CONTENTS

Uncertainty Analysis Spreadsheet For Speed Measurements

1 PURPOSE OF PROCEDURE

Provide a spreadsheet for calculating the bias and precision limits and total uncertainty using single or multiple test methods for model scale towing tank speed test following the Quality Manual Procedures 7.5-02-01-01 "Uncertainty Analysis in EFD, Uncertainty Assessment Methodology," 7.5-02-01-02 "Uncertainty Analysis in EFD, Guidelines for Resistance Towing Tank Tests," and 7.5-02-02-02, section 2.3.1.2 "Uncertainty Analysis in EFD, Example for Resistance Test."

2 PARAMETERS

The data reduction and bias equations are given in 7.5-02-02-02 "Uncertainty Analysis in EFD, Example for Resistance Test." The precision and total uncertainty equations are standard and are given in 7.5-02-01-01 "Uncertainty Analysis in EFD Uncertainty Assessment Methodology." The uncertainty analysis spreadsheet for speed test implements this procedure. Spreadsheet inputs and outputs are given in Sections 2.1 and 2.2, respectively, using same symbols, units, and definitions as 7.5-02-02-02 "Uncertainty Analysis in EFD, Example for Resistance Test." Spreadsheet table of contents is as follows:

Table of Contents

2.1 Inputs

Symbol	Units	Definition
		Facility
		Type of ship
		Period of tests performed
		References
N		Number of Tests
V	m/s	Measured speed value (single test)
σ_V	m/s	Standard deviation of V (single test)
V	m/s	Measured speed values (multiple test)
L_{WL}	m	Length along waterline
B	m	Beam
T	m	Draft, even keel
A_M	m^2	Midship sectional area
A_T	m^2	Sectional area of tow tank
B_T	m	Width of tow tank
h_T	m	Tow tank depth
g	m/s^2	Model basin gravity
N		Number of wheel windows
K		Coverage factor for standard deviation
n	pulse/s	Wheel pulse count

D	m	Wheel diameter
Δt	s	D/A and A/D card time bias
B_{n1}	bits	Pulse count calibration bias
B_{n2}	bits	Pulse count DAQ Board #1 bias
B_{n3}	bits	Pulse count DAQ Board #2 bias
B_{n4}	bits	Data reduction curve fit bias
B_D	m	Wheel diameter bias
$B_{\Delta t}$	s	Time base bias

2.2 Outputs

Symbol	Units	Definition
		Statement of purpose
V	m/s	Speed average (multiple test)
σ_V	m/s	Speed standard deviation (multiple test)
V	m/s	Model speed
Fr		Model Froude number
Fr_h		Froude number based on tow tank depth h
V_B		Blockage correction coefficient (from Tamura's formula, ITTC 1978)
		% of B_n^2 due to B_{n1}^2
		% of B_n^2 due to B_{n2}^2
		% of B_n^2 due to B_{n3}^2
		% of B_n^2 due to B_{n4}^2
B_n		Pulse count bias
		% of wheel pulse count range
		% of wheel diameter range
		% of time base range
θ_n	m/s	Sensitivity coefficient for wheel pulse count, n
θ_D	1/s	Sensitivity coefficient for wheel diameter, D
$\theta_{\Delta t}$	m/s^2	Sensitivity coefficient for time base, Δt
B_V	m/s	Total bias limit for Speed V
		% of Speed range, V
σ_V	m/s	Standard deviation of Speed V
M		Number of tests
P_V	m/s	Speed V precision limit
		% of Speed V
		% of Speed total Uncertainty, U_V due to bias
		% of Speed total Uncertainty, U_V due to precision
U_V		Speed total uncertainty
		% of Speed range, V

3 PROCEDURE

3.1 Instructions

The inputs appear as empty white boxes. The outputs appear as grey boxes and are calculated for the user. The user can select single or multiple test method by entering the corresponding number of tests, 1 for single test method, >1 for multiple test method. For single test method, enter average speed V and standard deviation of speed V from best available data. For multiple test method, enter measured speed V values from each test. There are 15 speed V inputs for multiple test

method. If the user does not have 15 speed V inputs, use as many as necessary and leave the remaining speed V inputs blank, not zero. Upon entering of all inputs, the uncertainty will be calculated for the user at the end of the spreadsheet.

3.2 Spreadsheet

The uncertainty analysis spreadsheet for speed test is provided by attached Speed-blank.xls excel document.

Speed-blank 4-11-02.lnk

4 VALIDATION

Example use of the uncertainty analysis spreadsheet for speed test for single and multiple test methods are provided by attached Speed-single test example.xls and Speed-multiple test example.xls excel documents. The examples are based on Longo and Stern (1998), which was one of the 22nd ITTC Resistance Committee member contributions to 7.5-02-02-02 "Uncertainty Analysis in EFD, Example for Resistance Test."

Speed-multiple test example 4-11-02.lnk

Speed-single test example 4-11-02.lnk

5 REFERENCES

Longo, J. and Stern, F., (1998) "Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512," Proc. 25th ATTC, Iowa City, IA.