHASE ANGLE =	[illegible]	167.2	[illegible]	[illegible]	208.0	272.9	279.1	272.3
RADIUS = .963								
AMPLITUDE =	[illegible]	.0018	.0049	[illegible]	.0014	.0016	.0018	.0013
PHASE ANGLE =	[illegible]	191.0	151.2	[illegible]	216.4	176.9	325.2	319.0

TABLE E-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 6

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 6
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0951	.0389	.0558	.0363	.0254	.0196	.0208	.0098
PHASE ANGLE =	234.9	282.1	295.9	254.4	277.1	213.1	274.9	129.2
RADIUS = .350								
AMPLITUDE =	.0766	.0383	.0454	.0304	.0221	.0170	.0150	.0087
PHASE ANGLE =	239.4	277.7	292.4	255.6	276.5	211.7	270.9	123.6
RADIUS = .400								
AMPLITUDE =	.0564	.0375	.0358	.0237	.0177	.0137	.0089	.0075
PHASE ANGLE =	247.6	272.6	290.0	257.2	275.0	209.4	260.7	116.5
RADIUS = .500								
AMPLITUDE =	.0410	.0348	.0163	.0131	.0108	.0083	.0035	.0053
PHASE ANGLE =	273.5	264.5	263.6	260.3	268.4	202.1	181.1	106.0
RADIUS = .600								
AMPLITUDE =	.0305	.0302	.0125	.0066	.0065	.0043	.0051	.0031
PHASE ANGLE =	298.7	258.9	244.6	258.0	251.0	186.0	137.5	110.1
RADIUS = .700								
AMPLITUDE =	.0196	.0202	.0106	.0057	.0058	.0016	.0014	.0031
PHASE ANGLE =	292.5	257.4	253.9	232.5	226.2	121.8	240.0	203.8
RADIUS = .800								
AMPLITUDE =	.0229	.0150	.0119	.0068	.0066	.0020	.0034	.0049
PHASE ANGLE =	250.0	255.0	264.3	211.6	210.9	102.2	208.8	207.2
RADIUS = .900								
AMPLITUDE =	.0261	.0179	.0142	.0077	.0080	.0040	.0037	.0051
PHASE ANGLE =	210.3	251.5	246.9	197.3	195.7	162.5	177.4	161.6
RADIUS = 1.000								
AMPLITUDE =	.0265	.0238	.0179	.0081	.0091	.0080	.0097	.0079
PHASE ANGLE =	244.6	250.4	229.9	189.6	195.2	179.9	146.8	124.9

TABLE E-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 6
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0086	.0182	.0295	.0159	.0112	.0052	.0015	.0056
PHASE ANGLE =	36.7	117.6	131.7	113.7	80.4	22.1	230.7	62.3
RADIUS = .350								
AMPLITUDE =	.0075	.0161	.0239	.0138	.0090	.0044	.0011	.0033
PHASE ANGLE =	50.2	111.9	125.5	108.7	78.4	26.9	263.8	57.9
RADIUS = .400								
AMPLITUDE =	.0067	.0137	.0178	.0114	.0065	.0035	.0014	.0009
PHASE ANGLE =	68.7	103.9	114.9	101.5	74.9	33.0	304.6	24.1
RADIUS = .500								
AMPLITUDE =	.0064	.0100	.0132	.0075	[illegible]	.0018	.0025	.0032
PHASE ANGLE =	97.5	87.3	83.8	[illegible]	54.7	39.5	321.7	261.1
RADIUS = .600								
AMPLITUDE =	.0057	.0069	[illegible]	[illegible]	.0008	.0006	.0034	.0049
PHASE ANGLE =	112.8	72.3	50.6	71.7	337.3	320.7	313.6	258.3
RADIUS = .700								
AMPLITUDE =	.0020	.0026	.0008	[illegible]	.0011	.0038	.0048	.0041
PHASE ANGLE =	166.2	71.5	171.8	[illegible]	260.3	[illegible]	287.0	263.9
RADIUS = .800								
AMPLITUDE =	.0003	.0007	.0053	.0012	.0016	.0050	.0053	.0028
PHASE ANGLE =	319.4	202.0	202.4	[illegible]	234.9	271.8	278.6	274.8
RADIUS = .900								
AMPLITUDE =	.0011	.0018	.0056	[illegible]	[illegible]	.0030	.0036	.0018
PHASE ANGLE =	175.5	212.0	185.0	[illegible]	[illegible]	[illegible]	265.9	294.7
RADIUS = 1.000								
AMPLITUDE =	.0033	.0018	.0049	.0018	.0014	.0016	.0018	.0013
PHASE ANGLE =	153.7	191.0	151.2	229.5	216.4	176.9	325.2	319.0

TABLE E-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 6

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R V ATHENA 6
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2533	.0034	.0047	.0029	.0023	.0008	.0036	.0042
PHASE ANGLE =	170.7	99.8	253.9	177.6	236.1	112.0	29.8	9.3
RADIUS = .633								
AMPLITUDE =	.2234	.0029	.0028	.0021	.0016	.0009	.0013	.0030
PHASE ANGLE =	176.9	105.4	234.2	267.5	222.8	306.2	330.4	347.1
RADIUS = .781								
AMPLITUDE =	.2061	.0065	.0044	.0025	.0014	.0012	.0023	.0007
PHASE ANGLE =	174.6	78.0	241.2	225.3	183.7	233.1	287.9	272.7
RADIUS = .963								
AMPLITUDE =	.1972	.0107	.0006	.0028	.0027	.0027	.0026	.0021
PHASE ANGLE =	173.1	96.2	128.6	132.3	99.6	101.4	97.9	74.5

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R V ATHENA 6
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0060	.0072	.0094	.0082	.0061	.0042	.0022	.0017
PHASE ANGLE =	355.4	356.8	348.8	352.3	349.9	341.4	305.8	233.0
RADIUS = .633								
AMPLITUDE =	.0029	.0024	.0026	.0015	.0013	.0023	.0040	.0043
PHASE ANGLE =	353.3	351.8	327.9	312.1	204.6	180.9	143.9	168.3
RADIUS = .781								
AMPLITUDE =	.0014	.0022	.0017	.0029	.0032	.0025	.0031	.0024
PHASE ANGLE =	252.3	221.2	216.8	205.0	203.4	194.5	193.2	184.5
RADIUS = .963								
AMPLITUDE =	.0015	.0010	.0013	.0012	.0016	.0014	.0005	.0006
PHASE ANGLE =	49.0	139.2	151.2	151.7	173.0	161.7	166.3	240.4

TABLE E-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 6

VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R V ATHENA 6
PROPELLER DIAMETER = 6.00 FEET JA = .7[illegible]

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2846	.0080	.0076	[illegible]	.0033	.0042	.007	.0044
PHASE ANGLE =	152.6	77.3	[illegible]	[illegible]	233.9	134.5	36.3	39.8
RADIUS = .3[illegible]								
AMPLITUDE =	.2757	.0064	.0063	[illegible]	.0026	.0031	.0012	.0043
PHASE ANGLE =	173.6	81.4	219.5	[illegible]	238.1	131.0	35.5	30.1
RADIUS = .400								
AMPLITUDE =	.2647	.0047	[illegible]	[illegible]	[illegible]	.0013	[illegible]	.0043
PHASE ANGLE =	174.7	88.8	[illegible]	[illegible]	[illegible]	125.8	33.7	19.1
RADIUS = .500								
AMPLITUDE =	.2451	.0029	[illegible]	.0025	[illegible]	.0003	.0027	.0040
PHASE ANGLE =	176.3	106.3	[illegible]	[illegible]	245.1	60.9	24.2	2.9
RADIUS = .600								
AMPLITUDE =	[illegible]	.0025	[illegible]	[illegible]	[illegible]	[illegible]	.0014	.0033
PHASE ANGLE =	177.0	111.1	[illegible]	[illegible]	227.6	315.3	[illegible]	351.0
RADIUS = .700								
AMPLITUDE =	.1138	.0045	[illegible]	[illegible]	.0016	.0012	[illegible]	.0015
PHASE ANGLE =	175.8	81.5	258.4	294.6	[illegible]	[illegible]	297.3	323.7
RADIUS = .800								
AMPLITUDE =	[illegible]	.0070	[illegible]	[illegible]	[illegible]	[illegible]	.0021	.0005
PHASE ANGLE =	[illegible]	78.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	250.5
RADIUS = .900								
AMPLITUDE =	[illegible]	.0092	[illegible]	[illegible]	[illegible]	.0012	[illegible]	.0008
PHASE ANGLE =	173.4	87.8	[illegible]	174.6	121.1	130.9	[illegible]	49.7
RADIUS = 1.000								
AMPLITUDE =	.1072	.0107	.0006	[illegible]	[illegible]	.0027	[illegible]	.0021
PHASE ANGLE =	173.1	96.2	[illegible]	[illegible]	[illegible]	101.4	[illegible]	74.5

TABLE E-6 (Continued)

VELOCITY COMPONENT RATIOS FOR [illegible] CORRELATION WITH R [illegible] ATHENA 6
PROPELLER DIAMETER = [illegible].00 FEET JA = [illegible]

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS [illegible]

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	[illegible]	.0113	[illegible]	[illegible]	[illegible]	.0146	[illegible]	.0085
PHASE ANGLE =	[illegible]	351.9	[illegible]	[illegible]	[illegible]	344.1	[illegible]	314.9
RADIUS = [illegible]								
AMPLITUDE =	[illegible]	.0102	[illegible]	[illegible]	[illegible]	.0114	[illegible]	.0069
PHASE ANGLE =	[illegible]	353.4	[illegible]	[illegible]	[illegible]	344.0	[illegible]	[illegible]
RADIUS = .400								
AMPLITUDE =	.0069	.0088	[illegible]	[illegible]	[illegible]	.0077	[illegible]	[illegible]
PHASE ANGLE =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	343.4	[illegible]	[illegible]
RADIUS = [illegible]								
AMPLITUDE =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PHASE ANGLE =	[illegible]	357.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
RADIUS = [illegible]								
AMPLITUDE =	[illegible]	.0033	[illegible]	[illegible]	[illegible]	.0017	[illegible]	.0042
PHASE ANGLE =	[illegible]	355.9	[illegible]	[illegible]	245.4	[illegible]	[illegible]	169.6
RADIUS = [illegible]								
AMPLITUDE =	[illegible]	.0012	[illegible]	[illegible]	.0025	.0025	[illegible]	.0034
PHASE ANGLE =	307.0	[illegible]	[illegible]	[illegible]	205.3	[illegible]	[illegible]	174.9
RADIUS = [illegible]								
AMPLITUDE =	[illegible]	.0024	.0018	[illegible]	.0032	.0024	[illegible]	.0022
PHASE ANGLE =	[illegible]	217.2	211.2	[illegible]	[illegible]	[illegible]	[illegible]	187.1
RADIUS = [illegible]								
AMPLITUDE =	.0003	.0019	[illegible]	[illegible]	[illegible]	.0019	[illegible]	.0011
PHASE ANGLE =	227.2	196.3	[illegible]	187.2	[illegible]	184.8	[illegible]	207.1
RADIUS = 1.000								
AMPLITUDE =	[illegible]	.0010	.0013	.0012	[illegible]	.0014	[illegible]	.0006
PHASE ANGLE =	[illegible]	139.2	151.2	151.7	[illegible]	161.7	[illegible]	240.4

