DDS 582-1-o

APPENDIX D

BLANK CALCULATION SHEETS

- 1 Wind and current forces, foot-pound units
- 1 Wind and current forces, metric units
- 2 Mooring line forces
- 3 Capstan design

CALCULATION SHEET–1
WIND AND CURRENT FORCES
(inch–pound units)

Ship: _____

Ship particulars			Value
1	Displacement, Δ	LT	
2	LWL	ft	
3	Draft, T	ft	
4	Beam, B	ft	
5	End projected wind area, A_e	ft^2	
6	Side projected wind area, A_s	ft^2	
7	Wind speed, V_w	kt	
8	Current speed, V_c	kt	
9	Wind angle, θ_w	degrees	
10	Current angle, θ_c	degrees	
11	Water depth, WD	ft	
Wind force			
12	C_{xw} (see figure 4)		
13	C_{yw} (see figure 5)		
14	C_{xyw} (see figure 6)		
15	$F_{xw} = 0.00338 \times (12) \times ((7))^2 \times (5)$	lb	
16	$F_{yw} = 0.00338 \times (13) \times ((7))^2 \times (6)$	lb	
17	$M_w = 0.00338 \times (14) \times ((7))^2 \times (6) \times (2)$	ft–lb	

From DDS 582–1

CALCULATION SHEET–1 (continued)
WIND AND CURRENT FORCES
(inch–pound units)

Ship: _____

	Current force		Value
18	Wetted surface, $S = 15.5\sqrt{(1) \times (2)}$	ft^2	
19	Water depth/draft, $WD/T = (11)/(3)$		
20	C_{xca} (see figure 1)		
21	C_{yc} (see figure 2)		
22	$C_{xcb} = (21) \times \cos^2 \theta_c$		
23	C_{xyc} (see figure 3)		
24	$F_{xc} = 2.835 \times ((8))^2 \times (4)[(20) \times (18)/(2) + (22) \times (3)]$	lb	
25	$F_{yc} = 2.835 \times (21) \times ((8))^2 \times (2) \times (3)$	lb	
26	$M_c = 2.835 \times (23) \times ((8))^2 \times (2)^2 \times (3)$	ft–lb	
	Total forces		
27	Total longitudinal force, $F_x = (15) + (24)$	lb	
28	Total lateral force, $F_y = (16) + (25)$	lb	
29	Total yaw moment, $M_r = (17) + (26) - 0.48 \times (2) \times (27)$	ft–lb	

From DDS 582–1

CALCULATION SHEET–1
WIND AND CURRENT FORCES
(metric units)

Ship: _____

Ship particulars			Value
1	Displacement, Δ	metric tons, t	
2	LWL	m	
3	Draft, T	m	
4	Beam, B	m	
5	End projected wind area, A_e	m^2	
6	Side projected wind area, A_s	m^2	
7	Wind speed, V_w	kt	
8	Current speed, V_c	kt	
9	Wind angle, θ_w	degrees	
10	Current angle, θ_c	degrees	
11	Water depth, WD	m	
Wind force			
12	C_{xw} (see figure 4)		
13	C_{yw} (see figure 5)		
14	C_{xyw} (see figure 6)		
15	$F_{xw} = 0.1618 \times (12) \times ((7))^2 \times (5)$	N	
16	$F_{yw} = 0.1618 \times (13) \times ((7))^2 \times (6)$	N	
17	$M_w = 0.1618 \times (14) \times ((7))^2 \times (6) \times (2)$	N•m	

From DDS 582–1

CALCULATION SHEET–1 (continued)
WIND AND CURRENT FORCES
(metric units)

Ship: _____

	Current force		Value
18	Wetted surface, $S = 2.588\sqrt{(1) \times (2)}$	m^2	
19	Water depth/draft, $WD/T = (11)/(3)$		
20	C_{xca} (see figure 1)		
21	C_{yc} (see figure 2)		
22	$C_{xcb} = (21) \times \cos^2 \theta_c$		
23	C_{xyc} (see figure 3)		
24	$F_{xc} = 135.95 \times ((8))^2 \times (4)[(20) \times (18)/(2) + (22) \times (3)]$	N	
25	$F_{yc} = 135.95 \times (21) \times ((8))^2 \times (2) \times (3)$	N	
26	$M_c = 135.95 \times (23) \times ((8))^2 \times (2)^2 \times (3)$	N·m	
	Total forces		
27	Total longitudinal force, $F_x = (15) + (24)$	N	
28	Total lateral force, $F_y = (16) + (25)$	N	
29	Total yaw moment, $M_r = (17) + (26) - 0.48 \times (2) \times (27)$	N·m	

