Contents

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Standard Format For Exchange of Sea Keeping Data on Computer-Compatible Media

1 PURPOSE OF PROCEDURE

To simplify the exchange of various types of seakeeping data between ITTC Member Organizations.

2 DESCRIPTION OF THE PROCEDURE

2.1 Introduction

The primary purpose of this format is to simplify the exchange of various types of sea keeping data between ITTC member Organizations. A modular file structure has been used in order to provide a reasonable degree of flexibility. Data are organised into groups with each group containing a particular type of data such as a frequency response function or a wave spectrum. The number of groups is arbitrary and they may be arranged in any order. Each group contains parameters which specify the type of data stored in the group. A typical file is organised as follows:

SHIP DEFINITION GROUP
WAVE SPECTRUM GROUP #1
WAVE SPECTRUM GROUP #2
.....
SHIP RESPONSE GROUP #1
SHIP RESPONSE GROUP #2
.....
SHIP RESPONSE GROUP #N

The format can accommodate seakeeping data from a variety of sources such as model tests, computer predictions or full scale trials.

All ship responses are defined with respect to a moving co-ordinate system *(x,y,z)*. This system moves in a horizontal plane with the mean velocity of the ship and the origin lies at the mean position of the ship cg. The x axis is towards the bow, the y axis is to starboard and the z axis is vertically downward. The positions for local responses such as accelerations or pressures are specified in a body axes co-ordinate system whose mean position coincides with the (*x,y,z*) system.

Any symbols which are not explicitly defined in this document are defined in References 1 and 2.

2.2 File Structure

The data are organised into one or more files with one file being used for each ship condition. A file consists of a set of data groups. A data group consists of a set of records. Each record contains 1 to 80 characters and is either a card or a card image.

Although magnetic tape will normally be used as the exchange medium, the records have been made card images so that other media such as diskettes or cards can also be used without changing the format. The card image

record also facilitates editing the data file with standard Text Editors after it has been loaded into a user's computer system.

The record formats are defined in terms of Fortran format specifications since this language is used by the vast majority of ITTC member organizations.

Each data group has the following basic format where N is the number of records in the group:

RECORD	CONTENTS	FORMAT
1	K1, K2, K3, K4	(4I8)
2 to *N-1*	Data <Records>	variable
N	%	(A1)

K1, K2, K3 and K4 are integer variables which are used to specify the type of data contained in the Data Records. The format of the data records depends on K1 and is defined in the following sections. The group may contain any number of data records. The last record in a group contains % as its first character to mark the end of the group.

The % record is used to delimit the group instead of a record count in order to simplify editing of the file. If a record count were used, it would have to be updated each time records are inserted or deleted. The % record also allows the beginning of the next group to be easily located in the event of a read error.

K1 identifies the basic class of data in the group as follows:

K1	CLASS OF DATA
1	Ship Definition
2	Uni-directional Wave Spectrum
3	Multi-directional Wave Spectrum
4	Time Domain Wave Data
5	Freq. Domain Ship Response Data
6	Time Domain Ship Response Data
9999	(End of File Marker)

The format of each of these classes is defined in the following sections. Other values of K1 may be used to define additional classes of data in the future. K1 values above 100 may used to define special data groups for local use by an organisation. When reading an exchange file, however, all data groups for which K1>100 are normally skipped.

Comment records may also be included anywhere in the file as an option to improve readability. Each comment record must contain * as its first character. All such records are skipped when processing the data.

2.3 Format of Ship Definition Group

RECORD(S).	CONTENTS	FORMAT
1	K1, K2, K3, K4	(4I8)
2	SDTEXT	(80A1)
3	L, B, T, XFG, ZKG, CB, CWP, CVP	(8F10.4)
4 to N-1	(User-defined Hull Definition Records)	variable
N	%	(A1)

K1 = 1
K2,,X3, X4 = 0, 0, 0
SDTEXT = 80-chatacter text string describing ship and condition.
L = reference ship 1ength (m). (usually L_{PP})
B = reference beam (m).
T = reference draught (m).
XFG = distance of centre of gravity from forward perpendicular (m).
ZKG = distance of centre of gravity from the moulded base or keel (m).
CB = block coefficient
CWP = designed load waterline coefficient
CVP = vertical prismatic coefficient

Note: There is too much variation in the methods used for detailed hull definition for a standard format to be defined. Thus, records 4 to N-1 are normally skipped when reading an exchange file. They may be used locally, however, for station offsets, mass distribution, etc.