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX F

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 8

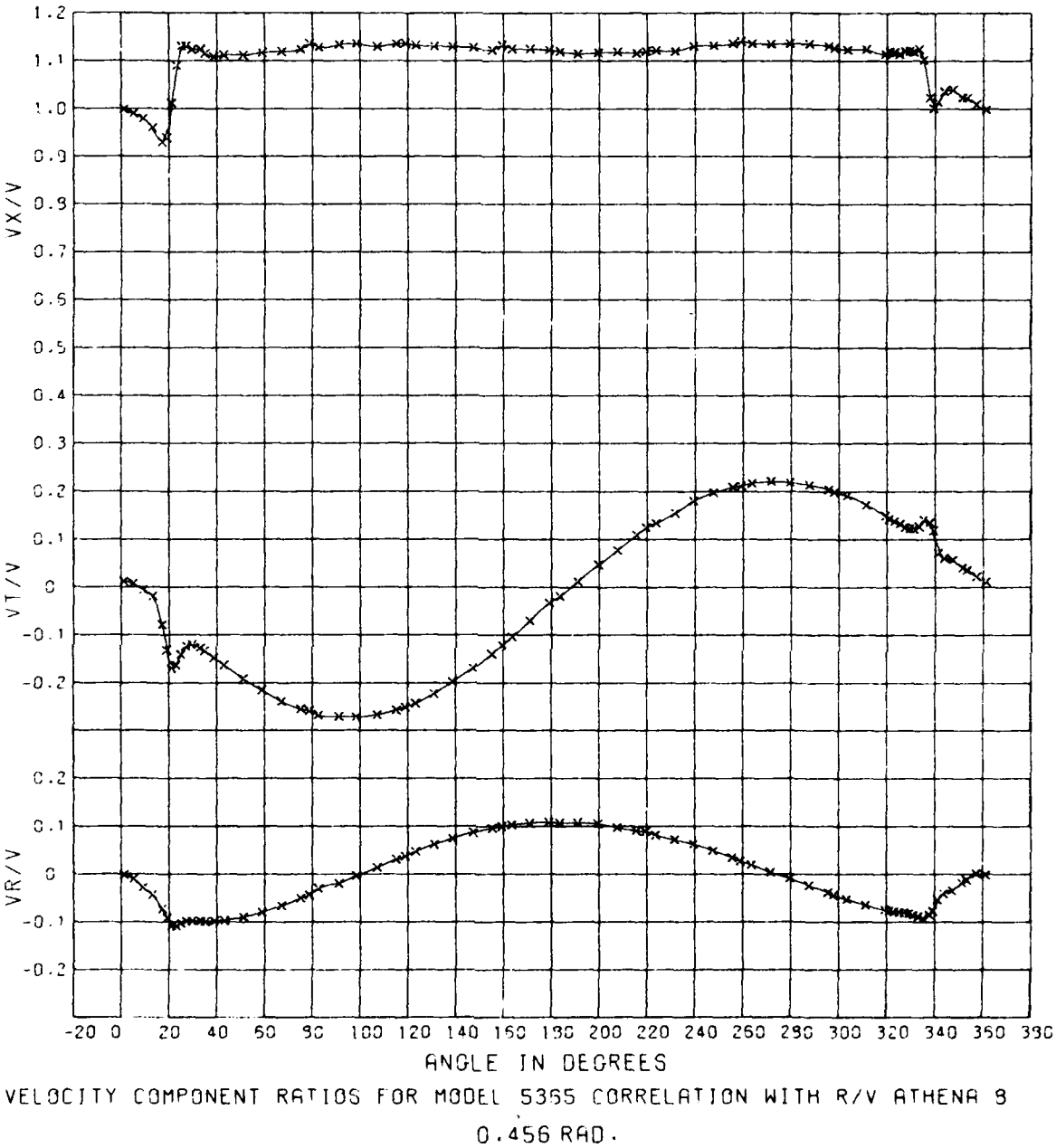


Figure F-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 8

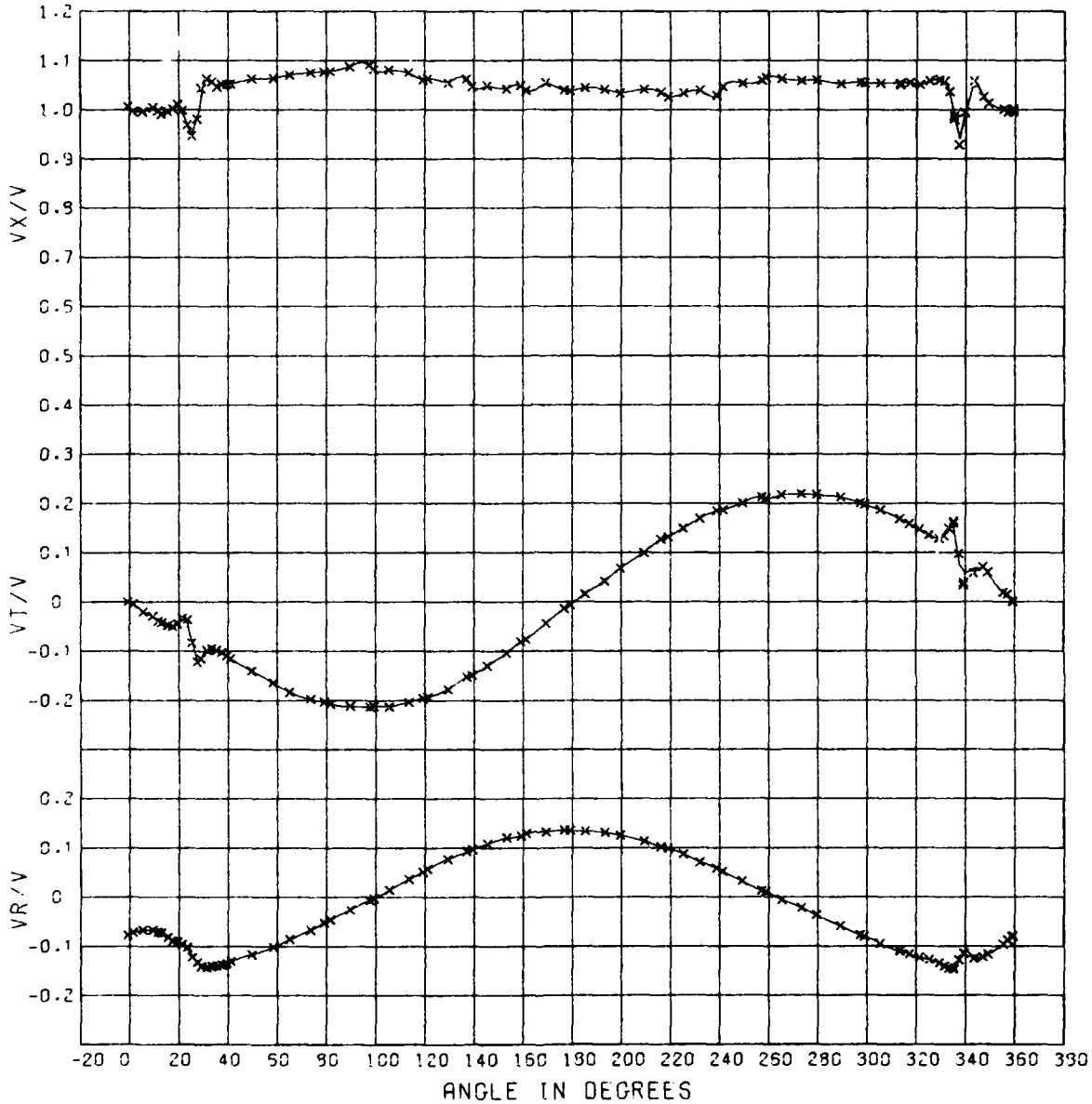


Figure F-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 8

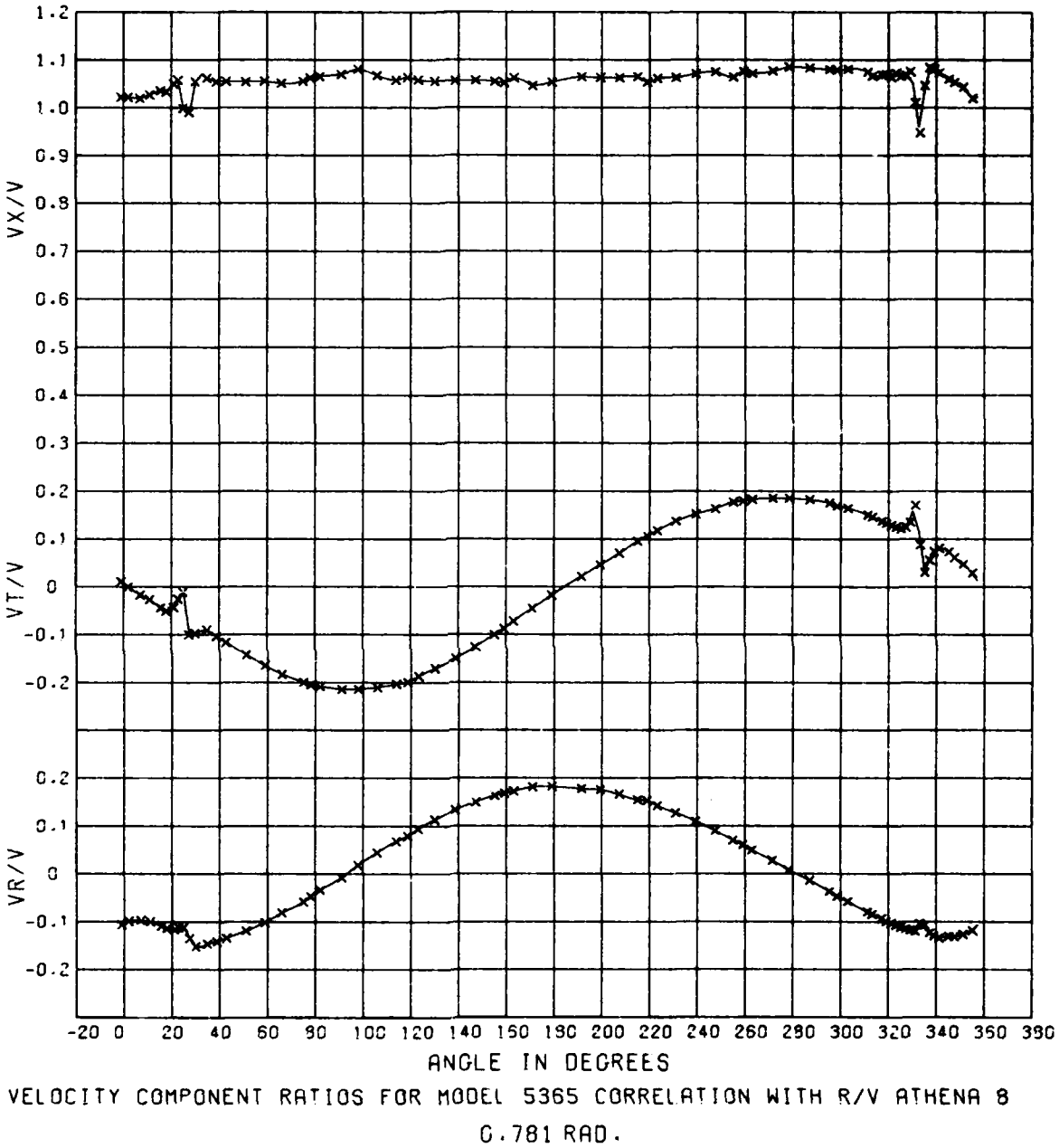
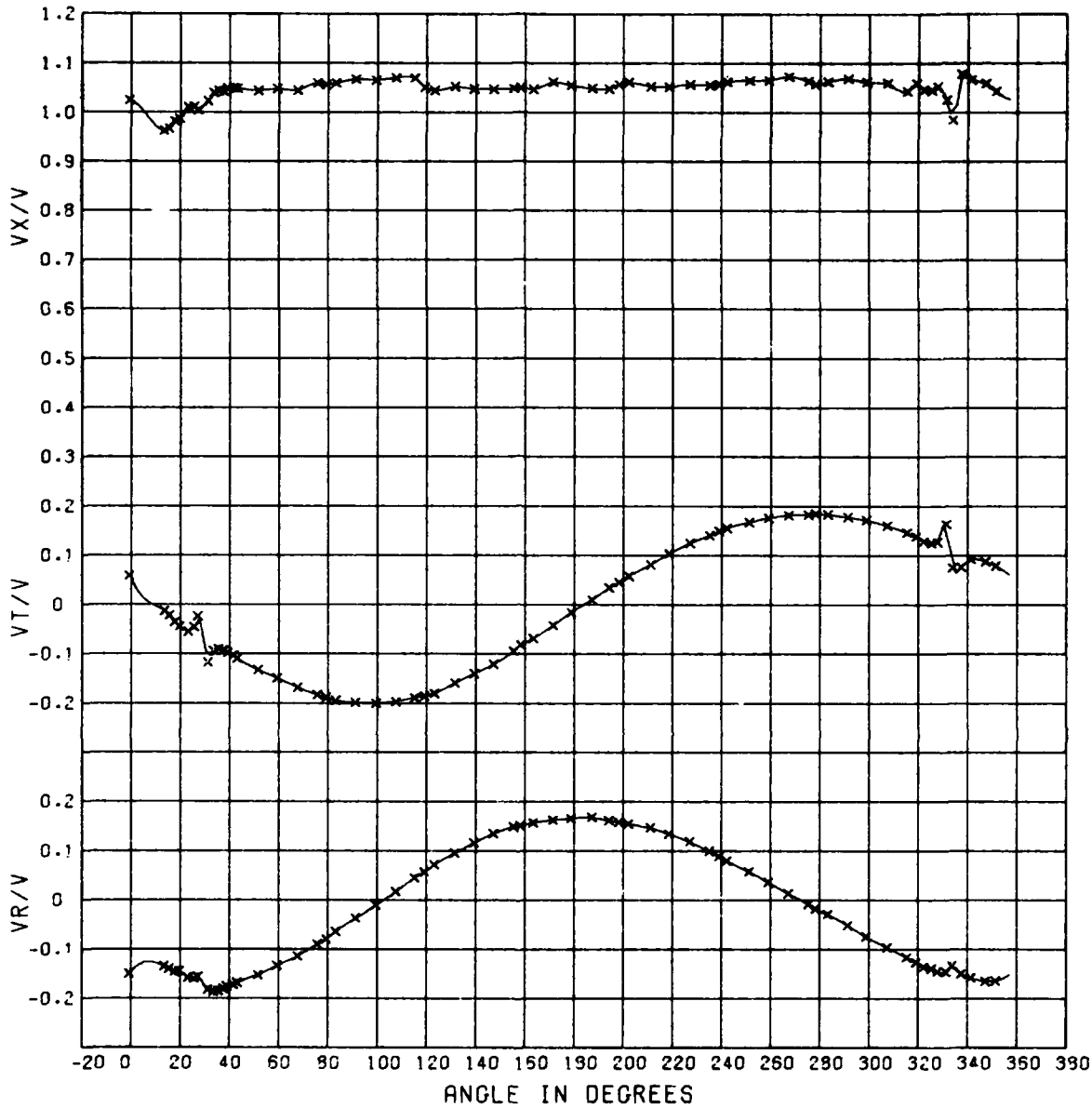


Figure F-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 8



VELOCITY COMPONENT RATIOS FOR MODEL 5365 CORRELATION WITH R/V ATHENA 8

0.963 RAD.

Figure F-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 8

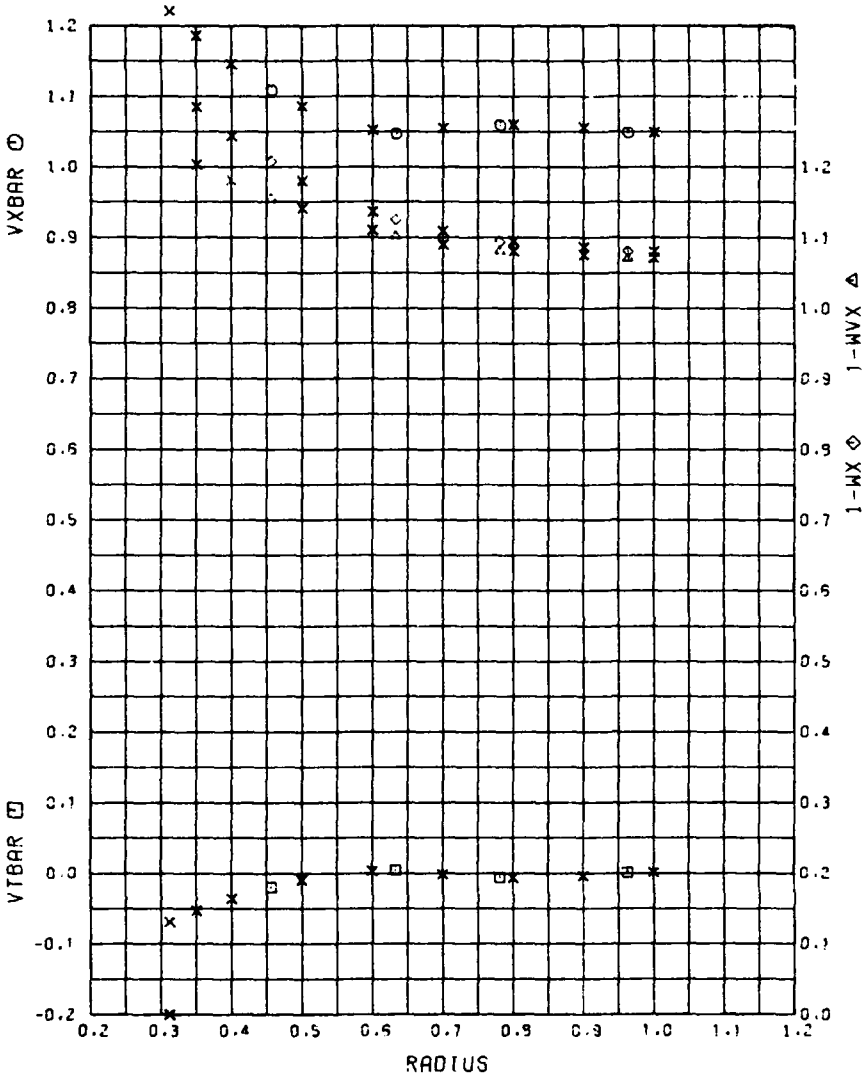


Figure F-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 8

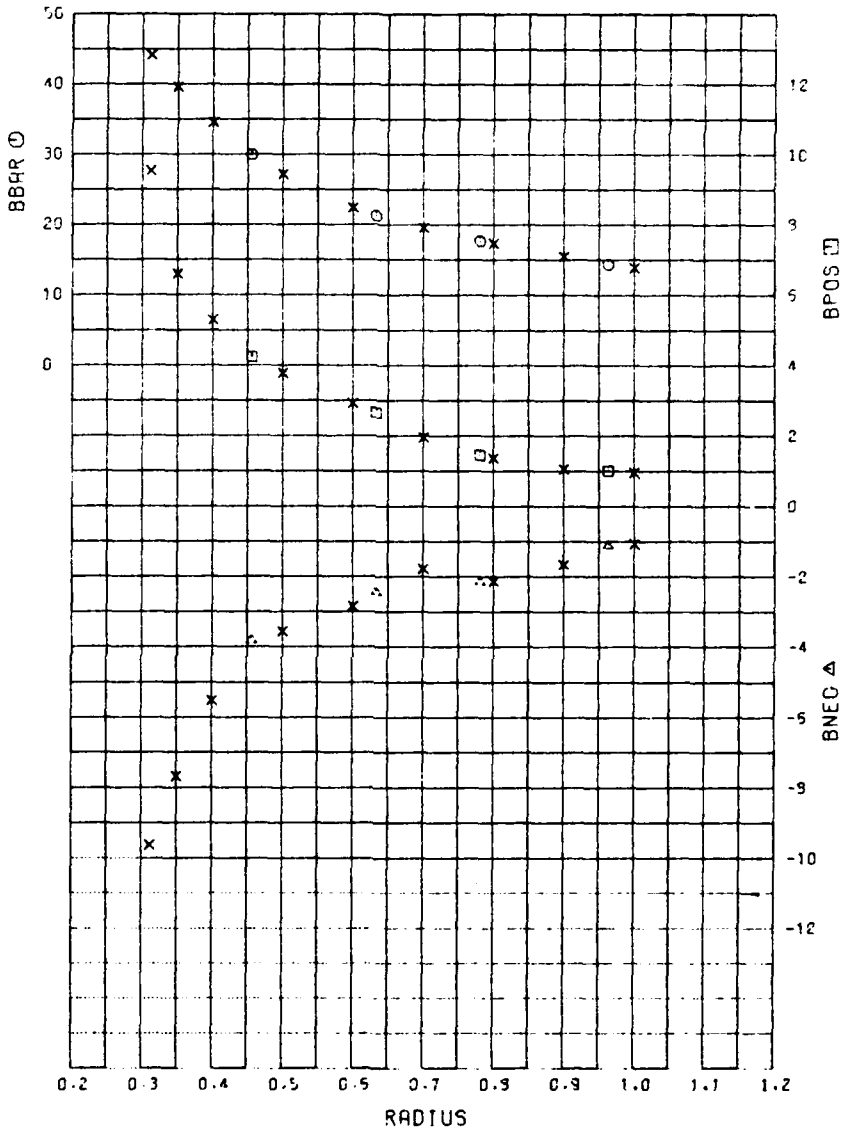


Figure F-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 8

TABLE F-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 8

RADIUS = .456

ANGLE	VX/V	VT/V	VR/V
1.1	.999	.012	-.002
5.1	.998	.037	-.010
9.1	.979	-.007	-.020
13.1	.968	-.019	-.044
17.1	.938	-.079	-.073
19.1	.936	-.126	-.040
19.2	.943	-.137	-.095
21.2	1.012	-.171	-.100
23.2	1.090	-.163	-.109
25.1	1.171	-.141	-.104
27.1	1.131	-.124	-.099
29.1	1.124	-.119	-.099
30.0	1.121	-.122	-.096
33.1	1.123	-.127	-.099
35.1	1.115	-.133	-.090
38.9	1.100	-.140	-.090
43.1	1.112	-.163	-.097
51.1	1.112	-.191	-.090
55.9	1.119	-.215	-.080
59.1	1.114	-.216	-.079
67.1	1.119	-.239	-.066
75.1	1.124	-.255	-.051
78.7	1.135	-.258	-.045
82.0	1.129	-.266	-.036
83.1	1.131	-.260	-.024
91.2	1.134	-.271	-.019
98.0	1.136	-.272	-.003
98.7	1.136	-.271	-.006
107.2	1.129	-.267	.014
115.2	1.135	-.257	.031
110.9	1.136	-.250	.036
123.1	1.133	-.243	.048
131.0	1.130	-.233	.063
130.0	1.127	-.197	.074
139.1	1.134	-.196	.076
147.3	1.120	-.170	.088
155.3	1.123	-.140	.096
159.3	1.133	-.122	.101
163.6	1.125	-.106	.103
171.0	1.126	-.078	.107
179.0	1.110	-.033	.109
179.0	1.127	-.033	.109
183.5	1.120	-.019	.109
191.0	1.115	.012	.100
199.5	1.114	.049	.107
199.6	1.120	.065	.105
207.6	1.119	.070	.090
215.6	1.116	.109	.091
219.4	1.121	.125	.090
223.6	1.122	.134	.082
231.6	1.120	.155	.071
239.0	1.131	.161	.063
239.6	1.171	.161	.063
247.6	1.132	.190	.049
255.6	1.136	.209	.035
259.0	1.141	.212	.027
263.6	1.136	.217	.020
271.5	1.136	.222	.004
279.3	1.138	.218	-.009
279.6	1.174	.219	-.009
287.5	1.139	.214	-.024
295.5	1.171	.205	-.030
298.0	1.127	.199	-.044
303.4	1.124	.192	-.053
311.3	1.125	.173	-.065
319.1	1.116	.150	-.075
319.6	1.114	.150	-.074
321.0	1.120	.144	-.077
325.0	1.118	.120	-.070
329.3	1.114	.133	-.061
327.3	1.121	.125	-.061
329.2	1.121	.123	-.063
331.0	1.119	.122	-.066
333.2	1.125	.127	-.060
335.2	1.123	.142	-.053
337.3	1.037	.151	-.050
338.0	1.010	.121	-.079
339.2	1.002	.119	-.070
341.2	1.015	.072	-.054
343.3	1.070	.061	-.049
344.0	1.043	.062	-.038
347.2	1.040	.058	-.035
351.2	1.024	.041	-.017
353.1	1.023	.036	-.012
357.1	1.010	.022	.002
361.1	.999	.012	-.002
365.1	.998	.007	-.010

RADIUS = .633

ANGLE	VX/V	VT/V	VR/V
-.7	1.007	-.000	-.070
1.4	.997	-.009	-.073
5.4	.996	-.011	-.067
9.4	1.003	-.029	-.067
9.5	1.007	-.029	-.069
11.5	.998	-.040	-.072
13.0	.991	-.042	-.073
15.5	.997	-.049	-.061
17.4	1.007	-.050	-.090
19.5	1.008	-.046	-.092
19.5	1.013	-.046	-.090
21.0	.995	-.053	-.097
21.5	1.004	-.033	-.096
23.4	.969	-.037	-.107
25.0	.963	-.063	-.172
25.5	.951	-.064	-.123
27.4	.901	-.132	-.133
29.0	1.043	-.115	-.141
31.4	1.063	-.090	-.143
33.4	1.061	-.094	-.141
33.5	1.052	-.094	-.142
35.4	1.044	-.098	-.140
37.4	1.051	-.103	-.138
39.4	1.051	-.110	-.135
41.0	1.057	-.116	-.131
49.4	1.062	-.140	-.117
57.4	1.065	-.161	-.103
59.0	1.063	-.167	-.102
65.0	1.070	-.193	-.306
73.4	1.075	-.197	-.067
79.0	1.277	-.253	-.057
81.5	1.070	-.200	-.046
89.5	1.047	-.212	-.025
97.5	1.041	-.213	-.006
99.2	1.042	-.212	-.015
105.4	1.041	-.215	.019
113.4	1.076	-.224	.037
119.1	1.041	-.196	.051
121.0	1.063	-.193	.050
129.4	1.054	-.174	.077
137.0	1.042	-.153	.093
139.1	1.042	-.149	.097
139.1	1.052	-.140	.399
145.3	1.049	-.130	.109
153.2	1.042	-.104	.121
159.0	1.050	-.091	.125
161.2	1.038	-.074	.130
169.2	1.055	-.044	.132
174.0	1.048	-.015	.136
177.1	1.040	-.013	.137
179.0	1.039	-.007	.136
185.1	1.044	.016	.134
193.1	1.042	.042	.132
198.9	1.038	.046	.127
201.0	1.038	.072	.126
209.1	1.041	.100	.114
214.0	1.038	.127	.102
216.0	1.034	.127	.102
218.4	1.026	.132	.099
225.1	1.034	.150	.088
232.0	1.040	.170	.071
238.0	1.029	.185	.059
241.1	1.047	.187	.052
249.1	1.054	.211	.032
257.0	1.059	.213	.013
258.7	1.066	.218	.010
265.1	1.063	.218	-.005
273.1	1.059	.220	-.022
278.7	1.059	.210	-.034
280.0	1.061	.217	-.040
289.2	1.053	.213	-.050
297.2	1.056	.201	-.070
298.9	1.055	.198	-.080
305.3	1.054	.187	-.095
313.3	1.059	.169	-.110
313.3	1.044	.169	-.111
313.3	1.051	.169	-.108
317.2	1.055	.159	-.116
321.3	1.051	.140	-.123
329.2	1.050	.130	-.128
329.3	1.060	.129	-.135
331.3	1.050	.136	-.141
333.3	1.037	.150	-.145
335.0	.970	.148	-.144
335.3	.987	.141	-.146
335.3	.981	.165	-.147
337.0	.922	.154	-.129
337.3	.936	.143	-.128
338.0	.993	.132	-.115
339.3	.996	.135	-.119
339.3	.996	.139	-.113
343.3	1.059	.058	-.126
343.3	1.058	.058	-.126
347.0	1.024	.073	-.122
349.0	1.017	.060	-.117
349.3	1.002	.019	-.096
357.0	.996	.015	-.007
359.0	.996	.008	-.044
359.0	.997	.004	-.001
359.3	.997	.010	-.004
359.3	1.007	-.008	-.070

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
-1.0	1.022	.011	-.106
2.0	1.022	-.001	-.099
7.0	1.020	-.017	-.097
11.0	1.027	-.027	-.100
15.0	1.029	-.043	-.109
16.0	1.043	-.046	-.109
18.0	1.031	-.051	-.113
18.0	1.035	-.052	-.116
21.0	1.050	-.044	-.116
22.9	1.057	-.036	-.113
24.0	.999	-.011	-.112
26.0	.993	-.002	-.126
28.0	1.027	-.119	-.144
30.0	1.054	-.090	-.152
34.9	1.062	-.091	-.146
36.9	1.049	-.107	-.143
38.9	1.059	-.102	-.140
42.9	1.055	-.117	-.139
46.0	1.054	-.142	-.119
50.7	1.050	-.165	-.102
54.0	1.054	-.164	-.101
66.0	1.051	-.183	-.081
75.0	1.055	-.199	-.058
78.0	1.062	-.205	-.047
82.0	1.065	-.210	-.034
91.0	1.070	-.214	-.020
98.0	1.070	-.219	.010
98.0	1.091	-.213	.019
106.0	1.068	-.211	.044
114.0	1.058	-.203	.049
118.7	1.064	-.199	.079
123.1	1.056	-.188	.094
123.1	1.061	-.184	.095
130.0	1.056	-.171	.114
138.0	1.059	-.150	.134
139.1	1.052	-.150	.131
147.1	1.057	-.127	.149
155.1	1.055	-.101	.163
159.1	1.052	-.086	.166
163.2	1.062	-.073	.172
171.0	1.064	-.046	.181
179.0	1.049	-.018	.184
179.2	1.047	-.017	.181
191.5	1.045	.022	.178
199.6	1.060	.046	.177
199.5	1.064	.066	.176
207.6	1.063	.071	.166
215.0	1.064	.096	.158
219.0	1.054	.107	.153
223.5	1.059	.119	.143
223.5	1.063	.117	.142
231.0	1.062	.130	.128
239.1	1.073	.152	.110
239.5	1.069	.152	.109
247.5	1.075	.164	.090
255.0	1.059	.178	.071
255.0	1.069	.175	.073
259.2	1.076	.180	.061
263.0	1.072	.183	.056
271.5	1.077	.186	.036
278.0	1.063	.185	.029
279.0	1.080	.184	.007
287.0	1.083	.183	-.016
295.3	1.100	.179	-.037
298.0	1.082	.169	-.049
299.0	1.076	.176	-.046
303.0	1.081	.165	-.050
311.3	1.375	.151	-.063
313.2	1.046	.147	-.064
317.2	1.049	.138	-.094
319.0	1.044	.136	-.131
319.0	1.075	.132	-.059
321.2	1.064	.129	-.103
323.2	1.073	.125	-.107
325.2	1.064	.121	-.111
327.2	1.047	.125	-.115
329.0	1.076	.136	-.118
331.2	1.011	.171	-.120
333.1	.968	.050	-.104
335.1	1.047	.071	-.107
337.1	1.044	.067	-.174
338.9	1.089	.073	-.130
339.1	1.077	.076	-.131
341.1	1.073	.081	-.134
343.1	1.060	.076	-.131
347.1	1.053	.067	-.133
348.0	1.053	.057	-.132
351.1	1.043	.048	-.127
353.0	1.020	.029	-.119
357.5	1.022	.011	-.106