From DDS 582–1

CALCULATION SHEET–2

MOORING LINE FORCES

Units: Inch–lb _____ Metric _____ Ship: _____

Line No.	Chock Coordinates			Bollard Coordinates			7	8	9	10
	1 X_{ch} m (ft)	2 Y_{ch} m (ft)	3 Z_{ch} m (ft)	4 X_{bl} m (ft)	5 Y_{bl} m (ft)	6 Z_{bl} m (ft)	$l_i = \sqrt{(X_{ch} - X_{bl})^2 + (Y_{ch} - Y_{bl})^2}$ m (ft)	$\Delta Z_i = Z_{ch} - Z_{bl}$ m (ft)	a_i mm^2 $(in)^2$	E_i GPa (1000 lb/in^2)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

From DDS 582–1

CALCULATION SHEET–2 (continued)

MOORING LINE FORCES

Units: Inch–lb _____ Metric _____ Ship: _____

Line No.	(11) $\cos\theta_i =$ ((5)–(2))/(7)	(12) $\phi_i = \tan^{-1}\frac{(8)}{(7)}$ (degrees)	(13) $\cos\phi_i$	(14) l_o m (ft)	(15) $L_i = (14) + \frac{(7)}{(13)}$ m (ft)	(16) (BS)* kN (1000 lb)	(17) $k_i = \frac{a_i E_i}{L_i}$ kN/m (1000 lb/ft)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

* (BS) is total line breaking strength=(BS)rope x (number of rope parts per line) From DDS 582–1

CALCULATION SHEET–2 (continued)

Units: Inch–lb ___ Metric ___

MOORING LINE FORCES

Ship: _____

Line No.	(18) $k_{yi} = k_i \cos\theta_i \cos\phi_i$ kN/m (1000 lb/ft)	(19) $k_{yi} \cdot X_{ch}$ kN (1000 lb)	(20) $k_{yi} \cdot X_{ch}^2$ kN•m (1000 ft–lb)	(25) $F_{yi} = k_{yi}(\delta_y + X_{ch} \cdot \gamma)$ kN (1000 lb)	(26) $T_i = \frac{F_{yi}}{\cos\theta_i \cos\phi_i}$ kN (1000 lb)	(27) $FS = \frac{(BS)}{T_i}$
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
(21)	a=	b=	c=	f=		

(22) F_y = _____ kN (1000 lb)
X_{cg} = _____ m (ft)
M_r = _____ kN•m (1000 ft–lb)

From DDS 582–1

(23) $\delta_y = \frac{F_y \cdot c - (M_r + F_y \cdot X_{cg}) \cdot b}{ac - b^2}$ = _____ m (ft)

(24) $\gamma = \frac{F_y \cdot b - (M_r + F_y \cdot X_{cg}) \cdot a}{b^2 - ac}$ = _____ radian

CALCULATION SHEET–3
CAPSTAN DESIGN

Units: Inch–lb _____ Metric _____ Ship: _____

	PROCEDURE		Value
1	LWL	m (ft)	
2	Draft, T	m (ft)	
3	Side projected wind area, A_s	m^2 (ft^2)	
4	Wind speed at 90 degrees to ship's keel, V_w	knots	
5	Capstan warping line speed, V_{cp}	m/min (ft/min)	
6	Ship's lateral berthing speed, $V_b = (5)\ {(m/min)/30 \atop (ft/min)/100}$	knots	
7	Number of capstans		
8	Lateral wind force, $F_{yw} = 0.1618 \times (4)^2 \times (3)$ Lateral wind force, $F_{yw} = 0.00338 \times (4)^2 \times (3)$	N (lb)	
9	Drag Coefficient — $N \cdot kt^{-2} m^{-2}$ — $(lb-kt^{-2}-ft^{-2})$ Destroyers — 709 — 14.8 Auxiliaries — 747 — 15.6		
10	Lateral current resistance, $F_{xc} = (9) \times (6)^2 \times (1) \times (2)$	N (lb)	
11	Capstan line pull, $P_{cp} = [(8) + (10)] / (7)$	N (lb)	
12	Capstan head efficiency, η_c		
	Electromechanical capstan		
13	Overall bearing and gear efficiency, η_g		
14	Power $= \frac{(11) \times (5)}{60 \times (12) \times (13)}$ watts $= \left(\frac{(11) \times (5)}{33{,}000 \times (12) \times (13)}\right)$(hp)		
	Electrohydraulic capstan		
15	Efficiency of hydraulic pump & motor, η_{hy}		
16	Power $= \frac{(11) \times (5)}{60 \times (12) \times (13) \times (15)}$ W $= \left(\frac{(11) \times (5)}{33{,}000 \times (12) \times (13) \times (15)}\right)$(hp)		

From DDS 582–1