2.4 Format of Uni-Directional Wave Spectrum Groups

RECORD(S)	COTENTS	FORMAT
1	K1, K2, K3, K4	(4I8)
2	WSTEXT	(80A1)
3	JMAX, DW, EDF	(I8,2F10.5)
4 to N-1	(S1ZET(J) , J=1,JMAX)	(8F10.4)
N	%	(A1)

K1 = 2
K2 = a tag no. which is used to label each particular spectrum (1-9999).
K3, K4 = 0, 0
WSTEXT = 80-character text string describing the wave spectrum.
JMAX = number of tabulated power spectral-density values.
DW = $\Delta\omega$ between tabulated spectral values in radians per second (rps).
EDF = equivalent number of Chi-square degrees of freedom per spectral estimate.
S1ZET(J) = $S_\varsigma(\omega)$ at ω = (J-1) *DW rps. S1ZET has units of m**2/rps.

Note: The parameter EDF applies only to measured spectra.
EDF is formally defined as 2* (ν/σ)**2 where ν and σ are the mean and standard deviation of the power spectral density estimates S1ZET(J) . It is calculated on the basis of the specific spectral analysis procedure used. EDF is usually given by 2*Be*Tr where Tr is the record length in seconds and Be is the effective filter bandwidth of the spectral analysis procedure in Hz.

2.5 Format of Multi -Directional Wave Spectrum Groups

RECORD(S)	CONTENTS	FORMAT
1	K1, K2, K3, K4	(4I8)
2	WSTEXT	(80A1)
3	JMAX, KMAX, KSYM, DW, DMUW, EDF	(3I8,3F10.5)
4 to N-1	((S2ZET(J,K) , J=1,JMA.X) , K=1,KMAX)	(8F10.4)
N	%	(A1)

K1 = 3
K2 = a tag no. which is used to label each particular spectrum (1-9999).
K3, K4 = 0, 0
WSTEXT = 80-character text string describing the wave spectrum.
JMAX = number of frequencies at which the spectrum is tabulated.
KMAX = number of wave angles at which the spectrum is tabulated.
KSYM = 0 if spec. is not symmetric; KSYM = 1 if spec. is symmetric about $\mu = 0$
DW = $\Delta\omega$ between tabulated spectral values in radians per second (rps).
DMUW = $\Delta\mu$ between tabulated spectral values in radians.
EDF = equivalent number of Chi-square degrees of freedom per spectral estimate
S2ZET(J,K) = $S_\varsigma(\omega,\mu)$ at ω = (J-1) *DW rps and μ = (K-1) DMUW radians.
S2ZET(J,K) has units of m**2/(rps*radian).

Note: If KSYM=1, S2ZET is only tabulated over the μ range from 0 to π since S2ZET(ω,$-\mu$) = S2ZET(ω,μ) . If KSYM=O, S2ZET is tabulated over the μ range from 0 to 2π . If KSYM=1, S2ZET is also assumed to be zero at angles greater than (KMAX-1)*DMUW. Thus, S2ZET is usually only tabulated over the range from 0 to $\pi/2$ when KSYM=1.

2.6 Format of Time Domain Wave Data Groups

This format can be used to store a general unidirectional time domain wave record. The time series samples are scaled as 16-bit integers in order to conserve space since wave records may be quite long. A single scaling factor SCF is used to convert the integer samples back to floating point wave elevation values in units of metres.