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
-.0	1.025	.059	-.158
1.4	.963	-.013	-.136
1.4	.962	-.012	-.136
1.4	.967	-.022	-.141
17.5	.982	-.036	-.146
19.5	.987	-.045	-.145
23.0	1.011	-.056	-.156
25.4	1.012	-.066	-.159
27.0	1.004	-.026	-.156
31.0	1.023	-.114	-.157
33.4	1.040	-.084	-.166
35.4	1.044	-.091	-.165
37.4	1.042	-.094	-.168
39.0	1.040	-.098	-.176
41.4	1.049	-.104	-.171
43.0	1.046	-.110	-.169
51.5	1.043	-.133	-.153
55.0	1.052	-.149	-.133
59.3	1.063	-.151	-.134
67.5	1.064	-.168	-.114
75.5	1.059	-.181	-.095
79.1	1.054	-.189	-.088
83.0	1.059	-.198	-.064
91.0	1.067	-.198	-.037
99.0	1.064	-.228	-.011
99.5	1.069	-.208	-.011
107.4	1.069	-.197	.017
115.0	1.070	-.189	.045
119.0	1.050	-.184	.057
123.0	1.065	-.188	.071
131.3	1.052	-.159	.094
139.0	1.049	-.140	.116
139.5	1.046	-.101	.118
147.0	1.047	-.121	.135
155.1	1.046	-.095	.149
159.3	1.053	-.082	.151
163.1	1.047	-.069	.157
171.1	1.057	-.042	.162
178.0	1.053	-.016	.164
179.0	1.057	-.016	.164
187.0	1.049	.010	.160
194.0	1.040	.034	.162
198.0	1.047	.046	.158
202.0	1.061	.059	.155
210.5	1.052	.082	.147
218.0	1.054	.104	.134
218.7	1.060	.104	.136
226.5	1.057	.125	.119
234.9	1.055	.141	.099
238.0	1.057	.158	.089
242.0	1.047	.156	.084
251.0	1.065	.168	.059
258.7	1.062	.176	.037
259.9	1.059	.177	.035
267.0	1.073	.187	.013
275.0	1.064	.183	-.020
278.0	1.058	.185	-.018
283.0	1.063	.181	-.029
291.1	1.069	.174	-.052
298.0	1.063	.172	-.074
299.1	1.068	.173	-.076
307.1	1.060	.161	.096
315.1	1.067	.167	-.115
318.9	1.059	.179	-.127
322.0	1.064	.179	-.136
325.1	1.065	.175	-.140
327.1	1.056	.174	-.143
329.0	1.051	.132	-.140
331.2	1.029	.166	-.147
333.1	.932	.187	-.131
336.0	1.039	.065	-.135
337.1	1.070	.077	-.150
341.2	1.067	.083	-.158
347.0	1.059	.080	-.165
351.2	1.063	.079	-.165
357.5	1.025	.059	-.152

TABLE F-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 8

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 8 WITH PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.109	1.047	1.059	1.049	1.221	1.186	1.146	1.086	1.052	1.055	1.060	1.056	1.049
VTBAR =	-.020	.004	-.006	.001	-.069	-.053	-.036	-.010	.003	-.002	-.007	-.004	.001
VRBAR =	.006	-.007	.017	-.009	.051	.036	.020	-.002	-.008	.009	.017	.007	-.009
1-WVX =	1.155	1.102	1.081	1.071	0.000	1.203	1.181	1.141	1.110	1.090	1.081	1.076	1.071
1-WX =	1.208	1.125	1.095	1.081	0.000	1.285	1.244	1.180	1.136	1.109	1.095	1.087	1.080
BBAR =	30.02	21.22	17.72	14.37	44.15	39.58	34.53	27.16	22.39	19.53	17.33	15.44	13.86
BPOS =	4.24	2.65	1.45	1.01	9.53	6.59	5.29	3.78	2.92	1.95	1.36	1.05	.95
THETA =	97.50	95.00	97.50	110.00	22.50	100.00	100.00	95.00	95.00	95.00	97.50	100.00	110.00
BNEG =	-3.82	-2.45	-2.15	-1.11	-9.63	-7.68	-5.52	-3.57	-2.85	-1.78	-2.14	-1.66	-1.07
THETA =	340.00	337.50	332.50	12.50	15.00	15.00	15.00	337.50	337.50	332.50	332.50	332.50	12.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE F-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 8

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 8 WITH PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0334	.0351	.0211	.0160	.0142	.0099	.0065	.0059
PHASE ANGLE =	266.3	260.1	269.0	257.4	255.5	240.3	216.8	172.9
RADIUS = .633								
AMPLITUDE =	.0132	.0263	.0114	.0028	.0061	.0016	.0039	.0041
PHASE ANGLE =	312.9	258.2	247.8	203.1	244.7	248.0	109.4	104.1
RADIUS = .781								
AMPLITUDE =	.0102	.0145	.0061	.0024	.0019	.0033	.0048	.0001
PHASE ANGLE =	218.6	254.5	246.8	328.9	257.7	211.1	164.9	223.0
RADIUS = .963								
AMPLITUDE =	.0138	.0167	.0086	.0048	.0069	.0085	.0070	.0060
PHASE ANGLE =	246.1	251.9	219.6	174.9	210.7	184.3	162.7	175.0

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0061	.0082	.0086	.0080	.0064	.0046	.0027	.0027
PHASE ANGLE =	130.1	121.7	111.8	104.9	91.7	80.3	53.7	340.3
RADIUS = .633								
AMPLITUDE =	.0029	.0029	.0019	.0008	.0024	.0041	.0047	.0038
PHASE ANGLE =	68.9	106.2	90.4	310.5	257.9	272.4	260.6	272.9
RADIUS = .781								
AMPLITUDE =	.0009	.0030	.0025	.0033	.0033	.0035	.0021	.0029
PHASE ANGLE =	172.8	239.2	263.0	301.7	279.5	297.3	299.6	302.3
RADIUS = .963								
AMPLITUDE =	.0033	.0028	.0007	.0025	.0008	.0015	.0022	.0027
PHASE ANGLE =	174.2	153.2	12.0	192.4	319.5	320.5	341.1	65.8

TABLE F-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 8

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 8 WITH PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0775	.0380	.0343	.0393	.0235	.0247	.0235	.0153
PHASE ANGLE =	241.8	261.2	283.1	269.4	262.9	235.4	231.2	213.3
RADIUS = .350								
AMPLITUDE =	.0630	.0376	.0303	.0321	.0208	.0201	.0181	.0120
PHASE ANGLE =	246.3	260.9	279.9	267.2	261.2	236.4	229.8	206.9
RADIUS = .400								
AMPLITUDE =	.0470	.0367	.0256	.0238	.0175	.0148	.0119	.0085
PHASE ANGLE =	254.2	260.5	275.1	263.4	258.6	237.9	226.3	194.5
RADIUS = .500								
AMPLITUDE =	.0257	.0334	.0181	.0112	.0118	.0068	.0035	.0049
PHASE ANGLE =	278.5	259.7	263.8	250.4	252.8	242.8	195.6	151.0
RADIUS = .600								
AMPLITUDE =	.0157	.0283	.0128	.0041	.0074	.0023	.0034	.0043
PHASE ANGLE =	307.4	258.7	251.4	219.6	246.5	249.4	113.6	111.5
RADIUS = .700								
AMPLITUDE =	.0073	.0194	.0083	.0015	.0035	.0022	.0037	.0016
PHASE ANGLE =	263.8	256.9	249.9	296.3	255.3	231.8	143.5	88.7
RADIUS = .800								
AMPLITUDE =	.0110	.0139	.0059	.0023	.0018	.0037	.0051	.0005
PHASE ANGLE =	216.0	253.9	244.7	329.8	252.1	206.9	167.0	222.1
RADIUS = .900								
AMPLITUDE =	.0131	.0138	.0065	.0009	.0037	.0063	.0064	.0031
PHASE ANGLE =	224.5	251.7	227.8	205.0	216.2	190.7	168.0	187.3
RADIUS = 1.000								
AMPLITUDE =	.0138	.0167	.0086	.0048	.0069	.0085	.0070	.0060
PHASE ANGLE =	246.1	251.9	219.6	174.9	210.7	184.3	162.7	175.0

TABLE F-4 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 8 WITH PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0148	.0137	.0162	.0200	.0198	.0196	.0175	.0092
PHASE ANGLE =	158.9	141.1	122.2	104.9	86.1	80.8	66.0	33.4
RADIUS = .350								
AMPLITUDE =	.0119	.0120	.0140	.0164	.0157	.0149	.0128	.0068
PHASE ANGLE =	154.0	136.2	119.8	105.0	87.0	81.0	65.3	27.7
RADIUS = .400								
AMPLITUDE =	.0087	.0101	.0113	.0122	.0109	.0095	.0074	.0043
PHASE ANGLE =	145.0	129.4	116.3	105.0	88.6	81.0	63.3	13.7
RADIUS = .500								
AMPLITUDE =	.0047	.0068	.0067	.0052	.0035	.0014	.0008	.0026
PHASE ANGLE =	114.4	115.9	107.8	104.3	97.0	74.3	312.3	306.7
RADIUS = .600								
AMPLITUDE =	.0032	.0039	.0029	.0005	.0015	.0033	.0043	.0037
PHASE ANGLE =	77.1	106.4	96.1	70.4	247.1	271.6	260.6	274.7
RADIUS = .700								
AMPLITUDE =	.0012	.0013	.0009	.0026	.0031	.0039	.0032	.0036
PHASE ANGLE =	83.0	207.2	252.3	307.7	271.4	285.4	272.6	285.9
RADIUS = .800								
AMPLITUDE =	.0012	.0032	.0026	.003[illegible]	.0032	.0034	.0020	.0027
PHASE ANGLE =	181.8	239.0	264.0	299.[illegible]	281.0	299.6	307.4	307.4
RADIUS = .900								
AMPLITUDE =	.0025	.0025	.0018	.0020	.0021	.0024	.0020	.0016
PHASE ANGLE =	183.7	212.5	275.0	261.1	290.9	311.0	337.3	13.6
RADIUS = 1.000								
AMPLITUDE =	.0033	.0028	.0007	.0025	.0008	.0015	.0022	.0027
PHASE ANGLE =	174.2	153.2	12.0	192.4	319.5	320.5	341.1	65.8

RADII FOR EXPERIMENT 8

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 8 WITH PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2463	.0063	.0016	.0042	.0033	.0035	.0026	.0032
PHASE ANGLE =	175.1	82.8	193.0	157.1	159.9	132.0	97.0	64.6
RADIUS = .633								
AMPLITUDE =	.2161	.0029	.0045	.0031	.0023	.0018	.0011	.0011
PHASE ANGLE =	177.0	356.5	269.0	240.0	255.7	234.6	270.7	329.6
RADIUS = .781								
AMPLITUDE =	.1981	.0070	.0035	.0022	.0018	.0011	.0011	.0003
PHASE ANGLE =	174.9	66.9	316.7	263.9	271.5	241.2	268.5	130.9
RADIUS = .963								
AMPLITUDE =	.1919	.0096	.0008	.0029	.0022	.0022	.0016	.0012
PHASE ANGLE =	173.0	82.3	140.3	136.4	125.5	115.0	114.7	112.2

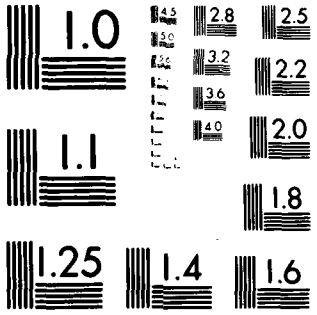
HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0042	.0048	.0059	.0055	.0045	.0035	.0023	.0019
PHASE ANGLE =	24.4	27.5	7.5	7.0	.4	338.7	328.0	261.6
RADIUS = .633								
AMPLITUDE =	.0018	.0009	.0009	.0008	.0012	.0021	.0025	.0023
PHASE ANGLE =	328.2	333.8	305.0	199.7	184.7	167.5	175.1	172.7
RADIUS = .781								
AMPLITUDE =	.0008	.0009	.0017	.0021	.0024	.0020	.0017	.0010
PHASE ANGLE =	253.4	183.5	170.2	192.9	191.0	186.1	205.6	244.4
RADIUS = .963								
AMPLITUDE =	.0011	.0016	.0017	.0017	.0022	.0018	.0018	.0009
PHASE ANGLE =	140.3	152.3	147.4	172.7	170.3	184.2	203.5	205.4

AD-A092 246 DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC F/G 20/4
ANALYSIS OF WAKE SURVEY EXPERIMENTAL DATA FOR MODEL 5365 REPRES--ETC(U)
OCT 80 R B HURWITZ, L B CROOK
UNCLASSIFIED DTNSRDC/SPD-0833-04 NL

3 OF 3
AD A
092246

END
DATE
FILMED
1-81
DTIC



MICROCOPY RESOLUTION TEST CHART

TABLE F-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 8

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 8 WITH PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2789	.0231	.0085	.0110	.0095	.0104	.0086	.0093
PHASE ANGLE =	171.1	96.6	99.2	124.8	133.7	111.8	96.0	84.7
RADIUS = .350								
AMPLITUDE =	.2695	.0176	.0058	.0087	.0075	.0082	.0068	.0073
PHASE ANGLE =	172.3	95.2	105.2	129.6	137.3	114.5	96.1	81.7
RADIUS = .400								
AMPLITUDE =	.2580	.0115	.0029	.0062	.0052	.0057	.0047	.0051
PHASE ANGLE =	173.7	91.8	123.1	139.1	144.6	120.1	96.3	75.8
RADIUS = .500								
AMPLITUDE =	.2379	.0035	.0025	.0032	.0023	.0022	.0014	.0021
PHASE ANGLE =	175.9	64.5	236.9	179.0	182.1	150.7	98.4	48.7
RADIUS = .600								
AMPLITUDE =	.2210	.0027	.0043	.0030	.0021	.0017	.0007	.0012
PHASE ANGLE =	177.0	356.6	263.5	230.0	245.0	222.0	268.5	345.4
RADIUS = .700								
AMPLITUDE =	.2065	.0044	.0040	.0028	.0023	.0017	.0013	.0004
PHASE ANGLE =	176.1	48.1	295.4	257.1	267.6	243.6	272.0	329.5
RADIUS = .800								
AMPLITUDE =	.1967	.0075	.0033	.0019	.0016	.0010	.0010	.0004
PHASE ANGLE =	174.7	69.2	320.3	262.7	270.6	236.4	266.1	131.3
RADIUS = .900								
AMPLITUDE =	.1921	.0093	.0014	.0010	.0006	.0010	.0005	.0010
PHASE ANGLE =	173.6	77.9	337.0	174.2	165.8	135.0	147.5	122.2
RADIUS = 1.000								
AMPLITUDE =	.1919	.0096	.0008	.0029	.0022	.0022	.0016	.0012
PHASE ANGLE =	173.0	82.3	140.3	136.4	125.5	115.0	114.7	112.2

TABLE F-6 (Continued)

VELOCITY COMPONENT RATIOS FOR MODEL 5365 FROM EXP. 8 WITH PROPELLER
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0087	.0108	.0132	.0145	.0127	.0127	.0110	.0081
PHASE ANGLE =	47.2	39.2	19.1	8.0	359.6	338.4	336.0	307.0
RADIUS = .350								
AMPLITUDE =	.0073	.0090	.0110	.0118	.0103	.0098	.0083	.0059
PHASE ANGLE =	42.7	36.9	16.8	7.8	359.8	338.6	335.5	302.7
RADIUS = .400								
AMPLITUDE =	.0057	.0069	.0084	.0086	.0073	.0066	.0052	.0036
PHASE ANGLE =	35.4	33.2	13.1	7.6	.1	338.8	333.9	292.1
RADIUS = .500								
AMPLITUDE =	.0034	.0035	.0043	.0035	.0027	.0015	.0007	.0016
PHASE ANGLE =	13.3	21.4	1.4	6.1	.6	337.2	296.2	218.0
RADIUS = .600								
AMPLITUDE =	.0021	.0013	.0015	.0002	.0005	.0015	.0021	.0023
PHASE ANGLE =	340.3	353.7	331.4	287.1	185.8	167.3	175.8	175.2
RADIUS = .700								
AMPLITUDE =	.0011	.0003	.0007	.0016	.0019	.0020	.0020	.0013
PHASE ANGLE =	302.5	242.5	198.3	196.3	191.3	178.1	189.4	198.8
RADIUS = .800								
AMPLITUDE =	.0007	.0011	.0018	.0022	.0024	.0020	.0017	.0010
PHASE ANGLE =	240.3	179.7	167.7	191.9	190.2	187.2	208.2	250.9
RADIUS = .900								
AMPLITUDE =	.0008	.0015	.0020	.0021	.0024	.0019	.0017	.0009
PHASE ANGLE =	175.0	164.0	157.3	183.8	181.7	188.2	211.0	247.0
RADIUS = 1.000								
AMPLITUDE =	.0011	.0016	.0017	.0017	.0022	.0018	.0018	.0009
PHASE ANGLE =	140.3	152.3	147.4	172.7	170.3	184.2	203.5	205.4

