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Prepared by	Approved
Resistance Committee of 23 <sup>rd</sup> ITTC	23 <sup>rd</sup> ITTC 2002
Date	Date

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## Uncertainty Analysis Spreadsheet for Wave Profile 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 wave profile test following the Quality Manual Procedures 7.5-02-01-01 “Uncertainty Analysis in EFD, Uncertainty Assessment Methodology,” and Longo, J. and Stern, F., (1998) “Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512,” Proc. 25<sup>th</sup> ATTC, Iowa City, IA.

### 2 PARAMETERS

The data reduction, bias and precision limit, and total uncertainty equations are given in Longo, J. and Stern, F., (1998) “Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512,” Proc. 25<sup>th</sup> ATTC, Iowa City, IA. The uncertainty analysis spreadsheet for wave profile test implements this procedure. Spreadsheet inputs and outputs are given in Sections 2.1 and 2.2, respectively, using definitions as Longo, J. and Stern, F., (1998) “Resistance, Sinkage and Trim, Wave Profile, and Nominal Wake and Uncertainty Assessment for DTMB Model 5512,” Proc. 25<sup>th</sup> ATTC, Iowa City, IA. Spreadsheet table of contents is as follows:


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1. General information
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3. Single or multiple test uncertainty
4. Input variables
5. Uncertainty analysis equations
6. Bias Limits
  - 6.1 Wave profile  $\square$  bias
  - 6.2 Sensitivity coefficient
7. Point Uncertainty
  - 7.1 X-position Bias
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#### 2.1 Inputs

Symbol	Units	Definition
		Facility
		Type of ship
		Period of tests performed
		References
$M$		Number of Tests
$\sigma_{\zeta_p}$	m	Standard deviation of wave profile $\zeta_p$ (single test)
$x$	m	$x$ -position along hull
$z_{P,M}$	m	Wave profile measured at each point along hull (single or multiple test)
$L_{WL}$	m	Length along waterline
$B$	m	Beam
$T$	m	Draft, even keel
$K$		Coverage factor for standard deviation
$B_{\zeta_1}$	m	Scale placement bias
$B_{\zeta_2}$	m	Marker placement bias
$B_{\zeta_3}$	m	Mark reapplication bias

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$B_{\zeta t}$	m	Wave elevation reading bias	$U_{\zeta}$	Point wave profile total uncertainty
$B_x$	m	x-position bias		% of $\zeta$
$dz/dx$		Point wave profile slope		Wave profile plot with uncertainty error bars


## 2.2 Outputs

Symbol	Units	Definition
		Statement of purpose
$z_p$	m	Average wave profile measured (single or multiple test)
$\zeta_p$		Average wave profile measured (single or multiple test)
$\sigma_{\zeta p}$		Standard deviation of wave profile $\zeta_p$ (single or multiple test)
$Fr$		Model Froude Number
$\zeta$	m	Range of wave profile % of $(B_{\zeta})^2$ % of $(B_{\zeta})^2$ % of $(B_{\zeta})^2$ % of $(B_{\zeta})^2$
$B_{\zeta}$	m	Wave profile bias % of $\zeta$
$\theta_{\zeta}$	1/m	Sensitivity coefficient for wave profile
$B_{\zeta}\theta_{\zeta}$		Product of wave profile bias and sensitivity coefficient % of $L$
$\theta_x$	1/m	Sensitivity coefficient for x-position
$B_{\zeta p}$		Point wave profile bias % of $(U_{\zeta})^2$
$P_{\zeta}$		Point precision % of $(U_{\zeta})^2$

## 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 measured wave profile  $z_p$  in column  $z_{p,1}$  only and standard deviation of wave profile  $z_p$  from best available data in the empty box preceding the table. For multiple test method, enter measured wave profile  $z_p$  in the columns of the table from each test. There are 5 wave profile  $z_p$  inputs for multiple test method. If the user does not have 5 wave profile  $z_p$  inputs, use as many as necessary and leave the remaining column inputs blank, not zero. The x positions should be non-dimensionalized by the model length. Upon entering of all inputs, the uncertainty will be calculated for the user at the end of the spreadsheet and the wave profile will be plotted with uncertainty error bars.

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### 3.2 Spreadsheet

The uncertainty analysis spreadsheet for wave profile test is provided by attached Wave Profile-blank.xls excel document.



"Wave  
Profile-blank.xls"

### 4 VALIDATION

Example use of the uncertainty analysis spreadsheet for wave profile test for single and multiple test methods are provided by attached Wave Profile-single test example.xls and Wave Profile-multiple test example.xls

excel documents. The examples are based on Longo and Stern (1998).



"Wave Profile-single  
test example.xls"



"Wave  
Profile-multiple test e  
xample.xls"

### 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. 25<sup>th</sup> ATTC, Iowa City, IA.