RECORDS(S)	CONTENTS	FORMAT
1	K1, K2, K3, K4	(4I8)
2	WVTEXT	(80A1)
3	XP, YP	(2F10.4)
4	JMAX, DT, SCF	(I8, 2E15.7)
5 to N-1	(M(J), J=I,JMAX)	(13I6)
N	%	(A1)

K1 = 4
K2 = a tag number used to identity each particular wave record (1-9999)
K3 = wave probe index: K3 = 0 it the wave record was measured with a moving probe.
K3 = 1 if the wave record was measured with a fixed probe.
K4 = 0
WVTEXT = 80-character text string describing the wave record.
XP, YP = mean position of the wave probe in the moving co-ordinate system (x,y,z) in metres. If a fixed probe is used, (XP,YP) is the position of the probe at time t = 0.
JMAX = number of integer time series samples in the wave record.
DT = time interval between samples in seconds.
SCF = scale factor for integer time series. ZETA(t) = SCF*M(J) where ZETA is the wave elevation in metres and t = (J-1)*DT seconds. SCF must be chosen such that the absolute value of M(J) is less than 32768 for all J.
M(J) = sample J of scaled integer time series. M(J) = ZETA(t)/SCF at t = (J-1)*DT.

2.7 Format of Frequency Domain Ship Response Data Groups

RECORD(S)	CONTENTS	FORMAT
1	K1, K2, K3, K4	(4I8)
2	RSTEXT	(80A1)
3	MFP, NSF, WASH	(2I8, F10.5)
4	FN, XB, YB, ZB	(4F10.4)
5	NWD, (WD(J), J=1,NWD)	(I8, 7F10.2)
6 to N-1	WTT, (GR(J), J=1,NWD)	(F9.4, 7F10.5)
N	%	(A1)

Note: Any number of WTT, GR records may be included after record 5.

K1 = 5
K2 = type of ship response. (See Table 1)
K3 = type of incident waves. (See Table 2)
K4 = source of response data; K4=1 for model tests, K4=2 for full scale trials and K4=3 for computer predictions.
RSTP.XT = 80-character text string describing the ship response data. This record is not processed but is included to make the file more readable for editing. For example, if K2=5 and K3=3, RSTEXT might be as follows: ND PITCH-FREQUENCY RESPONSE FUNCTION (AMPLITUDE).
MFP = fetch index for ITTC wave spectrum. (See Table 2).
NSF = wave spectrum spreading function parameter. (See Table 2)
WASH = wave amplitude, wave slope or significant wave height depending on the value of K3. (See Table 2)
FN Froude Number.
XB, YB, ZB = position at which the response has been measured or calculated in the body axes co-ordinate system. (m)
NWD = no of wave direction angles at which the response is tabulated. NWD may range from 1 to 7. Additional data groups may be used when more than 7 wave directions are required.
WD(J) = wave direction angle in degrees relative to mean heading of ship.
$WD(J) = \mu - \overline{\psi}$ if K3 < 6 ; $WD(J) = \mu_0 - \overline{\psi}$ if K3 > 5
WTT = nondimensional wave component frequency, average wave period or wave data tag number depending on K3. (See Table 2) .

GR(J) = generalized ship response at wave direction WD(J). GR is either the amplitude or phase of a nondimensional frequency response function or a dimensional RMS or Average value in irregular waves. (See Table 2)

Note: When the file is written, format F10.5 is suitable for GR for most responses. Some responses may require a different decimal point position, however. Therefore, format F10.d may be used to write the GR records where d may range from 1 to 8. Format F10.5 can be always be used to read the records regardless of which value of d was used to write them. The actual decimal point position in the record will override the implicit position in the F10.5 specifier.

TABLE 1

K2	TYPE OF RESPONSE	RMSAV UNITS
1	Surge	m
2	Sway	m
3	Heave	m
4	Roll	deg
5	Pitch	deg
6	Yaw	deg
7	Surge velocity	m/s
	Sway velocity	m/s
9	Heave velocity	m/s
10	Roll rate	deg/s
11	Pitch rate	deg/s
12	Yaw rate	deg/s
13	Surge acceleration (Note 1)	m/s**2
14	Sway acceleration (Note 1)	m/s**2
15	Heave acceleration (Note 1)	m/s**2
16	Surge acceleration (Note 2)	m/s**2
17	Sway acceleration (Note 2)	m/s**2
18	Heave acceleration (Note 2)	m/s**2