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX G

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 19

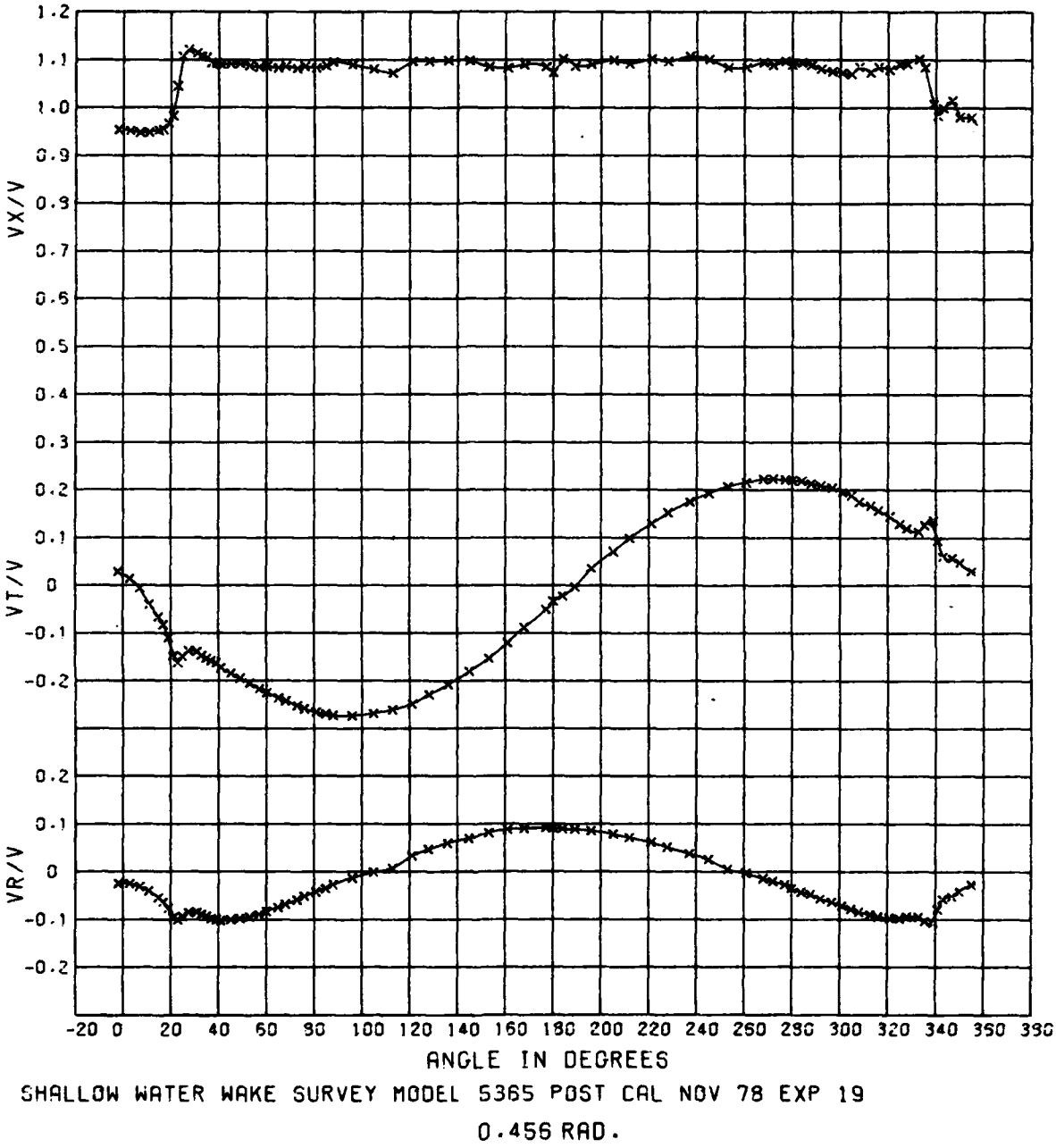


Figure G-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 19

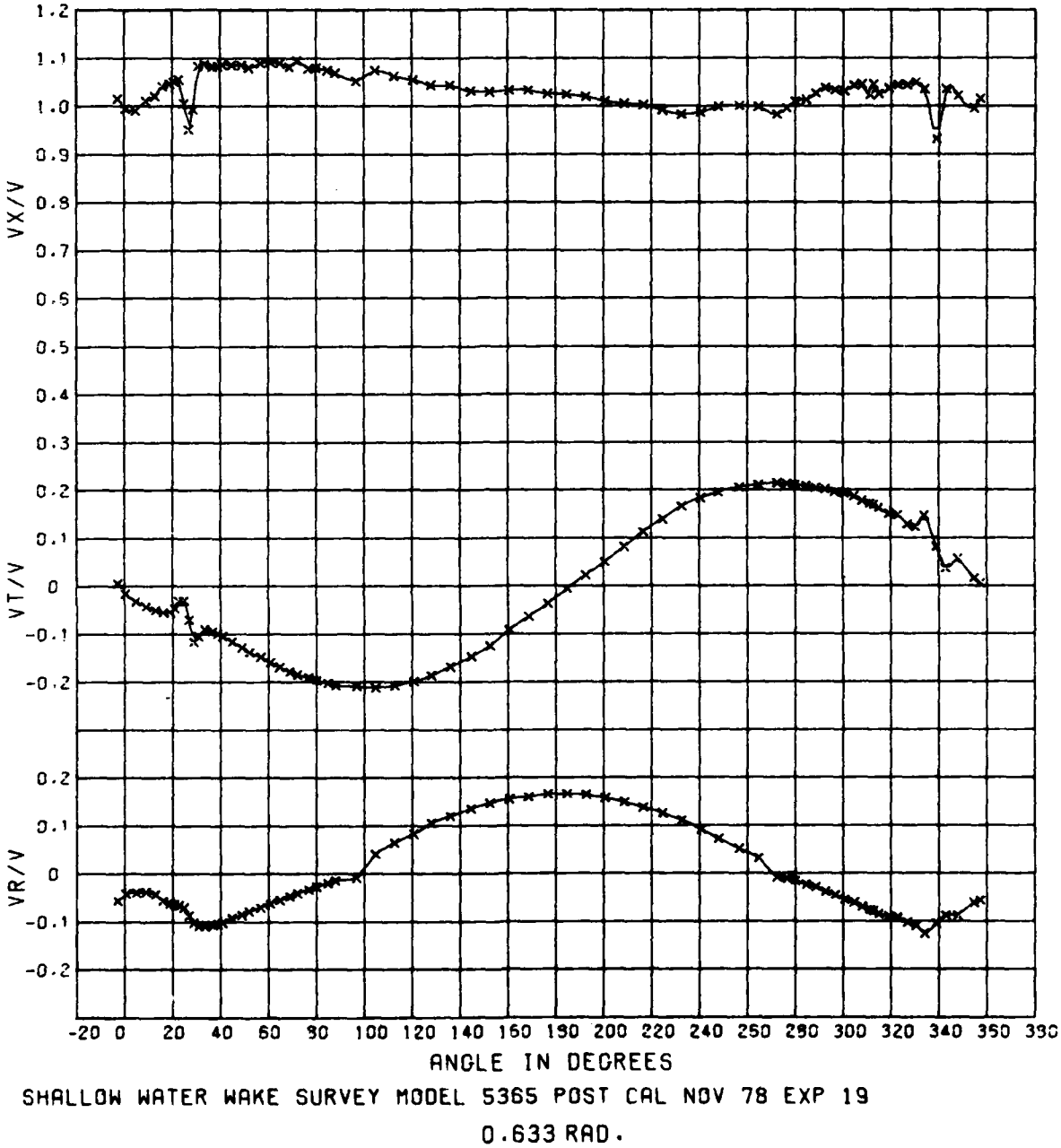


Figure G-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 19

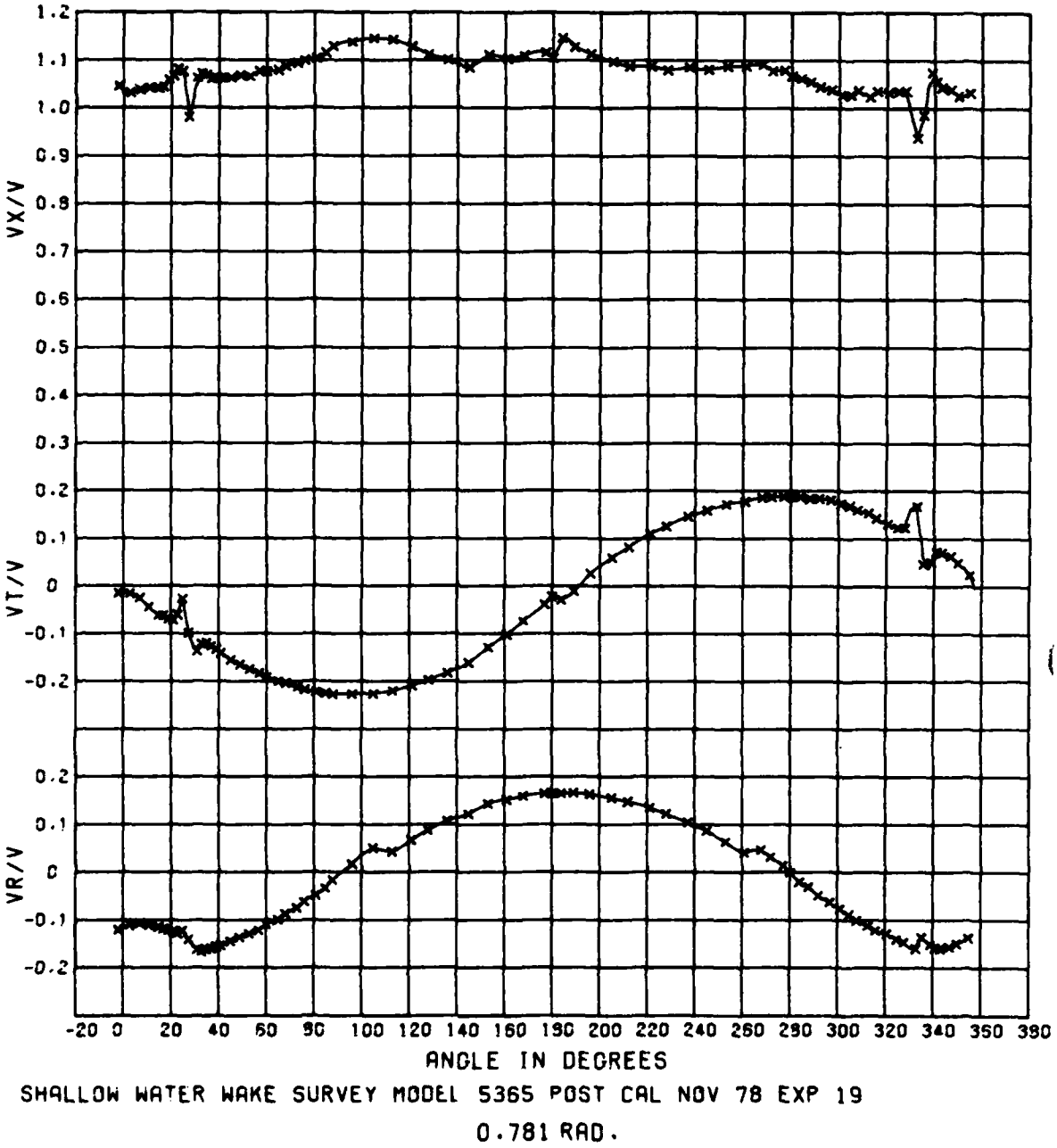


Figure G-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 19

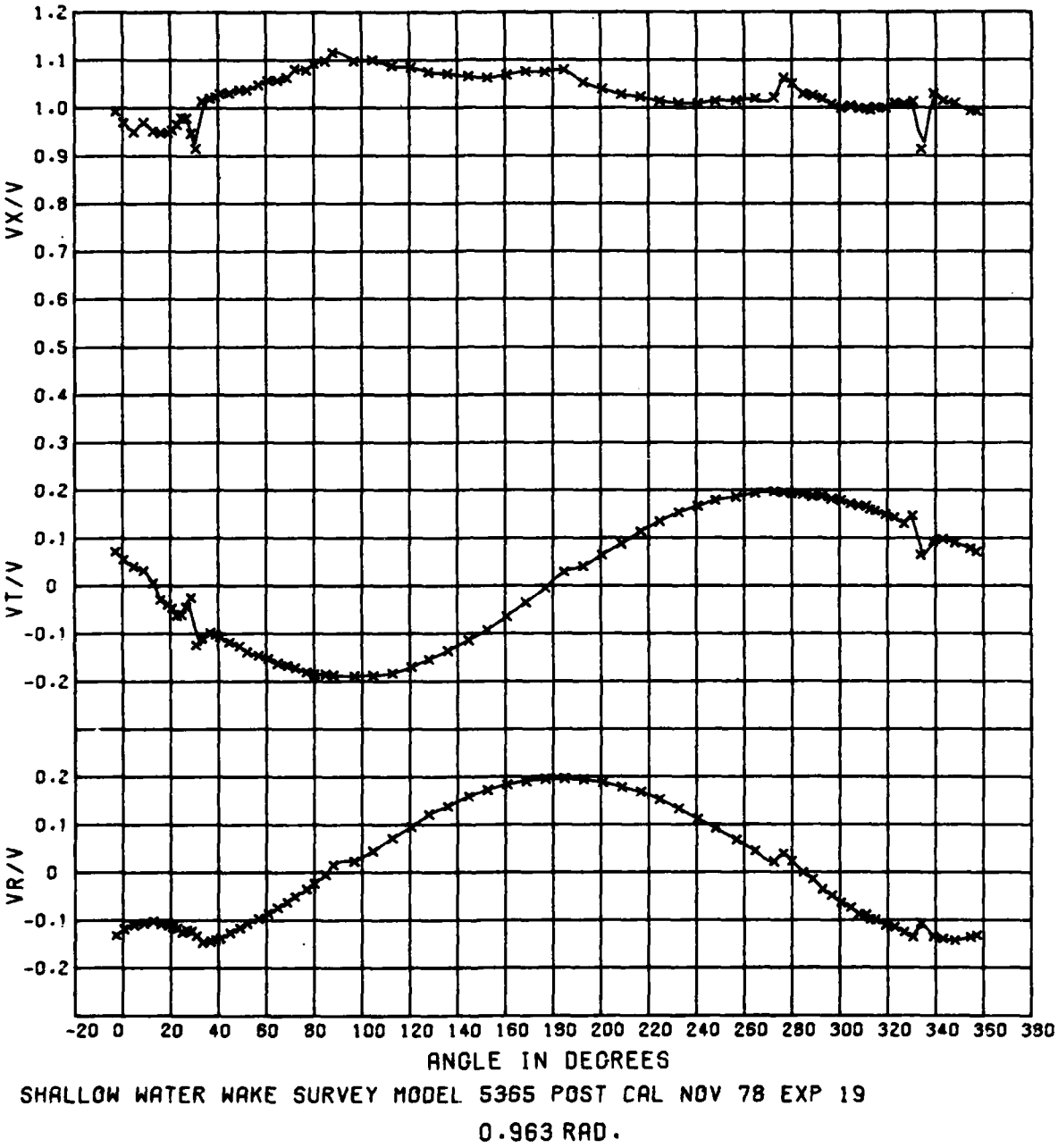


Figure G-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 19

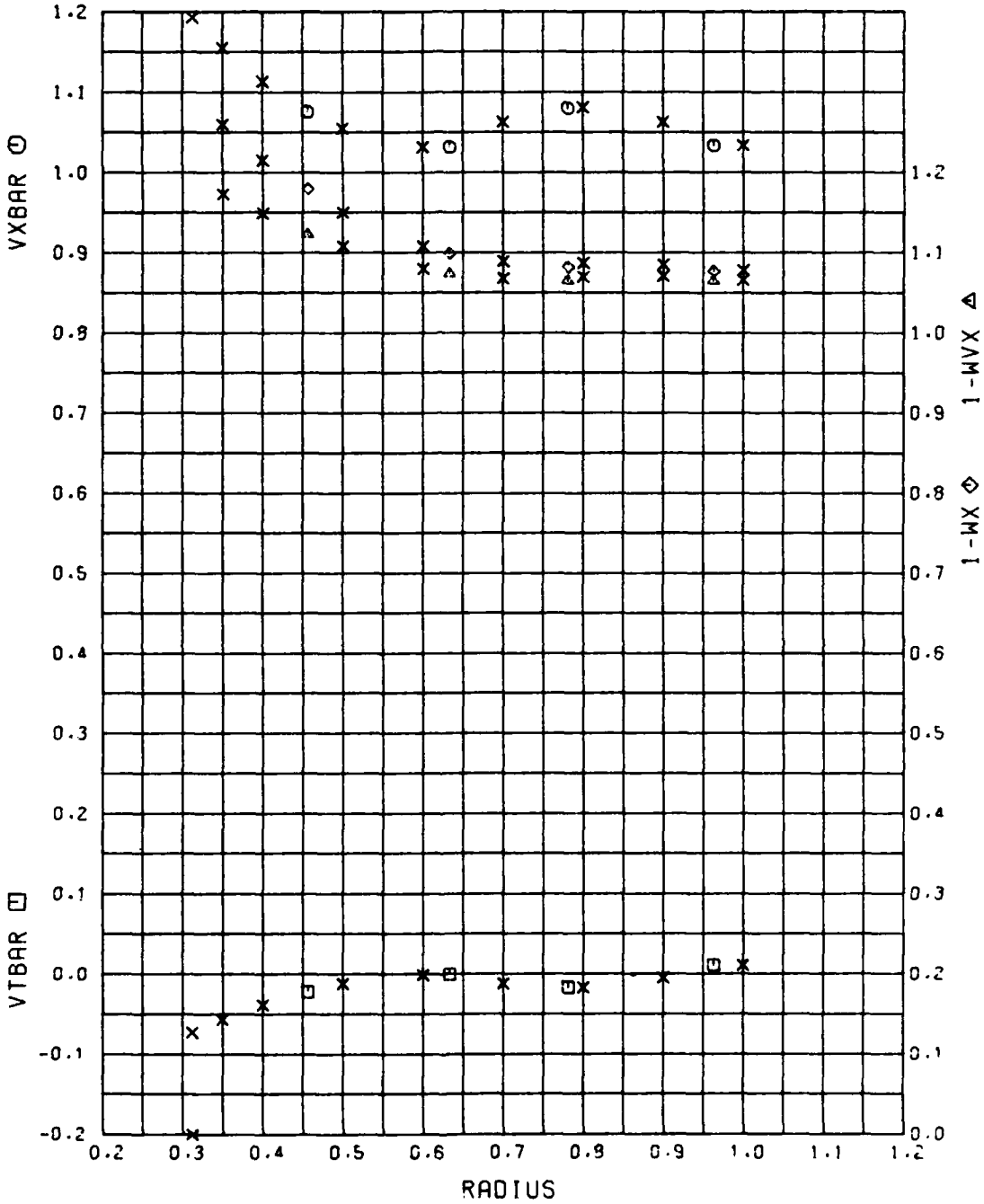


Figure G-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 19

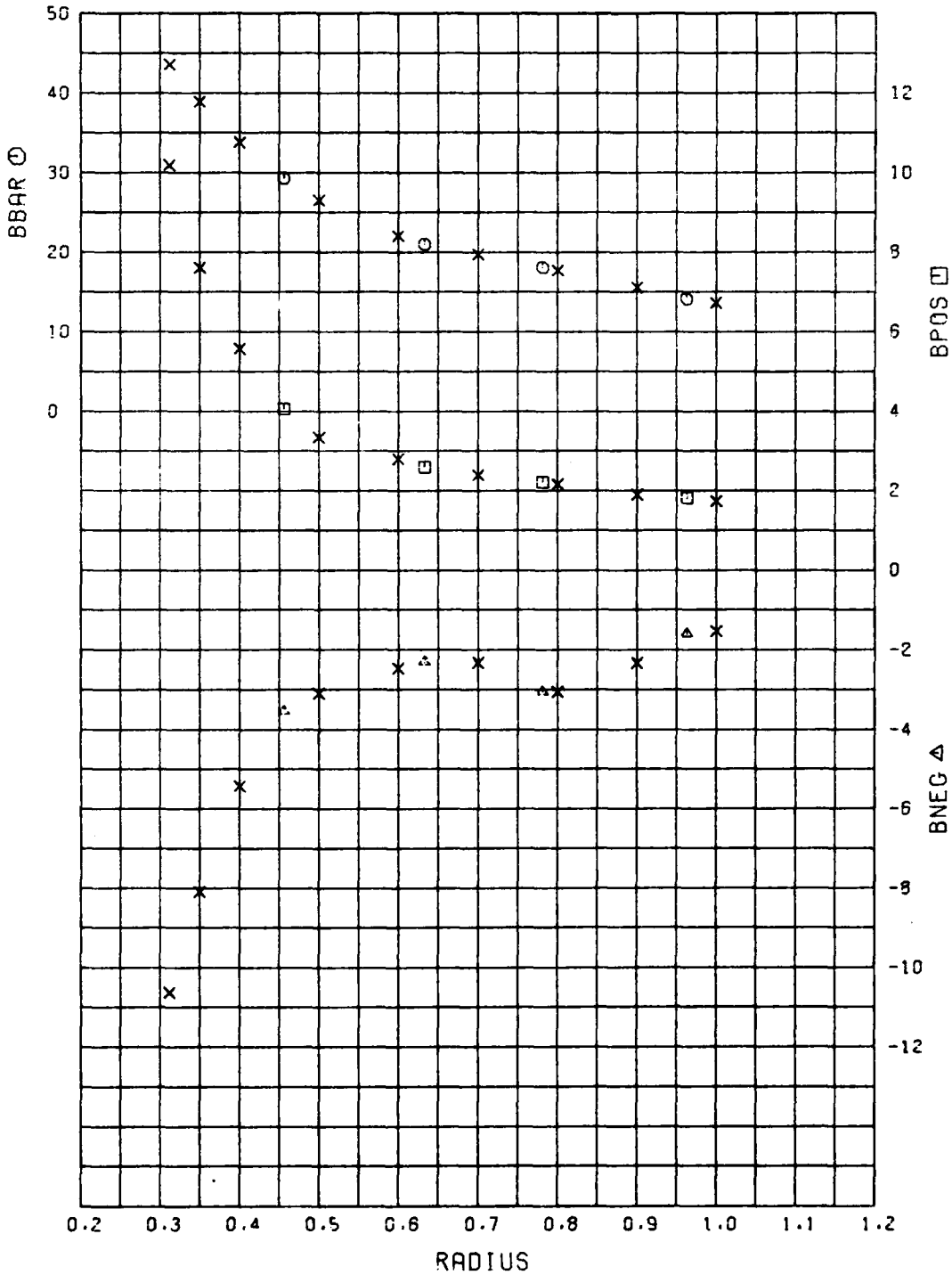


Figure G-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 19

TABLE G-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 19

RADIUS = .494

ANGLE	VT/V	VT/V	VR/V
-2.0	.954	.029	-.024
2.9	.952	.014	-.024
7.0	.948	-.006	-.031
10.9	.948	-.040	-.040
14.9	.952	-.067	-.054
16.9	.954	-.083	-.064
19.0	.948	-.110	-.077
21.0	.987	-.140	-.086
22.9	1.045	-.162	-.101
24.9	1.107	-.169	-.094
26.9	1.126	-.136	-.086
28.0	1.116	-.136	-.085
30.0	1.114	-.139	-.085
32.9	1.108	-.147	-.089
34.9	1.106	-.153	-.093
36.9	1.094	-.158	-.096
38.0	1.093	-.162	-.100
40.9	1.091	-.173	-.102
42.0	1.091	-.184	-.108
44.9	1.092	-.195	-.098
46.9	1.088	-.205	-.096
48.9	1.085	-.217	-.090
50.0	1.087	-.229	-.083
54.9	1.083	-.237	-.075
56.0	1.087	-.243	-.068
58.9	1.082	-.252	-.059
60.9	1.087	-.259	-.051
62.9	1.083	-.266	-.042
64.9	1.088	-.270	-.039
66.0	1.095	-.273	-.026
68.0	1.090	-.274	-.013
70.9	1.081	-.269	-.001
72.9	1.073	-.261	.007
74.9	1.097	-.249	.023
76.0	1.097	-.229	.047
78.0	1.099	-.208	.060
80.9	1.098	-.188	.070
82.9	1.086	-.152	.081
84.0	1.083	-.121	.088
86.0	1.090	-.088	.090
88.0	1.088	-.051	.092
90.0	1.074	-.033	.091
92.0	1.102	-.022	.090
94.0	1.087	-.003	.089
96.0	1.091	.036	.086
98.0	1.099	.071	.079
100.0	1.092	.099	.072
102.0	1.102	.130	.062
104.0	1.097	.153	.052
106.0	1.108	.175	.038
108.0	1.102	.192	.026
110.0	1.086	.208	.009
112.0	1.096	.216	-.002
114.0	1.095	.223	-.014
116.0	1.089	.224	-.020
118.0	1.097	.222	-.027
120.0	1.089	.221	-.034
122.0	1.095	.220	-.042
124.0	1.098	.216	-.047
126.0	1.091	.210	-.057
128.0	1.076	.209	-.064
130.0	1.076	.196	-.071
132.0	1.071	.189	-.078
134.0	1.086	.175	-.086
136.0	1.074	.167	-.090
138.0	1.095	.157	-.095
140.0	1.088	.146	-.096
142.0	1.091	.130	-.098
144.0	1.092	.128	-.096
146.0	1.102	.113	-.095
148.0	1.090	.119	-.100
150.0	1.071	.109	-.109
152.0	1.088	.107	-.105
154.0	.984	.094	-.095
156.0	1.088	.081	-.097
158.0	1.088	.081	-.097
160.0	1.016	.090	-.092
162.0	.981	.080	-.091
164.0	.980	.070	-.087
166.0	.994	.029	-.076

