

TABLE OF CONTENTS

LIST OF TABLES	viii
LIST OF FIGURES	xi
CHAPTER	
1. INTRODUCTION	1
2. BACKGROUND THEORY	7
2.1 Overview of Maneuvering Simulations	7
2.2 Mathematic Modeling and Hydrodynamic Derivatives	9
2.3 PMM Tests	13
2.3.1 Definitions of Motions	13
2.3.2 PMM Motions	15
2.3.3 Simplified Mathematic Models for PMM	19
2.3.4 Non-dimensionalization	22
2.3.5 Determination of hydrodynamic derivatives	23
2.3.5.1 Static drift test.....	24
2.3.5.2 Dynamic tests	24
2.3.5.3 Speed variation test.....	28
3. TEST DESIGN	30
3.1 Facility and coordinate systems	30
3.1.1 Towing Tank	30
3.1.2 PMM	31
3.1.3 Coordinate systems	32
3.2 Model	36
3.3 Mount and Mount Conditions	38
3.4 Test Conditions	40
3.5 Data Acquisition and Reduction Methodology	43
3.5.1 Forces and Moment and Motions	43
3.5.2 Phase-Averaged Flow field	45
3.6 Measurement Systems and Calibration Procedures	50
3.6.1 Carriage Speed.....	50
3.6.2 6-component loadcell	51
3.6.3 Motion Tracker	51
3.6.4 Stereo PIV	53
3.7 Data Acquisition Procedures	54
3.7.1 Forces and Moments.....	54
3.7.1.1 Data Acquisition Setup.....	54
3.7.1.2 Data Acquisition Procedures	55
3.7.2 Phase-Averaged Flowfield	56
3.7.2.1 Data Acquisition Setup.....	56
3.7.2.2 Data Acquisition Procedures	58
3.8 Data Reduction Procedures.....	59
3.8.1 Forces and Moment	59
3.8.2 Phase-Averaged Flowfield	59

4.	STATISTICAL CONVERGENCE	61
4.1	Forces and Moment and Motions Data.....	61
4.1.1	Time History of data.....	62
4.1.2	Stationarity Test.....	66
4.1.3	Statistical Convergence	70
4.2	Phase-Averaged Flow Field Data	83
5.	UNCERTAINTY ANALYSIS	95
5.1	UA for Forces and Moment and Motions.....	95
5.1.1	Bias limits	97
5.1.2	Precision limits	106
5.1.3	Total Uncertainty limits.....	107
5.1.4	UA Results and Discussions.....	107
5.1.5	Asymmetry Bias	111
5.1.6	UA Comparisons between Facilities	113
5.1.7	Facility Bias.....	115
5.2	UA for Phase-Averaged Flow Field	133
5.2.1	UA Methodology (ASME 2005)	137
5.2.2	UA Procedures.....	138
5.2.2.1	Systematic standard uncertainty	138
5.2.2.2	Random standard uncertainty	142
5.2.2.3	Combined standard and expanded uncertainty	143
5.2.3	UA Results and Discussions.....	143
5.2.3.1	Open water Tests	143
5.2.3.2	Pure yaw test.....	147
6.	RESULTS AND DISCUSSION	158
6.1	Forces and Moment and Motions	158
6.1.1	Time-mean and -histories of Data	158
6.1.2	Hydrodynamic Derivatives.....	165
6.1.2.1	Static drift test.....	165
6.1.2.2	Dynamic tests	165
6.1.2.3	Speed variation test.....	172
6.1.3	Comparisons between Facilities	181
6.1.4	Heave, Pitch, and Roll Motions.....	192
6.1.5	The Effects of Motions and Mount Conditions	202
6.2	Stereo-PIV measured flow fields	213
6.2.1	Pure sway flow field	213
6.2.1.1	Vortical structure of the flow	214
6.2.1.2	Phase-averaged velocity field.....	216
6.2.1.3	Turbulent kinetic energy and Reynolds stresses	219
6.2.1.4	Axial vorticity field	221
6.2.2	Pure yaw flow field	258
6.2.2.1	Vortical flow structure.....	260
6.2.2.2	Phase-averaged velocity field.....	261
6.2.2.3	Turbulent kinetic energy and Reynolds stresses	264
6.2.2.4	Axial vorticity.....	267
7.	SUMMARY AND CONCLUSIONS AND FUTURE WORK.....	308
	REFERENCES	316