K2	TYPE OF RESPONSE	RMSAV UNITS
19	Roll acceleration	deg/d**2
20	Pitch acceleration	deg/s**2
21	Yaw acceleration	deg/s**2
22	Relative vertical motion	m
23	Relative vertical velocity	m/s
24	Relative vertical acc.	m/s**2
25	Hydrodynamic Pressure	kN/m**2
26	Longitudinal Force	kN
27	Longitudinal Shear Force	kN
28	Vertical Shear Force	kN
29	Torsional Moment	kNm
30	Horizontal Bending Moment	kNm
31	Vertical Bending Moment	kNm
32	Added Resistance in Waves	kN
33	Added Thrust due to Waves	kN
34	Added Torque due to Waves	kNm
35	Added RPM due to Waves	rpm
36	Added Power due to Waves	kW

Note 1: Accelerations 13-15 are relative to the moving co-ordinate system (x,y,z) and do not include gravity.

Note 2: Accelerations 16-18 are accelerations 13-15 resolved along the instantaneous position of the body axes co-ordinate system with gravity included. Thus, 16-18 are the

accelerations which would be sensed by accelerometers strapped down to the body axes at (XB, YB, ZB)

Note 3: Responses 26-31 are the dynamic forces and moments acting on the hull caused by the action of waves and ship motions. They are resolved along the body axes.

TABLE 2

K3	TYPE OF WAVES	MFP	NSF	WASH	WTT	GR
1	Regular, Constant Amplitude	0	0	ζ_A	$\omega\sqrt{L/g}$	H
2	Regular, Constant Amplitude	0	0	ζ_A	$\omega\sqrt{L/g}$	ε
3	Regular, Constant Slope	0	0	$k\zeta_A$	$\omega\sqrt{L/g}$	H
4	Regular, Constant Slope	0	0	$k\zeta_A$	$\omega\sqrt{L/g}$	ε
5	Specified Time Domain Wave Record	0	0	$\breve{\zeta}_{W1/3}$	WVTAG	RMSAV
6	15th ITTC Spectrum with opt. spreading function	m	n	$\breve{\zeta}_{W1/3}$	T	RMSAV
7	Specified unidirectional spectrum with opt. S. f.	0	n	$\breve{\zeta}_{W1/3}$	WVTAG	RMSAV
8	Specified multi-directional spectrum	0	0	$\breve{\zeta}_{W1/3}$	WVTAG	RMSAV

H = amplitude of non dimensional frequency response function. For example, if K2=4, $H = \phi_A/(k\zeta_A)$ etc. The frequency response functions are made non dimensional by dividing by the following factors:

linear motion:	ζ_A	force:	ρ g L ζ_A
linear velocity:	$\zeta_A\sqrt{g/L}$	moment:	ρ g L²B ζ_A
linear acceleration:	ζ_A g/L	added resistance:	$\rho g\zeta_A^2 B^2$ /L
angle:	$k\zeta_A$.	added thrust:	$\rho g\zeta_A^2 B^2$ /L
angular velocity:	$k\zeta_A\sqrt{g/L}$	added torque:	$\rho g\zeta_A^2 B^2$ D/L
angular acceleration:	$k\zeta_A$ g/L	added rpm:	$\rho g\zeta_A^2 B^2$ /(LD³V)
hydrodynamic pressure:	ρ g ζ_A	added power:	$\rho g\zeta_A^2 B^2$ V/L

ε = phase lead in degrees of frequency response function relative to wave elevation at midship. (See Ref. 1)

m = index specifying the type of ITTC wave spectrum. m=0 for open ocean spectrum $S(\omega)$. m=1 for limited fetch spectrum $S_J(\varpi)$ (See Ref.3)

n = index specifying type of spreading function used. n=0 for long-crested waves. Otherwise, n is the power of cosine used in the ITTC spreading function.

k = wave number = $2\pi / \lambda = \omega^2 / g$

T = average wave period = $2\pi . m_0 / m_1$

RMSAV = dimensional RMS or Average value of the response in the specified waves.
RMSAV = RMS value if K2 < 32 and RMSAV = average value if K2 > 31.
The dimensional units are listed in Table 1.