RADIUS = .633

ANGLE	VT/V	VT/V	VR/V
-2.0	1.016	.086	-.056
2.9	.987	-.016	-.043
6.0	1.003	-.017	-.039
8.0	.991	-.032	-.039
10.9	1.011	-.042	-.037
12.0	1.021	-.050	-.042
14.0	1.042	-.055	-.056
16.0	1.046	-.058	-.062
18.0	1.048	-.055	-.062
20.0	1.051	-.046	-.063
22.0	1.056	-.031	-.065
24.0	1.006	-.030	-.070
26.0	.952	-.070	-.087
28.7	.994	-.116	-.102
30.0	1.004	-.105	-.109
32.0	1.006	-.092	-.111
34.0	1.007	-.089	-.108
36.7	1.002	-.094	-.107
38.0	1.003	-.099	-.104
40.0	1.007	-.104	-.102
42.0	1.006	-.116	-.093
44.0	1.005	-.128	-.086
46.0	1.000	-.138	-.079
48.0	1.090	-.147	-.070
50.0	1.092	-.159	-.062
52.0	1.089	-.160	-.054
54.0	1.082	-.170	-.047
56.0	1.095	-.184	-.040
58.0	1.078	-.190	-.033
60.0	1.080	-.196	-.026
62.0	1.075	-.202	-.019
64.0	1.069	-.207	-.014
66.0	1.052	-.200	-.008
68.0	1.075	-.212	.001
70.0	1.063	-.207	.005
72.0	1.055	-.199	.013
74.0	1.044	-.196	.106
76.0	1.043	-.160	.120
78.0	1.031	-.147	.135
80.0	1.029	-.129	.147
82.0	1.033	-.092	.155
84.0	1.033	-.064	.160
86.0	1.026	-.037	.165
88.0	1.025	-.006	.164
90.0	1.020	.022	.164
92.0	1.012	.051	.158
94.0	1.010	.090	.158
96.0	1.005	.082	.149
98.0	1.003	.113	.138
100.0	.992	.140	.126
102.0	.983	.166	.111
104.0	.987	.183	.092
106.0	.999	.195	.072
108.0	1.001	.206	.052
110.0	.999	.211	.032
112.0	.983	.215	-.000
114.0	.996	.213	-.011
116.0	1.010	.211	-.015
118.0	1.013	.209	-.023
120.0	1.027	.205	-.020
122.0	1.030	.202	-.030
124.0	1.032	.196	-.045
126.0	1.031	.194	-.055
128.0	1.043	.187	-.061
130.0	1.049	.178	-.070
132.0	1.023	.172	-.077
134.0	1.045	.170	-.070
136.0	1.026	.163	-.085
138.0	1.037	.151	-.090
140.0	1.042	.152	-.090
142.0	1.044	.144	-.095
144.0	1.044	.129	-.102
146.0	1.044	.124	-.110
148.0	1.055	.122	-.100
150.0	1.044	.147	-.126
152.0	1.022	.097	-.080
154.0	.993	.019	-.062
156.0	.997	.012	-.061
157.1	1.015	.006	-.096
160.0	.987	-.030	-.063

RADIUS = .701

ANGLE	VT/V	VT/V	VR/V
-2.0	1.045	-.015	-.121
2.9	1.031	-.016	-.111
6.0	1.038	-.025	-.107
8.0	1.042	-.044	-.111
10.9	1.041	-.062	-.115
12.0	1.044	-.062	-.119
14.0	1.059	-.070	-.122
16.0	1.067	-.072	-.124
18.0	1.082	-.061	-.120
20.0	1.077	-.027	-.122
22.0	.977	-.054	-.128
24.0	.985	-.144	-.154
26.0	1.063	-.137	-.163
28.7	1.071	-.122	-.166
30.0	1.064	-.120	-.162
32.0	1.062	-.126	-.160
34.0	1.052	-.133	-.156
36.7	1.062	-.141	-.154
38.0	1.063	-.155	-.145
40.0	1.060	-.165	-.137
42.0	1.066	-.174	-.129
44.0	1.077	-.183	-.122
46.0	1.076	-.192	-.109
48.0	1.079	-.199	-.099
50.0	1.080	-.203	-.087
52.0	1.094	-.212	-.075
54.0	1.099	-.218	-.062
56.0	1.103	-.222	-.048
58.0	1.115	-.225	-.033
60.0	1.129	-.227	-.016
62.0	1.138	-.227	.017
64.0	1.146	-.226	.051
66.0	1.143	-.228	.043
68.0	1.120	-.209	.067
70.0	1.112	-.197	.080
72.0	1.101	-.182	.107
74.0	1.085	-.161	.122
76.0	1.111	-.129	.143
78.0	1.104	-.102	.152
80.0	1.110	-.074	.190
82.0	1.116	-.039	.166
84.0	1.109	-.022	.165
86.0	1.147	-.029	.165
88.0	1.120	-.011	.166
90.0	1.114	.026	.163
92.0	1.090	.060	.156
94.0	1.080	.082	.148
96.0	1.080	.109	.135
98.0	1.080	.126	.122
100.0	1.085	.146	.104
102.0	1.081	.159	.087
104.0	1.080	.172	.064
106.0	1.080	.170	.041
108.0	1.092	.166	.017
110.0	1.070	.167	.032
112.0	1.079	.160	-.016
114.0	1.067	.157	-.030
116.0	1.062	.150	-.040
118.0	1.095	.146	-.050
120.0	1.070	.141	-.060
122.0	1.076	.135	-.065
124.0	1.075	.124	-.068
126.0	1.076	.123	-.067
128.0	.938	.160	-.060
130.0	.914	.088	-.148
132.0	1.050	.014	-.133
134.0	1.075	.092	-.192
136.0	1.097	.073	-.199
138.0	1.044	.071	-.160
140.0	1.044	.064	-.157
142.0	1.039	.064	-.150
144.0	1.026	.050	-.150
146.0	1.022	.024	-.130
148.0	1.045	-.015	-.121

RADIUS = .963

ANGLE	VT/V	VT/V	VR/V
-2.0	.993	.072	-.132
2.9	.990	.059	-.121
6.0	.981	.057	-.116
8.0	.990	.041	-.110
10.9	.979	.032	-.107
12.0	.991	.006	-.102
14.0	.968	-.029	-.108
16.9	.965	-.040	-.112
18.0	.990	-.020	-.110
20.0	.953	-.046	-.114
22.0	.965	-.062	-.116
24.0	.988	-.061	-.125
26.0	.979	-.044	-.121
28.7	.967	-.025	-.123
30.0	.915	-.126	-.133
32.0	1.006	-.123	-.149
34.0	1.020	-.099	-.147
36.7	1.020	-.099	-.145
38.0	1.023	-.102	-.141
40.0	1.030	-.107	-.138
42.0	1.031	-.116	-.126
44.0	1.037	-.127	-.116
46.0	1.037	-.139	-.107
48.0	1.048	-.144	-.097
50.0	1.057	-.153	-.084
52.0	1.050	-.162	-.074
54.0	1.063	-.167	-.062
56.0	1.081	-.172	-.048
58.0	1.079	-.181	-.035
60.0	1.093	-.185	-.023
62.0	1.090	-.185	-.004
64.0	1.116	-.187	.016
66.0	1.098	-.189	.023
68.0	1.120	-.184	.045
70.0	1.088	-.183	.072
72.0	1.095	-.178	.095
74.0	1.075	-.154	.122
76.0	1.072	-.134	.134
78.0	1.066	-.114	.159
80.0	1.063	-.093	.172
82.0	1.049	-.065	.183
84.0	1.076	-.039	.190
86.0	1.075	-.025	.195
88.0	1.080	.029	.194
90.0	1.093	.041	.194
92.0	1.039	.066	.188
94.0	1.060	.083	.186
96.0	1.029	.088	.178
98.0	1.023	.114	.168
100.0	1.014	.135	.152
102.0	1.009	.154	.133
104.0	1.009	.167	.112
106.0	1.014	.179	.092
108.0	1.015	.186	.068
110.0	1.029	.194	.045
112.0	1.021	.197	.022
114.0	1.063	.196	.000
116.0	1.051	.193	.023
118.0	1.079	.192	0.000
120.0	1.024	.187	-.014
122.0	1.019	.188	-.035
124.0	1.008	.182	-.048
126.0	1.008	.179	-.064
128.0	1.006	.172	-.074
130.0	.990	.160	-.080
132.0	.990	.167	-.089
134.0	.999	.160	-.098
136.0	1.021	.158	-.099
138.0	1.008	.158	-.110
140.0	1.010	.147	-.111
142.0	1.011	.141	-.117
144.0	1.007	.131	-.125
146.0	1.009	.146	-.137
148.0	1.017	.140	-.135
150.0	.914	.095	-.197
152.0	1.020	.093	-.129
154.0	1.015	.090	-.139
156.0	1.010	.088	-.143
158.0	.999	.079	-.136
159.2	.991	.070	-.136
160.1	.993	.072	-.132
160.0	.990	.059	-.121

TABLE G-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 19

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

RADIUS =	.456	.633	.781	.983	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.076	1.032	1.080	1.034	1.193	1.155	1.113	1.055	1.032	1.063	1.081	1.063	1.034
VTBAR =	-.022	-.000	-.017	.011	-.073	-.057	-.038	-.012	-.001	-.012	-.017	-.005	.011
VRBAR =	-.009	.022	.003	.023	-.078	-.056	-.031	.005	.021	.010	.003	.010	.023
1-WVX =	1.123	1.074	1.065	1.065	0.000	1.173	1.149	1.108	1.080	1.068	1.070	1.071	1.066
1-WX =	1.180	1.099	1.082	1.077	0.000	1.260	1.215	1.150	1.107	1.089	1.087	1.085	1.078
BBAR =	29.30	20.98	18.10	14.14	43.57	38.89	33.79	26.51	22.02	19.73	17.71	15.55	13.64
BPOS =	4.06	2.60	2.21	1.82	10.18	7.60	5.56	3.34	2.80	2.39	2.16	1.89	1.73
THETA =	90.00	72.50	105.00	90.00	25.00	25.00	92.50	87.50	72.50	105.00	105.00	92.50	90.00
BNEG =	-3.53	-2.30	-3.04	-1.59	-10.63	-8.08	-5.43	-3.09	-2.46	-2.32	-3.05	-2.33	-1.53
THETA =	340.00	272.50	332.50	335.00	7.50	357.50	0.00	340.00	272.50	332.50	332.50	332.50	335.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE G-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 19

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0305	.0249	.0197	.0223	.0153	.0138	.0117	.0022
PHASE ANGLE =	267.6	276.3	268.2	262.6	255.2	255.0	241.2	180.2
RADIUS = .633								
AMPLITUDE =	.0350	.0114	.0179	.0077	.0050	.0026	.0020	.0021
PHASE ANGLE =	14.6	263.6	262.5	277.0	260.0	80.5	82.9	225.5
RADIUS = .781								
AMPLITUDE =	.0456	.0139	.0031	.0144	.0073	.0017	.0020	.0015
PHASE ANGLE =	299.9	285.1	135.3	65.1	258.5	141.5	73.0	75.1
RADIUS = .963								
AMPLITUDE =	.0470	.0247	.0156	.0110	.0065	.0074	.0042	.0053
PHASE ANGLE =	311.5	239.2	233.9	114.6	190.6	174.8	193.7	97.7

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0035	.0058	.0063	.0073	.0047	.0030	.0035	.0015
PHASE ANGLE =	126.4	149.5	108.4	95.5	88.6	87.4	68.8	311.0
RADIUS = .633								
AMPLITUDE =	.0022	.0047	.0005	.0038	.0032	.0044	.0062	.0059
PHASE ANGLE =	27.5	65.3	132.0	247.1	216.8	244.1	228.4	224.0
RADIUS = .781								
AMPLITUDE =	.0037	.0019	.0041	.0032	.0041	.0033	.0014	.0019
PHASE ANGLE =	175.5	255.7	213.2	279.9	258.8	303.7	308.2	28.1
RADIUS = .963								
AMPLITUDE =	.0032	.0028	.0043	.0027	.0023	.0035	.0041	.0021
PHASE ANGLE =	88.6	149.5	228.7	275.0	261.0	248.6	239.3	311.3

TABLE G-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 19

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 76 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.1565	.0505	.0042	.0259	.0342	.0422	.0337	.0049
PHASE ANGLE =	243.9	286.0	302.8	260.8	254.0	253.8	243.8	106.9
RADIUS = .350								
AMPLITUDE =	.1150	.0424	.0094	.0257	.0283	.0334	.0270	.0035
PHASE ANGLE =	245.5	284.0	278.3	261.1	254.2	254.0	243.4	119.5
RADIUS = .400								
AMPLITUDE =	.0691	.0332	.0153	.0246	.0215	.0233	.0191	.0024
PHASE ANGLE =	250.2	280.8	271.3	261.7	254.6	254.4	242.7	147.7
RADIUS = .500								
AMPLITUDE =	.0165	.0198	.0215	.0197	.0114	.0078	.0070	.0024
PHASE ANGLE =	318.8	272.1	266.7	263.7	255.9	255.5	238.7	205.9
RADIUS = .600								
AMPLITUDE =	.0327	.0126	.0201	.0112	.0058	.0011	.0008	.0024
PHASE ANGLE =	16.9	263.9	263.8	270.2	258.8	79.8	118.5	223.9
RADIUS = .700								
AMPLITUDE =	.0328	.0122	.0054	.0064	.0068	.0018	.0024	.0004
PHASE ANGLE =	324.9	284.1	252.4	41.7	263.6	91.1	68.8	209.2
RADIUS = .800								
AMPLITUDE =	.0480	.0143	.0037	.0153	.0072	.0020	.0018	.0019
PHASE ANGLE =	297.9	282.4	133.9	67.7	255.9	151.7	78.4	76.4
RADIUS = .900								
AMPLITUDE =	.0514	.0184	.0064	.0147	.0061	.0049	.0019	.0040
PHASE ANGLE =	299.7	256.7	203.6	85.2	226.3	172.5	168.9	88.7
RADIUS = 1.000								
AMPLITUDE =	.0470	.0247	.0156	.0110	.0065	.0074	.0042	.0053
PHASE ANGLE =	311.5	239.3	233.9	114.6	190.6	174.8	193.7	97.7

TABLE G-4 (Continued)

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0150	.0192	.0147	.0251	.0148	.0168	.0242	.0174
PHASE ANGLE =	160.6	195.0	121.3	84.1	65.4	65.2	52.8	29.3
RADIUS = .350								
AMPLITUDE =	.0111	.0145	.0121	.0196	.0116	.0124	.0175	.0119
PHASE ANGLE =	158.9	189.1	118.4	85.7	68.8	67.3	54.0	26.8
RADIUS = .400								
AMPLITUDE =	.0069	.0095	.0091	.0132	.0080	.0074	.0101	.0058
PHASE ANGLE =	148.4	178.4	114.1	88.7	75.2	72.1	57.0	18.8
RADIUS = .500								
AMPLITUDE =	.0023	.0047	.0044	.0036	.0029	.0011	.0012	.0032
PHASE ANGLE =	88.9	118.8	103.4	109.7	111.4	158.4	177.5	240.5
RADIUS = .600								
AMPLITUDE =	.0025	.0049	.0012	.0029	.0027	.0039	.0058	.0061
PHASE ANGLE =	31.3	72.7	99.2	236.7	202.5	238.1	225.9	225.0
RADIUS = .700								
AMPLITUDE =	.0018	.0009	.0023	.0034	.0037	.0033	.0026	.0014
PHASE ANGLE =	167.2	33.6	205.6	264.8	243.8	278.6	246.7	229.9
RADIUS = .800								
AMPLITUDE =	.0039	.0022	.0043	.0032	.0042	.0033	.0014	.0023
PHASE ANGLE =	174.1	250.6	214.4	282.0	260.7	305.2	315.6	28.0
RADIUS = .900								
AMPLITUDE =	.0031	.0021	.0048	.0030	.0035	.0029	.0018	.0025
PHASE ANGLE =	146.7	209.9	221.4	283.7	265.1	285.2	272.0	8.1
RADIUS = 1.000								
AMPLITUDE =	.0032	.0028	.0043	.0027	.0023	.0035	.0041	.0021
PHASE ANGLE =	88.6	149.5	228.7	275.0	261.0	248.6	239.3	311.3

TABLE G-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 19

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2498	.0040	.0044	.0045	.0055	.0038	.0027	.0024
PHASE ANGLE =	175.7	94.4	154.7	147.1	137.9	127.2	99.6	72.8
RADIUS = .633								
AMPLITUDE =	.2115	.0100	.0060	.0063	.0045	.0026	.0028	.0012
PHASE ANGLE =	174.7	310.4	266.9	244.5	273.2	245.9	276.7	287.3
RADIUS = .781								
AMPLITUDE =	.2111	.0030	.0039	.0013	.0017	.0021	.0023	.0020
PHASE ANGLE =	174.5	109.0	207.0	254.5	298.7	239.0	312.7	249.2
RADIUS = .963								
AMPLITUDE =	.1941	.0104	.0032	.0054	.0034	.0052	.0025	.0046
PHASE ANGLE =	174.8	91.4	112.2	104.2	77.6	79.3	68.8	79.7

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0029	.0032	.0047	.0036	.0036	.0024	.0020	.0005
PHASE ANGLE =	29.6	28.2	18.1	10.7	9.8	10.2	354.6	35.4
RADIUS = .633								
AMPLITUDE =	.0014	.0010	.0003	.0010	.0025	.0025	.0032	.0022
PHASE ANGLE =	292.1	274.0	111.4	154.3	149.0	147.4	148.9	145.1
RADIUS = .781								
AMPLITUDE =	.0014	.0012	.0008	.0026	.0021	.0035	.0018	.0016
PHASE ANGLE =	325.7	197.9	121.6	151.3	174.7	165.6	208.6	190.6
RADIUS = .963								
AMPLITUDE =	.0012	.0016	.0013	.0009	.0019	.0012	.0011	.0014
PHASE ANGLE =	94.4	114.2	165.4	164.2	211.4	237.4	258.2	331.3

TABLE G-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 19

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.3109	.0379	.0228	.0202	.0224	.0131	.0121	.0072
PHASE ANGLE =	176.6	119.3	124.5	99.5	118.2	109.4	92.2	88.0
RADIUS = .350								
AMPLITUDE =	.2921	.0268	.0167	.0148	.0170	.0102	.0092	.0057
PHASE ANGLE =	176.4	118.1	126.8	104.0	120.4	111.5	93.2	85.6
RADIUS = .400								
AMPLITUDE =	.2702	.0145	.0100	.0089	.0109	.0068	.0058	.0040
PHASE ANGLE =	176.1	114.5	132.9	115.0	125.2	116.0	95.2	81.3
RADIUS = .500								
AMPLITUDE =	.2363	.0033	.0027	.0038	.0027	.0022	.0008	.0014
PHASE ANGLE =	175.4	335.9	211.2	194.0	169.5	149.9	115.9	58.6
RADIUS = .600								
AMPLITUDE =	.2155	.0099	.0056	.0061	.0039	.0022	.0022	.0009
PHASE ANGLE =	174.9	311.2	265.9	239.9	266.2	237.5	272.8	304.6
RADIUS = .700								
AMPLITUDE =	.2128	.0033	.0047	.0040	.0033	.0030	.0027	.0021
PHASE ANGLE =	174.6	312.7	240.4	251.1	280.2	244.8	293.5	260.0
RADIUS = .800								
AMPLITUDE =	.2102	.0042	.0038	.0007	.0014	.0017	.0021	.0017
PHASE ANGLE =	174.5	109.9	199.4	248.1	308.9	235.1	318.5	246.1
RADIUS = .900								
AMPLITUDE =	.2021	.0086	.0031	.0029	.0017	.0019	.0015	.0014
PHASE ANGLE =	174.6	101.7	153.1	99.9	60.2	90.2	22.7	92.3
RADIUS = 1.000								
AMPLITUDE =	.1941	.0104	.0032	.0054	.0034	.0052	.0025	.0046
PHASE ANGLE =	174.8	91.4	112.2	104.2	77.6	79.3	68.8	79.7

TABLE G-6 (Continued)

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 19
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0091	.0087	.0122	.0097	.0129	.0086	.0121	.0051
PHASE ANGLE =	45.0	44.6	18.2	10.7	353.2	349.8	332.7	327.5
RADIUS = .350								
AMPLITUDE =	.0071	.0070	.0099	.0079	.0100	.0067	.0088	.0036
PHASE ANGLE =	43.1	41.9	18.1	10.4	355.2	352.3	334.6	330.8
RADIUS = .400								
AMPLITUDE =	.0049	.0050	.0072	.0057	.0066	.0045	.0052	.0018
PHASE ANGLE =	39.0	37.0	18.0	10.2	359.5	357.5	339.1	340.0
RADIUS = .500								
AMPLITUDE =	.0018	.0021	.0031	.0022	.0018	.0013	.0008	.0009
PHASE ANGLE =	13.4	16.1	18.9	13.0	32.5	39.8	75.2	113.9
RADIUS = .600								
AMPLITUDE =	.0013	.0009	.0005	.0005	.0020	.0020	.0029	.0021
PHASE ANGLE =	302.5	301.8	40.8	130.5	139.7	139.4	144.1	140.4
RADIUS = .700								
AMPLITUDE =	.0015	.0010	.0006	.0021	.0023	.0033	.0022	.0020
PHASE ANGLE =	309.7	231.4	111.2	151.5	160.0	158.0	173.3	168.0
RADIUS = .800								
AMPLITUDE =	.0013	.0012	.0008	.0026	.0021	.0034	.0018	.0015
PHASE ANGLE =	330.1	190.8	125.1	151.5	178.3	167.5	215.8	196.2
RADIUS = .900								
AMPLITUDE =	.0007	.0013	.0011	.0019	.0019	.0022	.0015	.0007
PHASE ANGLE =	29.9	145.7	148.6	154.3	198.3	185.0	243.5	263.9
RADIUS = 1.000								
AMPLITUDE =	.0012	.0016	.0013	.0009	.0019	.0012	.0011	.0014
PHASE ANGLE =	94.4	114.2	165.4	164.2	211.4	237.4	258.2	331.3

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX H

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR EXPERIMENT 21

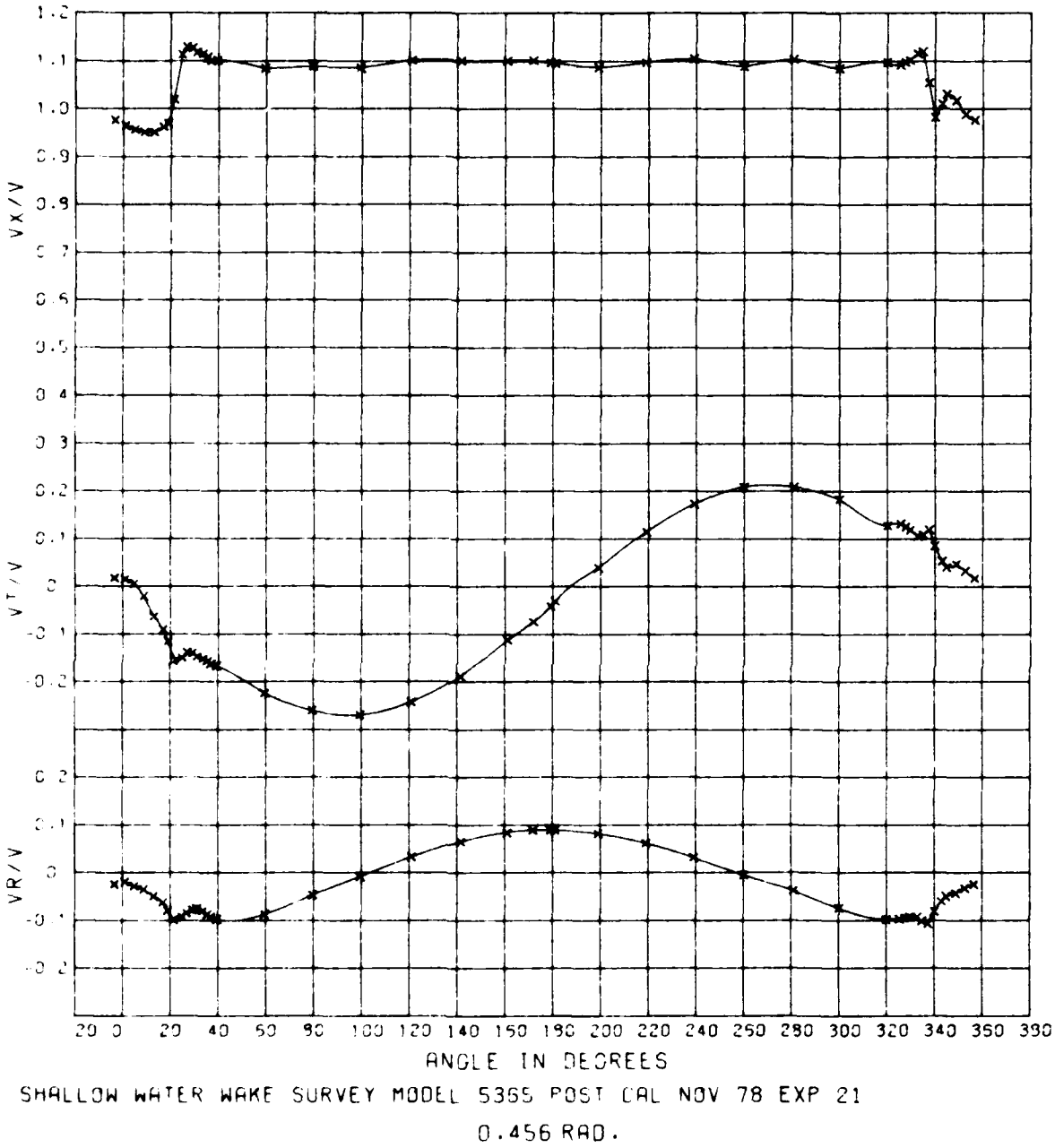


Figure H-1 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.456 for Experiment 21

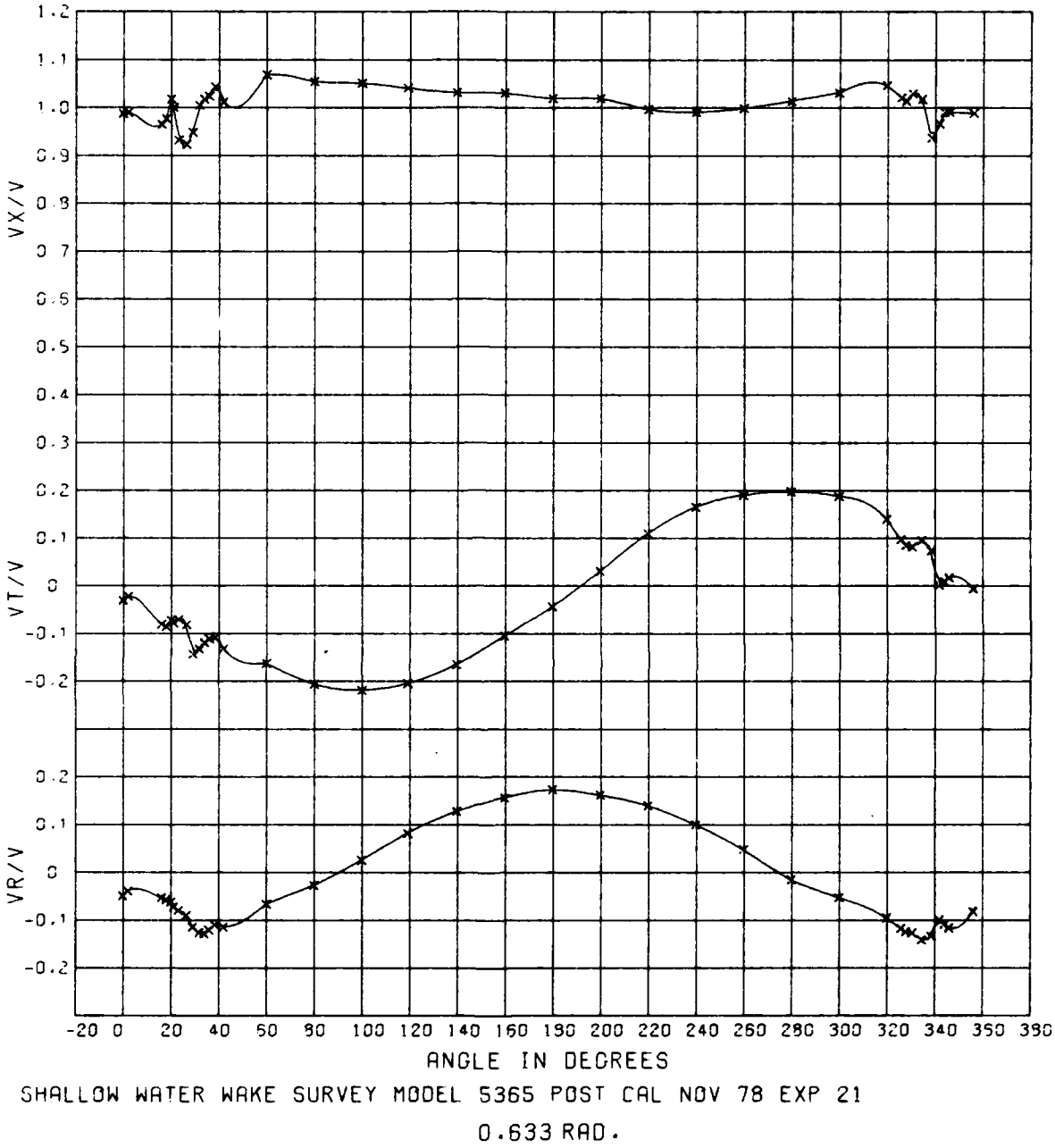


Figure H-2 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.633 for Experiment 21

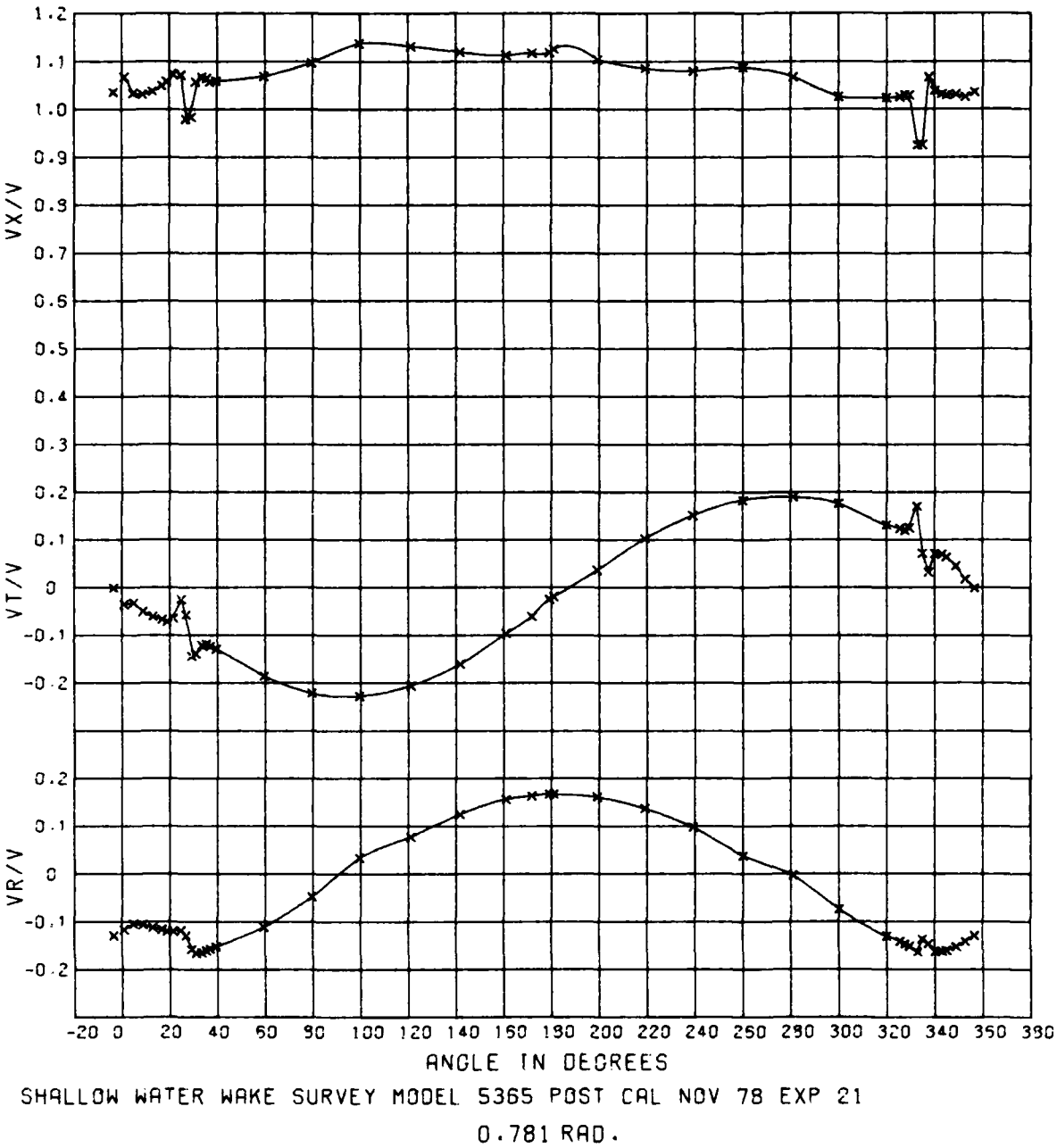


Figure H-3 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.781 for Experiment 21

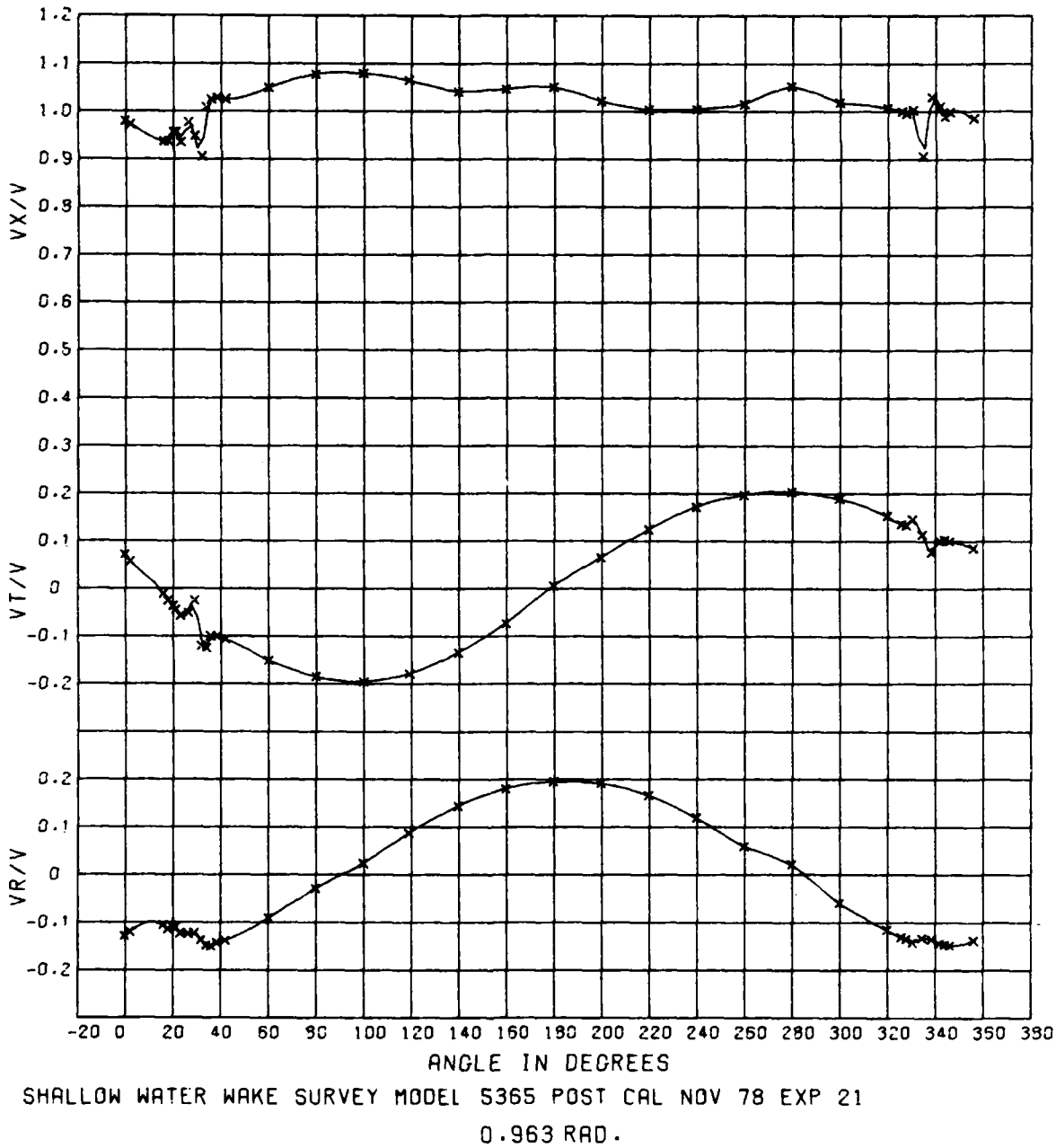


Figure H-4 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.963 for Experiment 21

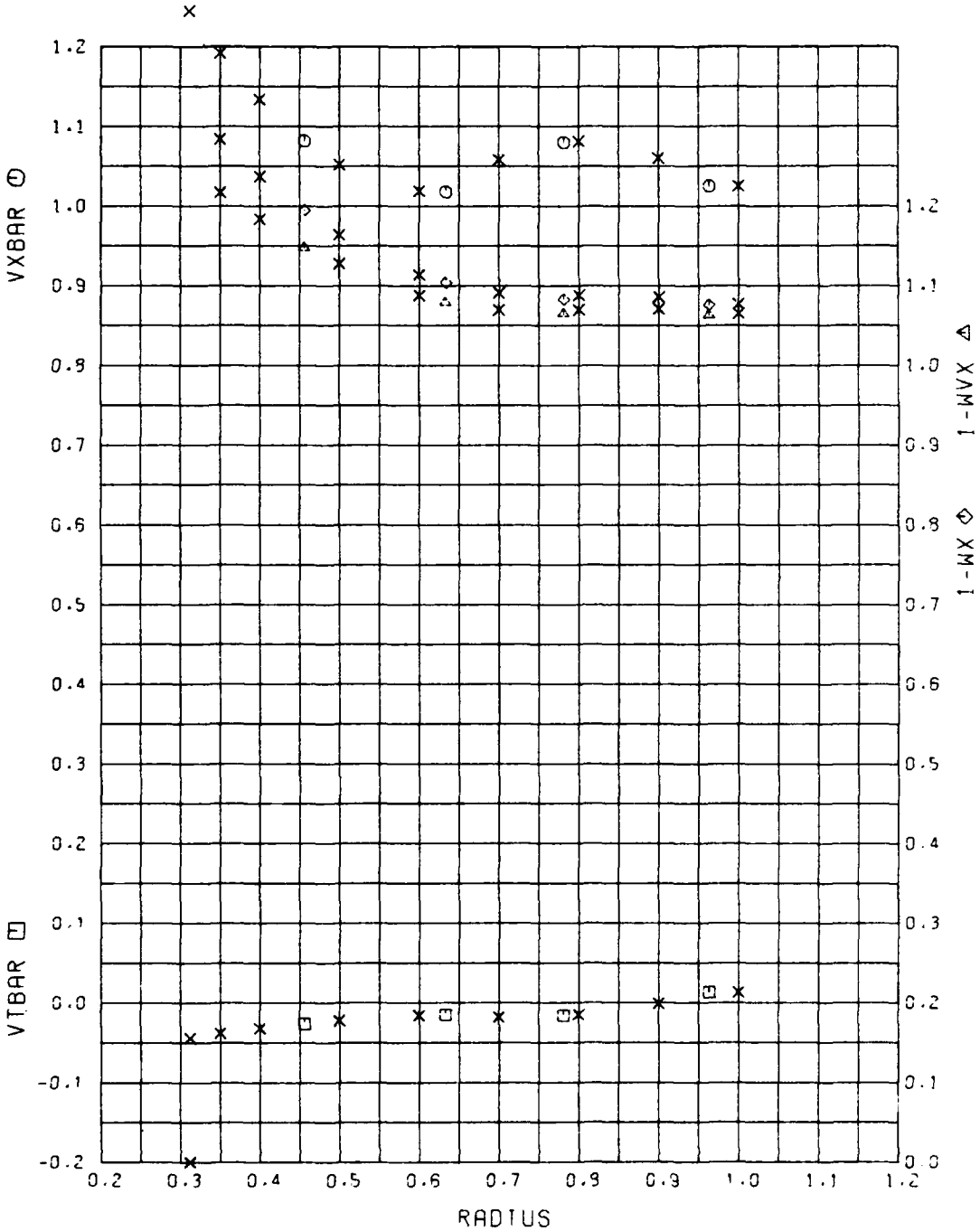


Figure H-5 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 21

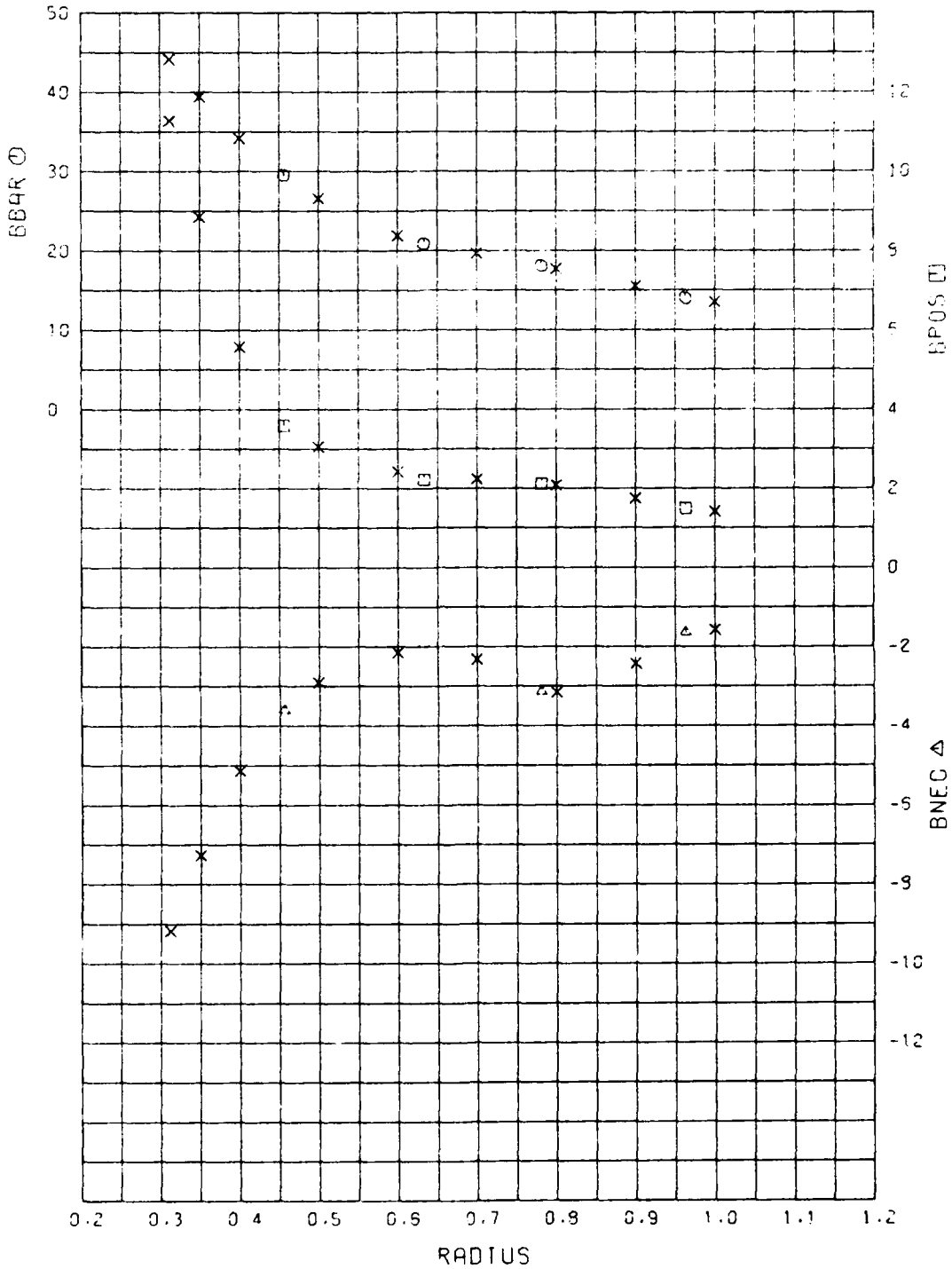


Figure H-6 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 21

TABLE H-1

INPUT DATA FOR HARMONIC ANALYSIS FOR R/V ATHENA, MODEL 5365, EXPERIMENT 21

RADIUS = .455

ANGLE	VX/V	VT/V	VR/V
-3.4	.977	.818	-.024
1.8	.966	.816	-.019
6.9	.957	.804	-.028
8.9	.951	-.870	-.035
13.0	.951	-.867	-.049
16.9	.963	-.891	-.062
18.9	.978	-.115	-.080
21.1	.983	-.148	-.097
22.0	1.057	-.166	-.101
26.9	1.114	-.150	-.092
26.9	1.170	-.130	-.086
28.9	1.151	-.135	-.082
29.6	1.125	-.143	-.073
31.0	1.118	-.140	-.075
33.9	1.115	-.157	-.088
35.5	1.109	-.156	-.087
37.0	1.101	-.163	-.097
39.6	1.102	-.167	-.097
39.6	1.095	-.274	-.087
39.6	1.089	-.268	-.086
99.6	1.086	-.278	-.088
121.0	1.102	-.267	.033
141.7	1.107	-.189	.065
161.0	1.101	-.112	.084
171.0	1.107	-.074	.089
179.1	1.097	-.041	.089
181.0	1.096	-.030	.089
199.2	1.087	.048	.082
219.1	1.097	.115	.062
239.2	1.104	.171	.032
260.0	1.089	.229	-.005
280.9	1.124	.269	-.057
300.0	1.085	.184	-.074
320.0	1.098	.120	-.090
325.6	1.092	.132	-.097
337.6	1.098	.126	-.095
339.6	1.102	.119	-.093
337.9	1.114	.104	-.093
334.9	1.120	.109	-.101
336.6	1.091	.120	-.100
338.3	1.019	.120	-.106
340.0	.987	.086	-.081
341.9	1.011	.056	-.040
344.9	1.031	.041	-.049
348.9	1.010	.048	-.043
352.0	.989	.036	-.032
356.6	.977	.010	-.024
361.0	.966	.016	-.019