WVTAG = tag number K2 of the data group containing the incident wave description.

2.8 Format of Time Domain Ship Response Data Groups

This format can be used to store time histories of ship responses. The time series samples are scaled as 16-bit integers in order to conserve space. A single scaling factor SCF is used to convert the integer samples back to the actual response values in appropriate physical units as listed in Table 1 of Section 7.

RECORD(S)	CONTENTS	FORMAT
1	K1, K2, K3, K4	(4I8)
2	RSTEXT	(80A1)
3	MFP, NSF, WASH, WTT, WD	(2I8, 3F10.5)
4	FN, XB, YB, ZB	(4F10.4)
5	JMAX, DT, SCF	(I8, 2E15.7)
6 to N-1	(M(J), J=1,JMAX)	(13I6)
N	%	(A1)

K1 = 6
K2 = type of ship response. (See Table 1.in Section 7
K3 = type of incident waves. (See Table 2 in Section 7)
K4 = source of response data; K4=1 for model tests, K4=2 for full scale trials and K4=3 for computer predictions.
RSTEXT = 80-character text string describing the ship response.
MFP = fetch index for ITTC wave spectrum. (See Table 2 in Section 7)
NSF = wave spectrum spreading function parameter. (See Table 2 in Section 7)
WASH = wave amplitude, wave slope or significant wave height depending on the value of K3. (See Table 2 in Section 7)
WTT = non dimensional wave component frequency, average wave period or wave data tag number depending on the value of K3. (See Table 2 in Section 7)
WD = wave direction angle in degrees relative to mean heading of ship. $WD = \mu - \overline{\psi}$ if K3<6; $WD = \mu_0 - \overline{\psi}$ if K3>5.
FN = Froude Number.
XB,YB,ZB = position at which the response has been measured or calculated in the body axes co-ordinate system (m).
JMAX = number of time series samples.
DT = time interval in seconds between time series samples.

SCF = scale factor for the integer time series. R(t) = SCF*M(J) where R is the physical response in the units of Table 1 in Section 7 and t = (J-1)*DT. SCP must be chosen such that the absolute value of M(J) is less than 32768 for all J.

M(J) = sample J of scaled integer time series where J = 1 to JMAX. M(J) = R(t)/SCF at t = (J-1)*DT seconds where R(t) is the dimensional ship response

2.9 Magnetic Tape Format

The best medium for exchange of seakeeping data is magnetic tape Standard 0.5 inch 9-track tape should be used with either 1600 bpi PE or 800 bpi NRZI format. The 1600 bpi density is preferred.

Each tape may contain one or more data files. Each file consists of fixed length tape blocks. Each block is 4000 bytes long and contains 50 card image records. Each card image record is padded with space characters if necessary so that it is exactly 80 bytes long. The last tape block in a file is also padded with blank records if necessary in order to maintain the fixed block length. The last file should be followed by two EOF marks to denote the end of data on the tape.

The tape should contain only the data files and should not have any label or header records. The binary character code may be either ASCII or EBCDIC but the code used should be marked on the tape reel. ASCII code is preferred since this is the most common code used in minicomputers.

Punched cards or diskette may also be used an alternative to magnetic tape in cases where the seakeeping data file is not too large. Cards may be punched in either 029 or 026 code with the 029 code being preferred.

It is not normally feasible to use diskettes unless both organizations have the same type of computer because of the wide variety of formats in use. If they are used, however, the seakeeping data file is processed just like any other formatted sequential Fortran data file.

3 REFERENCES

(1) Appendix III of Seakeeping Committee Report, Proc. of 10th ITTC, Vol. 1, Sept., 1963, pp. 220-226.

(2) "International Towing Tank Conference Standard Symbols 1976", B.S.R.A. Tech. Memo. No. 500, May, 1976.

(3) Seakeeping Committee Recommendation No.2, Proc. of 15th ITTC, Vol.2, Sept 1978, pp.219-2