RADIUS = .633

ANGLE	VX/V	VT/V	VR/V
-.3	.968	-.038	-.049
2.0	.990	-.022	-.039
14.9	.965	-.081	-.053
17.6	.977	-.086	-.057
19.4	1.004	-.085	-.065
20.0	1.031	-.060	-.059
21.0	1.080	-.070	-.072
23.0	.932	-.078	-.080
25.0	.947	-.058	-.077
27.0	.999	-.105	-.103
29.0	.968	-.143	-.114
31.7	1.005	-.133	-.126
33.0	1.018	-.119	-.120
34.0	1.074	-.111	-.120
37.7	1.074	-.112	-.115
39.0	1.092	-.104	-.104
41.0	1.012	-.132	-.114
49.9	1.069	-.143	-.066
79.0	1.055	-.286	-.027
99.0	1.092	-.219	.026
119.0	1.042	-.285	.082
139.6	1.031	-.169	.124
159.6	1.031	-.105	.154
179.6	1.026	-.034	.178
179.7	1.015	-.052	.176
199.6	1.078	.031	.142
219.6	.997	.110	.140
239.6	.991	.165	.108
259.7	.999	.190	.060
279.6	1.014	.190	-.015
299.7	1.071	.180	-.092
319.7	1.047	.140	-.095
329.7	1.021	.097	-.117
327.7	1.014	.089	-.124
329.7	1.010	.082	-.125
331.0	1.030	.081	-.120
333.7	1.041	.082	-.131
335.0	.995	.100	-.151
337.7	.997	.105	-.147
339.0	.917	.043	-.119
341.7	.967	.082	-.099
343.0	.991	.089	-.109
345.0	.991	.010	-.116
346.0	.989	-.006	-.082
349.7	.988	-.030	-.069

RADIUS = .781

ANGLE	VX/V	VT/V	VR/V
-3.6	1.036	-.081	-.129
1.0	1.040	-.039	-.116
4.9	1.033	-.032	-.105
8.9	1.031	-.050	-.106
13.0	1.038	-.069	-.112
16.9	1.050	-.067	-.116
18.9	1.058	-.072	-.120
21.0	1.064	-.073	-.121
22.0	1.081	-.057	-.120
24.9	1.072	-.025	-.118
26.0	.988	-.057	-.129
28.9	.985	-.142	-.157
29.6	.983	-.146	-.159
31.0	1.050	-.139	-.146
33.9	1.058	-.121	-.165
35.5	1.065	-.119	-.161
37.0	1.050	-.123	-.157
39.6	1.059	-.129	-.152
39.6	1.069	-.186	-.111
79.6	1.098	-.221	-.047
99.6	1.138	-.228	.034
121.0	1.132	-.206	.077
141.7	1.128	-.161	.125
161.0	1.113	-.096	.156
171.0	1.118	-.068	.163
179.1	1.119	-.024	.167
181.0	1.124	-.019	.167
199.2	1.106	.037	.161
219.1	1.086	.103	.137
239.2	1.088	.151	.098
260.0	1.088	.183	.038
280.9	1.068	.198	-.003
300.0	1.074	.174	-.074
320.0	1.024	.131	-.130
325.6	1.024	.174	-.141
327.6	1.030	.120	-.147
329.5	1.029	.125	-.151
332.0	.925	.170	-.164
334.9	.926	.072	-.136
336.0	1.066	.012	-.130
338.0	1.060	.053	-.155
340.0	1.039	.071	-.163
343.0	1.037	.078	-.162
346.9	1.029	.066	-.161
348.9	1.031	.066	-.157
352.0	1.024	.010	-.141
356.6	1.036	-.001	-.129
361.0	1.040	-.035	-.116

RADIUS = .963

ANGLE	VX/V	VT/V	VR/V
-.3	.988	.071	-.128
2.0	.973	.047	-.128
15.0	.937	-.031	-.106
17.0	.937	-.025	-.116
19.6	.959	-.035	-.110
20.0	.955	-.038	-.108
21.0	.957	-.044	-.111
23.0	.935	-.057	-.123
25.6	.967	-.067	-.128
27.0	.991	-.068	-.129
29.0	.968	-.075	-.122
31.7	.985	-.171	-.137
33.0	1.008	-.174	-.149
35.0	1.025	-.180	-.150
37.7	1.027	-.098	-.165
39.0	1.038	-.122	-.160
41.0	1.025	-.166	-.158
49.0	1.050	-.151	-.091
79.0	1.070	-.185	-.029
99.0	1.080	-.195	.025
119.0	1.066	-.179	.067
139.6	1.062	-.136	.106
159.6	1.067	-.073	.158
179.6	1.054	.005	.196
179.7	1.050	.007	.194
199.6	1.077	.065	.192
219.6	1.084	.174	.166
239.6	1.085	.172	.128
259.7	1.014	.147	.060
279.6	1.053	.206	.022
299.7	1.019	.189	-.059
319.7	1.088	.153	-.119
329.7	1.088	.136	-.138
327.7	.996	.111	-.136
329.7	1.089	.115	-.136
331.0	.997	.147	-.147
333.7	.988	.148	-.147
335.0	.986	.061	-.117
337.7	1.030	.059	-.179
339.0	1.027	.095	-.148
341.7	1.011	.101	-.144
343.0	.989	.107	-.146
345.0	.999	.108	-.148
346.0	.985	.086	-.137
349.7	.980	.071	-.128

TABLE H-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 21

WAKE ANALYSIS
PROGRAM VERSION OF 08/07/74

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET
JA = .739

RADIUS =	.456	.633	.781	.963	.312	.350	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.082	1.018	1.080	1.025	1.245	1.192	1.134	1.052	1.019	1.058	1.081	1.060	1.025
VTBAR =	-.026	-.015	-.016	.013	-.044	-.038	-.032	-.022	-.016	-.018	-.015	-.001	.013
VRBAR =	-.010	.021	.004	.021	-.077	-.056	-.032	.003	.020	.010	.004	.010	.021
1-WVX =	1.148	1.079	1.065	1.063	0.000	1.217	1.184	1.128	1.088	1.070	1.070	1.071	1.065
1-WX =	1.195	1.104	1.083	1.076	0.000	1.284	1.237	1.164	1.114	1.091	1.088	1.086	1.077
BBAR =	29.49	20.82	18.09	14.01	44.14	39.43	34.18	26.56	21.89	19.67	17.69	15.49	13.52
BPOS =	3.59	2.23	2.12	1.49	11.27	8.85	5.57	3.05	2.43	2.24	2.07	1.73	1.41
THETA =	110.00	95.00	102.50	92.50	25.00	25.00	25.00	87.50	70.00	100.00	102.50	100.00	92.50
BNEG =	-3.60	-1.93	-3.14	-1.63	-9.18	-7.27	-5.14	-2.91	-2.15	-2.32	-3.16	-2.43	-1.57
THETA =	340.00	337.50	332.50	335.00	5.00	5.00	5.00	340.00	337.50	332.50	332.50	332.50	335.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE H-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 21

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.0277	.0230	.0202	.0225	.0168	.0131	.0106	.0045
PHASE ANGLE =	266.6	264.2	276.1	261.2	260.0	242.1	247.4	198.6
RADIUS = .633								
AMPLITUDE =	.0188	.0224	.0210	.0045	.0013	.0050	.0059	.0026
PHASE ANGLE =	331.3	232.3	239.5	234.6	96.6	42.2	63.5	90.0
RADIUS = .781								
AMPLITUDE =	.0512	.0105	.0059	.0124	.0038	.0017	.0024	.0040
PHASE ANGLE =	298.7	272.9	61.2	64.1	230.9	67.8	106.7	69.8
RADIUS = .963								
AMPLITUDE =	.0321	.0299	.0169	.0092	.0066	.0084	.0029	.0051
PHASE ANGLE =	310.1	244.2	247.8	115.0	170.5	155.7	153.2	109.5

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0053	.0058	.0051	.0059	.0057	.0043	.0026	.0009
PHASE ANGLE =	142.2	136.2	120.4	103.5	94.8	87.9	75.8	348.5
RADIUS = .633								
AMPLITUDE =	.0053	.0043	.0036	.0024	.0028	.0036	.0048	.0052
PHASE ANGLE =	118.3	117.6	81.7	13.7	312.1	258.9	224.7	201.1
RADIUS = .781								
AMPLITUDE =	.0023	.0012	.0030	.0030	.0029	.0022	.0004	.0014
PHASE ANGLE =	163.5	162.4	208.1	262.6	238.9	275.3	201.5	29.2
RADIUS = .963								
AMPLITUDE =	.0049	.0022	.0019	.0024	.0031	.0025	.0016	.0002
PHASE ANGLE =	115.4	142.8	253.4	281.0	270.9	261.4	256.3	113.2

TABLE H-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 21

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.0951	.0383	.0359	.0382	.0504	.0451	.0412	.0120
PHASE ANGLE =	255.9	320.7	358.3	274.3	259.1	236.4	243.9	215.5
RADIUS = .350								
AMPLITUDE =	.0728	.0308	.0262	.0339	.0399	.0351	.0317	.0097
PHASE ANGLE =	256.6	308.5	342.4	271.0	259.3	237.1	244.4	213.2
RADIUS = .400								
AMPLITUDE =	.0484	.0249	.0197	.0284	.0279	.0237	.0207	.0070
PHASE ANGLE =	258.9	287.9	310.8	266.5	259.6	238.7	245.3	208.5
RADIUS = .500								
AMPLITUDE =	.0172	.0234	.0226	.0180	.0100	.0066	.0044	.0029
PHASE ANGLE =	282.5	249.9	259.9	256.7	260.4	249.3	252.4	182.6
RADIUS = .600								
AMPLITUDE =	.0157	.0235	.0232	.0079	.0003	.0036	.0046	.0022
PHASE ANGLE =	331.7	233.8	242.7	243.7	218.4	33.6	60.4	105.2
RADIUS = .700								
AMPLITUDE =	.0377	.0129	.0038	.0056	.0018	.0035	.0038	.0033
PHASE ANGLE =	304.5	249.9	234.5	60.9	234.7	38.5	76.0	71.6
RADIUS = .800								
AMPLITUDE =	.0524	.0109	.0064	.0131	.0041	.0015	.0023	.0040
PHASE ANGLE =	298.3	273.8	59.9	65.6	227.4	90.0	115.8	71.5
RADIUS = .900								
AMPLITUDE =	.0462	.0186	.0023	.0121	.0052	.0048	.0026	.0045
PHASE ANGLE =	300.9	256.2	270.5	81.8	196.5	151.6	148.8	90.7
RADIUS = 1.000								
AMPLITUDE =	.0321	.0299	.0169	.0092	.0066	.0084	.0029	.0051
PHASE ANGLE =	310.1	244.2	247.8	115.0	170.5	155.7	153.2	109.5

TABLE H-4 (Continued)

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0072	.0070	.0107	.0146	.0194	.0185	.0181	.0168
PHASE ANGLE =	203.6	171.5	175.4	133.2	113.0	82.5	56.3	17.6
RADIUS = .350								
AMPLITUDE =	.0060	.0064	.0083	.0118	.0151	.0141	.0131	.0116
PHASE ANGLE =	188.1	161.0	165.0	127.9	110.4	83.1	57.5	16.8
RADIUS = .400								
AMPLITUDE =	.0052	.0060	.0062	.0086	.0101	.0090	.0075	.0058
PHASE ANGLE =	164.5	148.2	145.9	118.6	105.3	84.4	60.9	14.5
RADIUS = .500								
AMPLITUDE =	.0056	.0056	.0049	.0044	.0031	.0014	.0012	.0022
PHASE ANGLE =	130.7	129.0	103.2	86.7	75.7	100.4	178.0	209.5
RADIUS = .600								
AMPLITUDE =	.0056	.0048	.0042	.0026	.0023	.0030	.0045	.0053
PHASE ANGLE =	118.9	119.0	83.0	33.3	327.9	256.3	223.2	201.8
RADIUS = .700								
AMPLITUDE =	.0031	.0023	.0017	.0017	.0023	.0027	.0022	.0014
PHASE ANGLE =	138.7	128.9	150.5	295.8	265.9	267.1	220.0	196.2
RADIUS = .800								
AMPLITUDE =	.0023	.0011	.0032	.0032	.0030	.0021	.0002	.0018
PHASE ANGLE =	164.7	170.4	212.7	260.8	237.3	276.3	186.5	28.0
RADIUS = .900								
AMPLITUDE =	.0029	.0013	.0031	.0032	.0031	.0021	.0004	.0017
PHASE ANGLE =	136.0	165.5	230.0	263.7	247.2	271.0	281.5	28.4
RADIUS = 1.000								
AMPLITUDE =	.0049	.0022	.0019	.0024	.0031	.0025	.0016	.0002
PHASE ANGLE =	115.4	142.8	253.4	281.0	270.9	261.4	256.3	113.2

TABLE H-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 21

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .456								
AMPLITUDE =	.2407	.0046	.0031	.0066	.0054	.0037	.0024	.0034
PHASE ANGLE =	176.5	83.6	133.0	141.9	148.2	130.4	101.8	40.3
RADIUS = .633								
AMPLITUDE =	.2084	.0124	.0065	.0059	.0042	.0026	.0023	.0006
PHASE ANGLE =	175.9	281.9	274.0	270.2	15.9	54.8	48.2	114.2
RADIUS = .781								
AMPLITUDE =	.2092	.0014	.0044	.0028	.0038	.0027	.0033	.0022
PHASE ANGLE =	175.5	92.9	266.4	256.2	259.0	245.1	272.9	280.8
RADIUS = .963								
AMPLITUDE =	.2004	.0107	.0023	.0055	.0037	.0052	.0025	.0030
PHASE ANGLE =	173.7	83.8	113.8	105.2	93.9	87.6	83.0	77.4

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .456								
AMPLITUDE =	.0043	.0060	.0040	.0038	.0016	.0017	.0009	.0013
PHASE ANGLE =	38.5	26.4	40.8	30.6	38.3	3.7	324.2	316.5
RADIUS = .633								
AMPLITUDE =	.0010	.0004	.0007	.0015	.0010	.0007	.0020	.0028
PHASE ANGLE =	153.3	149.3	32.2	10.5	19.3	101.8	138.0	140.8
RADIUS = .781								
AMPLITUDE =	.0024	.0007	.0018	.0025	.0033	.0031	.0021	.0008
PHASE ANGLE =	278.9	280.2	202.7	165.9	177.9	163.1	178.6	157.1
RADIUS = .963								
AMPLITUDE =	.0011	.0010	.0010	.0017	.0018	.0016	.0010	.0002
PHASE ANGLE =	77.9	119.4	178.7	165.2	167.2	159.7	161.1	214.6

TABLE H-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 21

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .312								
AMPLITUDE =	.2939	.0451	.0197	.0273	.0232	.0113	.0053	.0081
PHASE ANGLE =	177.0	96.7	110.6	121.6	177.7	181.7	195.1	16.1
RADIUS = .350								
AMPLITUDE =	.2775	.0321	.0144	.0207	.0174	.0085	.0036	.0065
PHASE ANGLE =	176.8	96.1	112.1	123.7	174.2	174.3	180.2	20.8
RADIUS = .400								
AMPLITUDE =	.2585	.0175	.0084	.0132	.0109	.0056	.0024	.0049
PHASE ANGLE =	176.7	94.3	115.9	128.5	166.9	159.0	145.3	28.6
RADIUS = .500								
AMPLITUDE =	.2293	.0033	.0015	.0033	.0030	.0032	.0028	.0024
PHASE ANGLE =	176.3	298.1	223.8	176.5	109.5	103.2	82.0	52.0
RADIUS = .600								
AMPLITUDE =	.2117	.0120	.0058	.0052	.0040	.0029	.0027	.0010
PHASE ANGLE =	176.0	282.5	272.6	265.0	26.7	63.1	57.3	90.6
RADIUS = .700								
AMPLITUDE =	.2097	.0054	.0059	.0048	.0026	.0012	.0018	.0015
PHASE ANGLE =	175.8	280.2	271.0	266.5	299.9	264.2	295.0	274.3
RADIUS = .800								
AMPLITUDE =	.2088	.0028	.0039	.0022	.0038	.0026	.0033	.0021
PHASE ANGLE =	175.4	93.5	264.8	250.3	254.7	242.2	271.5	282.7
RADIUS = .900								
AMPLITUDE =	.2047	.0084	.0010	.0023	.0013	.0012	.0010	.0006
PHASE ANGLE =	174.5	88.7	219.5	120.7	205.5	132.3	271.8	7.5
RADIUS = 1.000								
AMPLITUDE =	.2004	.0107	.0023	.0055	.0037	.0052	.0025	.0030
PHASE ANGLE =	173.7	83.6	113.8	105.2	93.9	87.6	83.0	77.4

TABLE H-6 (Continued)

SHALLOW WATER WAKE SURVEY MODEL 5365 POST CAL NOV 78 EXP 21
PROPELLER DIAMETER = 6.00 FEET JA = .739

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .312								
AMPLITUDE =	.0120	.0182	.0070	.0054	.0029	.0019	.0060	.0097
PHASE ANGLE =	17.1	20.6	47.5	64.3	140.6	345.1	308.0	318.0
RADIUS = .350								
AMPLITUDE =	.0096	.0131	.0061	.0049	.0019	.0020	.0044	.0070
PHASE ANGLE =	20.8	21.7	45.8	54.8	122.4	350.5	309.7	318.0
RADIUS = .400								
AMPLITUDE =	.0068	.0094	.0051	.0043	.0013	.0019	.0025	.0040
PHASE ANGLE =	27.3	23.4	43.5	42.7	77.8	356.7	313.1	317.8
RADIUS = .500								
AMPLITUDE =	.0028	.0038	.0031	.0034	.0018	.0014	.0003	.0004
PHASE ANGLE =	52.5	30.3	38.6	22.8	25.3	10.7	89.4	145.7
RADIUS = .600								
AMPLITUDE =	.0011	.0006	.0013	.0021	.0014	.0007	.0018	.0026
PHASE ANGLE =	120.7	73.1	33.6	11.4	16.6	59.1	133.4	140.5
RADIUS = .700								
AMPLITUDE =	.0015	.0005	.0008	.0009	.0016	.0021	.0020	.0017
PHASE ANGLE =	263.8	266.0	201.8	148.6	173.5	156.3	162.9	145.2
RADIUS = .800								
AMPLITUDE =	.0025	.0007	.0019	.0027	.0035	.0032	.0020	.0007
PHASE ANGLE =	280.6	280.4	202.3	166.7	178.0	163.6	180.5	162.2
RADIUS = .900								
AMPLITUDE =	.0011	.0001	.0017	.0027	.0032	.0028	.0015	.0003
PHASE ANGLE =	296.1	192.5	196.2	167.7	175.7	163.9	180.2	209.0
RADIUS = 1.000								
AMPLITUDE =	.0011	.0010	.0010	.0017	.0019	.0016	.0010	.0002
PHASE ANGLE =	77.9	119.4	178.7	165.2	167.2	159.7	161.1	214.6

APPENDIX I

VELOCITY COMPONENT RATIOS FOR R/V ATHENA AND MODEL EXPERIMENTS 8 AND 21

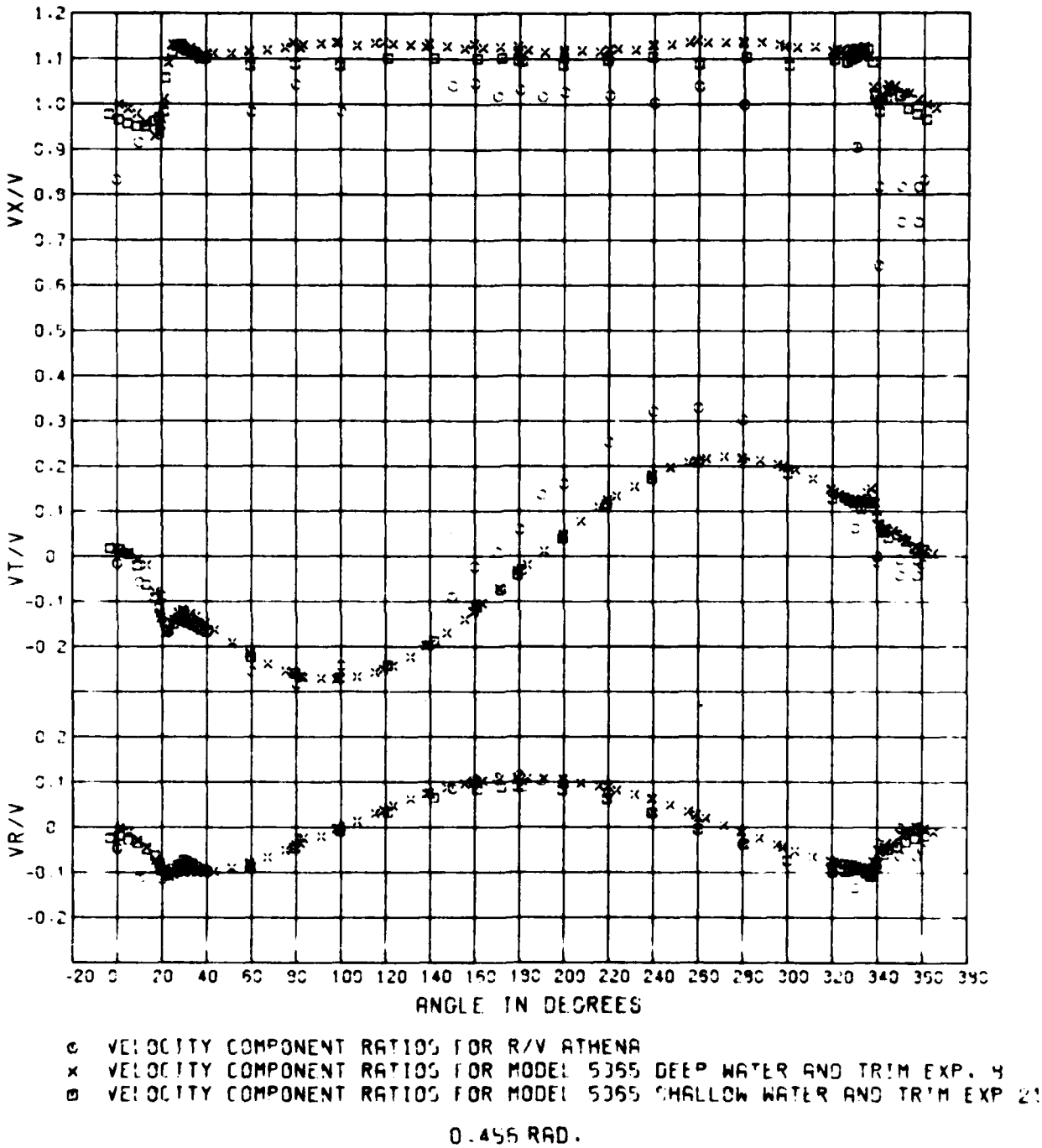


Figure I-1 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.456 Radius

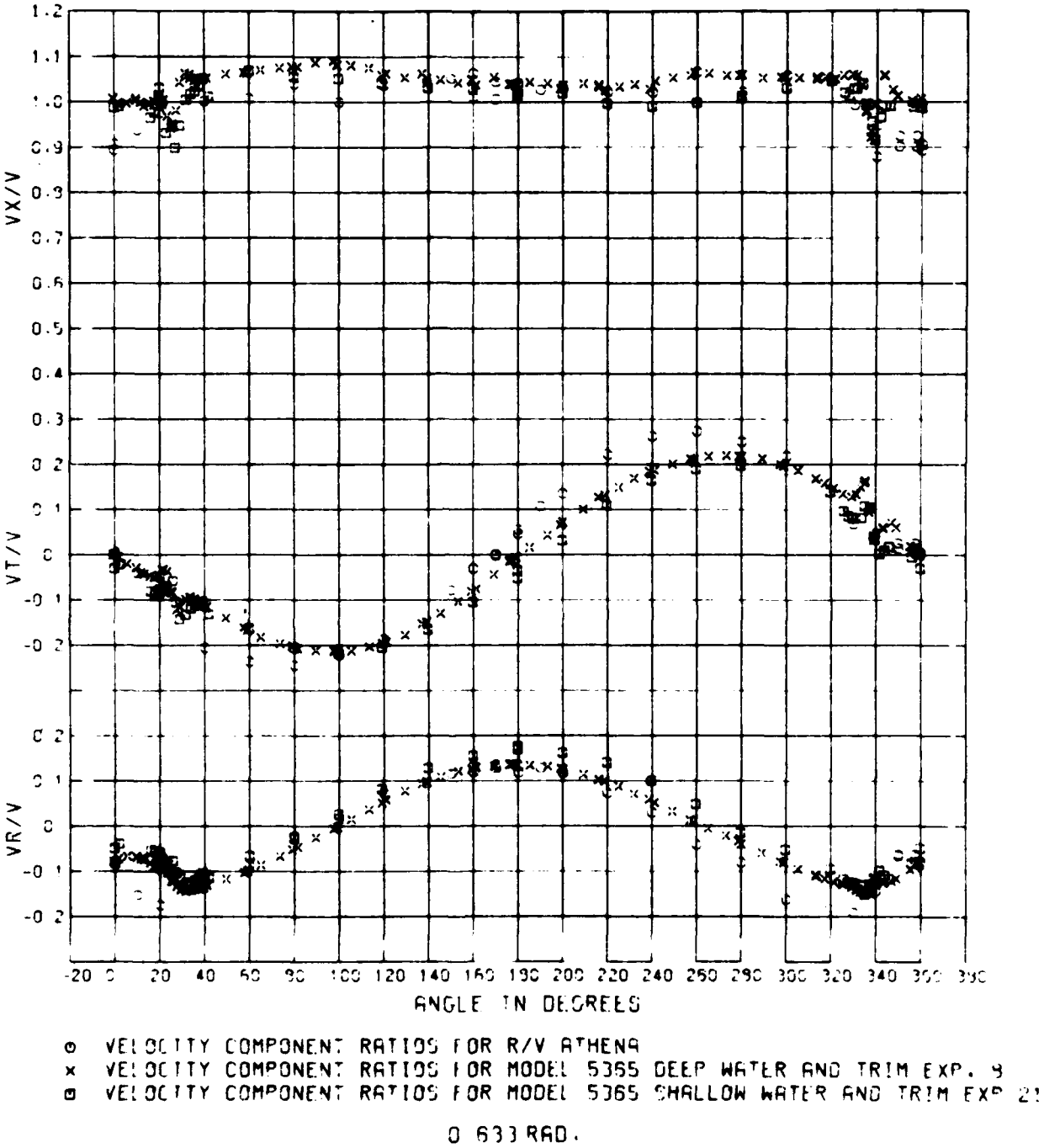


Figure I-2 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.633 Radius

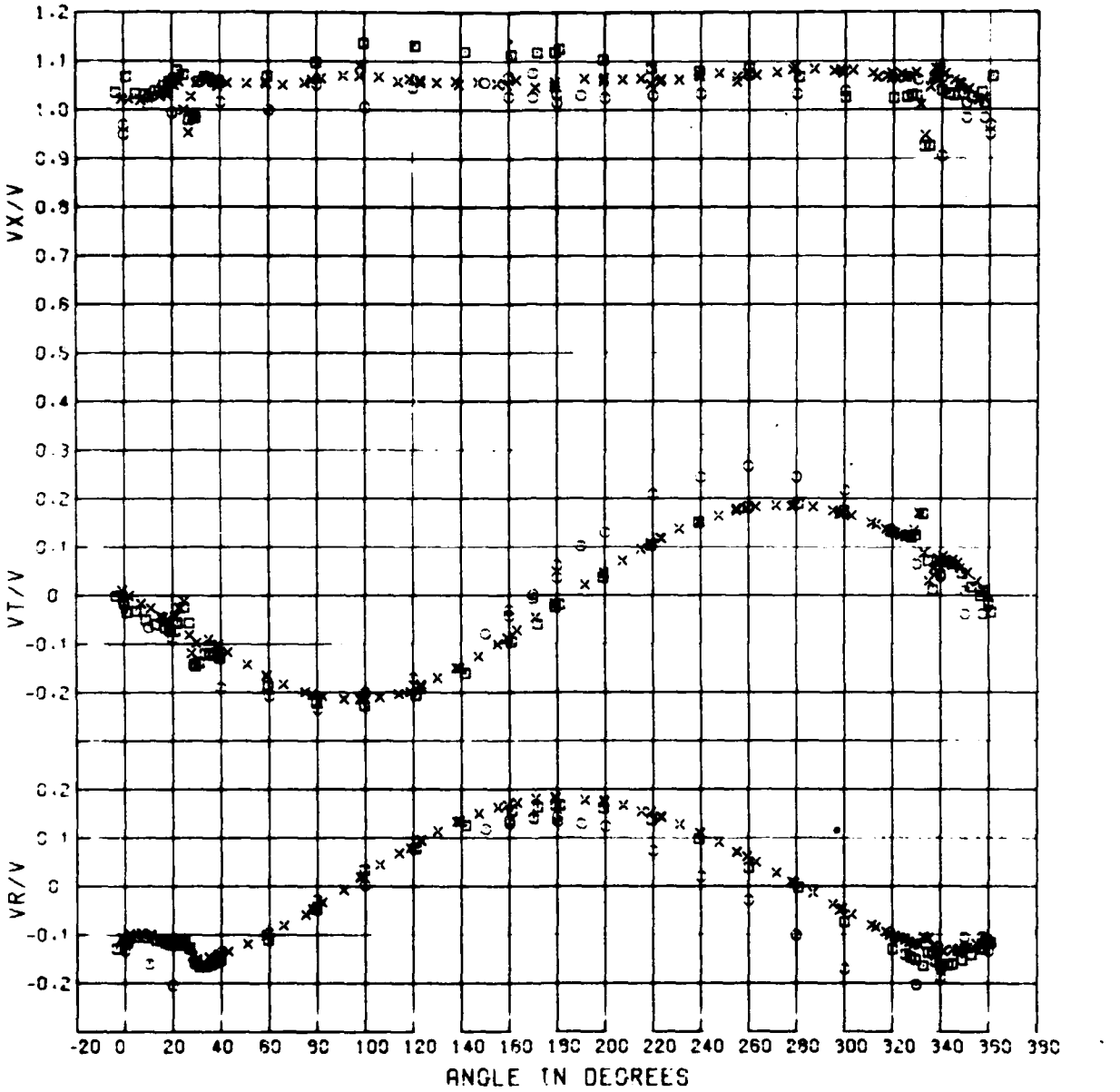


Figure I-3 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.781 Radius

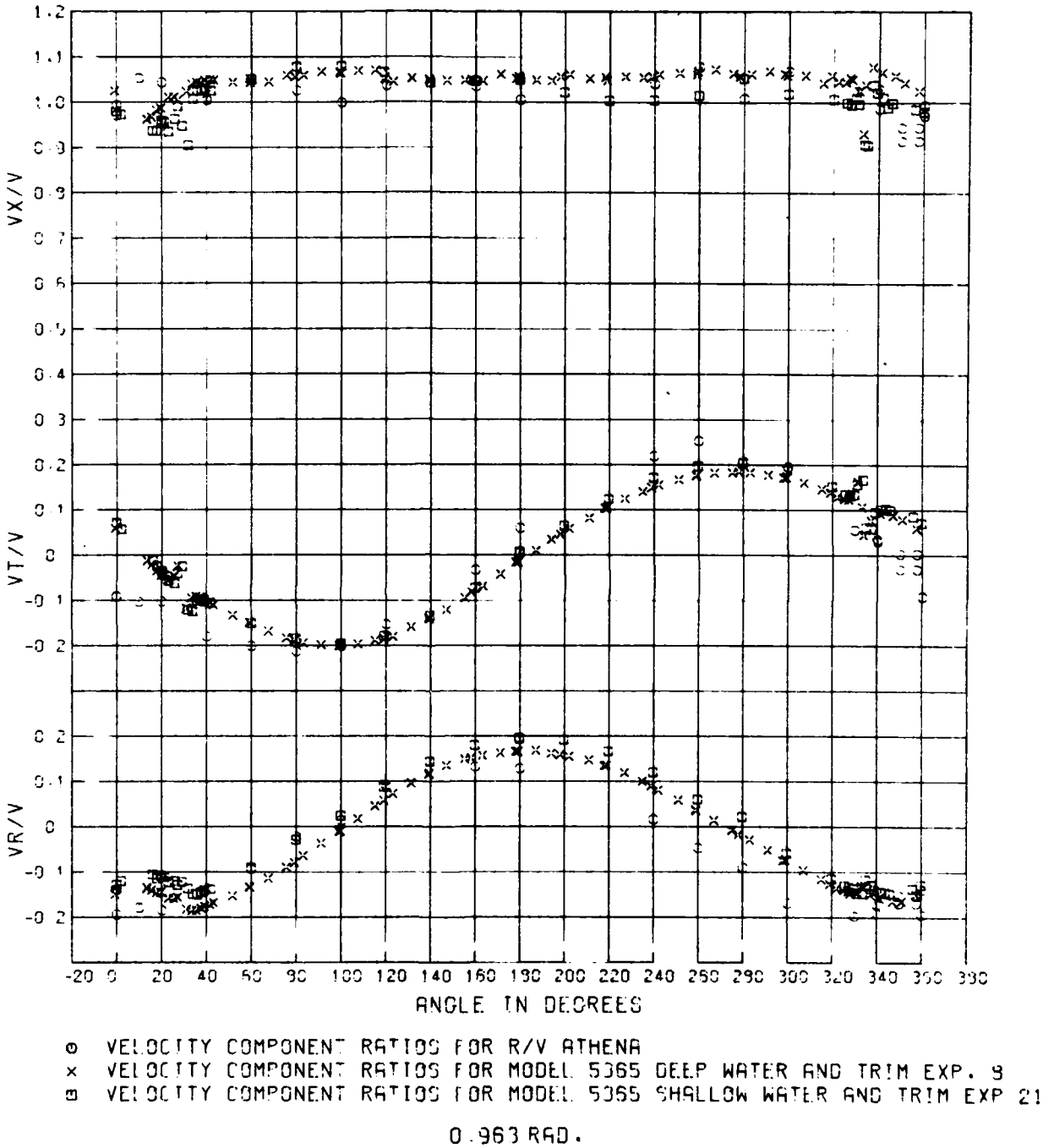


Figure I-4 - Composite Plot of Velocity Component Ratios for R/V ATHENA and Model Experiments 8 and 21 for the 0.963 Radius

TABLE I-1

INPUT DATA FOR HARMONIC ANALYSIS
OF WAKE DATA FOR R/V ATHENA

RADIUS = 0.456

ANGLE	VX/V	VT/V	VR/V
0.0	.833	-.016	-.047
10.0	.916	-.057	-.112
20.0	.953	-.088	-.115
60.0	.984	-.256	-.085
80.0	1.044	-.283	-.026
100.0	.985	-.242	.001
150.0	1.041	-.090	.086
160.0	1.047	-.023	.107
170.0	1.018	.010	.111
180.0	1.033	.060	.114
190.0	1.017	.137	.103
200.0	1.027	.161	.096
220.0	1.020	.253	.075
240.0	1.004	.322	.032
260.0	1.040	.330	.007
280.0	1.000	.304	-.037
330.0	.905	.042	-.134
340.0	.818	0.000	-.089
340.0	.644	-.013	-.035
350.0	.739	-.042	-.001
350.0	.818	-.007	-.063
357.5	.739	-.042	-.001
357.5	.818	-.007	-.063
360.0	.833	-.016	-.047

RADIUS = 0.633

ANGLE	VX/V	VT/V	VR/V
0.0	.907	.001	-.084
0.0	.894	.006	-.078
10.0	.938	-.040	-.152
20.0	.976	-.077	-.175
40.0	1.002	-.206	-.125
60.0	1.008	-.236	-.087
80.0	1.040	-.245	-.022
100.0	1.000	-.221	.017
120.0	1.038	-.187	.073
150.0	1.052	-.079	.116
160.0	1.064	-.030	.133
160.0	1.011	-.031	.119
170.0	1.045	.001	.135
170.0	1.007	-.002	.128
180.0	1.042	.046	.133
180.0	1.021	.055	.118
190.0	1.027	.107	.128
200.0	1.031	.136	.117
220.0	1.024	.222	.073
240.0	1.022	.262	.030
260.0	1.067	.274	-.041
280.0	1.023	.250	-.081
300.0	1.059	.219	-.162
330.0	.993	.068	-.191
340.0	.880	.034	-.121
340.0	.949	.047	-.144
350.0	.925	.025	-.063
350.0	.902	.014	-.066
357.5	.925	.025	-.063
357.5	.902	.014	-.066
360.0	.894	.006	-.078
360.0	.907	.001	-.084

RADIUS = 0.781

ANGLE	VX/V	VT/V	VR/V
0.0	.950	-.013	-.112
0.0	.969	-.019	-.133
10.0	1.010	-.066	-.161
20.0	.994	-.089	-.205
40.0	1.016	-.190	-.136
60.0	1.000	-.208	-.096
80.0	1.052	-.235	-.028
100.0	1.006	-.201	.003
120.0	1.045	-.171	.078
150.0	1.056	-.080	.118
160.0	1.027	-.043	.130
160.0	1.068	-.031	.136
170.0	1.026	-.007	.140
170.0	1.075	.001	.142
180.0	1.015	.062	.134
180.0	1.033	.036	.144
190.0	1.030	.101	.129
200.0	1.025	.130	.124
220.0	1.030	.209	.073
240.0	1.033	.244	.020
260.0	1.072	.267	-.029
280.0	1.033	.245	-.101
300.0	1.039	.218	-.171
330.0	1.061	.065	-.203
340.0	1.065	.045	-.167
340.0	.905	.040	-.188
350.0	.983	.010	-.127
350.0	1.013	-.038	-.105
357.5	.983	.010	-.127
357.5	1.013	-.038	-.105
360.0	.969	-.019	-.133
360.0	.950	-.013	-.112

RADIUS = 0.963

ANGLE	VX/V	VT/V	VR/V
0.0	.971	-.091	-.139
0.0	.994	-.091	-.194
10.0	1.053	-.103	-.175
20.0	1.044	-.102	-.184
40.0	1.005	-.180	-.136
60.0	1.008	-.201	-.093
80.0	1.026	-.213	-.022
100.0	.999	-.201	.013
120.0	1.036	-.153	.085
160.0	1.035	-.033	.132
180.0	1.006	.060	.128
240.0	1.041	.219	.016
260.0	1.079	.253	-.047
280.0	1.009	.208	-.090
300.0	1.069	.196	-.165
330.0	1.026	.056	-.197
340.0	1.030	.031	-.191
340.0	.987	.035	-.171
350.0	.945	-.031	-.165
350.0	.916	.003	-.152
357.5	.945	-.031	-.165
357.5	.916	.003	-.152
360.0	.994	-.091	-.194

DTNSRDC ISSUES THREE TYPES OF REPORTS

1. DTNSRDC REPORTS, A FORMAL SERIES, CONTAIN INFORMATION OF PERMANENT TECHNICAL VALUE. THEY CARRY A CONSECUTIVE NUMERICAL IDENTIFICATION REGARDLESS OF THEIR CLASSIFICATION OR THE ORIGINATING DEPARTMENT.

2. DEPARTMENTAL REPORTS, A SEMIFORMAL SERIES, CONTAIN INFORMATION OF A PRELIMINARY, TEMPORARY, OR PROPRIETARY NATURE OR OF LIMITED INTEREST OR SIGNIFICANCE. THEY CARRY A DEPARTMENTAL ALPHANUMERICAL IDENTIFICATION.

3. TECHNICAL MEMORANDA, AN INFORMAL SERIES, CONTAIN TECHNICAL DOCUMENTATION OF LIMITED USE AND INTEREST. THEY ARE PRIMARILY WORKING PAPERS INTENDED FOR INTERNAL USE. THEY CARRY AN IDENTIFYING NUMBER WHICH INDICATES THEIR TYPE AND THE NUMERICAL CODE OF THE ORIGINATING DEPARTMENT. ANY DISTRIBUTION OUTSIDE DTNSRDC MUST BE APPROVED BY THE HEAD OF THE ORIGINATING DEPARTMENT ON A CASE-BY-CASE BASIS.