GUIDANCE NOTES
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CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR PREPARATION OF SEMI- SUBMERSIBLE VESSEL TRANSPORTATION MANUAL

2020

Effective from 10 December 2020

CONTENTS

CHAPTER 1 GENERAL

1.1 General provisions

1.1.1 This Guidelines intends to provide a guidance for shipowners and designers to prepare transportation manual for semi-submersible vessels in single transport, and also provide a basis for CCS to approve the manual.

1.1.2 Special consideration may be given to semi-submersible vessels which are specially designed or arranged for carrying specific cargoes and their transportation manuals with the consent of CCS.

1.2 Certificate of compliance

1.2.1 A certificate of compliance may be issued for the transportation manual which is approved to meet the requirements of this Guidelines.

1.3 Definitions

1.3.1 Semi-submersible vessel: means a ship, having the capability of loading and uploading cargoes in a semi-submerged condition, with large open weather cargo deck and fitted with forward and aft high superstructure or deckhouse or pontoon.

1.3.2 Cargo: generally means ship, offshore installations, floating cargo or other large cargo carried by semi-submersible vessels in this Guidelines.

1.4 Contents of transportation manual

1.4.1 A transportation manual is at least to include the following contents:

(1) Semi-submersible vessel's particulars (ship length, breadth, moulded depth, draught, propulsion plant and ballast system capacity, etc.);
(2) Basic parameters of cargoes intended to transport (dimensions and position of center of gravity, etc.);
(3) Purpose of manual preparation and overview of project;
(4) Stowage and securing arrangement;
(5) Routing and meteorological data;
(6) Motion response analysis;
(7) Ship's stability calculation;
(8) Hull strength calculation;
(9) Cribbing pressure and seafastening load calculation;
(10) Fastener welds strength calculation;
(11) Loading procedure;
(12) Unloading procedure;
(13) Ballast water discharge procedure during the submerging and floating;
(14) Mooring arrangement plan (submerged operation at the dock).

CHAPTER 2 ROUTING AND METEOROLOGICAL DATA

2.1 General provisions

2.1.1 The transportation manual is to include the routes, estimated navigation time and ship's speed.

2.1.2 The sea areas that may be exposed to the most adverse environmental conditions during the whole voyage are to be determined based on a reliable wave and meteorological data base. The design values of transportation (such as wind velocity, significant wave height, peak period, etc.) are to take the 10-year monthly extremes for the areas (on the basis of a 30 day exposure).

2.1.3 For the voyage with the exposure time less than 30 days in the sea area mentioned in 2.1.2, the 10-year monthly extreme may be determined based on the actual exposure time.

2.1.4 The extremes given by the designer may be accepted for calculation with the consent of CCS.

2.2 Wave height reduction

2.2.1 For the self-propelled semi-submersible vessel fitted with redundant propulsion system, the wave height under different sea directions may be reduced according to the following table.

Wave height reduction Table 2.2.1

Sea direction	Percentage of significant wave height Hs in design sea condition
0～±30°	100%
±（30～60°）	Linear interpolation between 100% and 80%
±60 °	80%
±（60～90°）	Linear interpolation between 80% and 60%
±90°	60%
±（90～120°）	Linear interpolation between 60% and 80%
±120°	80%
±（120～150°）	Linear interpolation between 80% and 100%
±（150～180°）	100%

2.2.2 The self-propelled semi-submersible vessel fitted with redundant propulsion system is to meet the following requirements as a minimum:

(1) Two or more independent main engines;

(2) Two or more independent fuel suppliers;

(3) Two or more independent power transmission systems;

(4) Two or more independent switchboards;

(5) Two or more independent steering systems, or an alternative means of operation of a single steering system (but excluding emergency steering systems that cannot be operated from the bridge);

(5) The ability to maintain any desired heading in all conditions up to and including the design condition in case of the single failure of above-mentioned equipment or devices, taking account of the cargo.

CHAPTER 3 SHIP MOTION RESPONSE

3.1 General provisions

3.1.1 The transportation manual is to include the motion responses at the center of gravity of the cargo in the process of transportation, containing the pitch angle, roll angle and longitudinal, transverse and vertical accelerations under each sea direction, which are usually obtained by motion response analysis.

3.2 Sea conditions

3.2.1 The motion response analysis is to be conducted based on the designed sea conditions determined in accordance with the requirements of Chapter 2 in this Guidelines.

3.2.2 The most probable maximum extreme responses used for design are to be based on a 3-hour exposure period.

3.2.3 Long-crested sea condition is generally to be considered for acceleration analysis unless a reasonable interpretation for using short-crested sea condition is given.

3.3 Course and speed

3.3.1 The analysis is to be carried out for head, bow quartering, beam, stern quartering and following seas under zero ship speed. The range of probable peak wave period, Tp, is to be calculated by following formula:

$$\sqrt{13H} \le T_p \le \sqrt{30H} \qquad \text{s}$$

Where: H - significant wave height, in m.

3.3.2 In addition, the analysis is to be carried out for non-beam sea cases for the maximum service speed of the ship or the maximum speed that can be maintained in the given sea conditions. Where this cannot be handled directly by the software, a zero speed analysis may be carried out with the range of probable peak wave periods, Tp, adjusted for the ship speed as follows:

$$\frac{\sqrt{13H}}{1+\frac{V\cdot\cos\theta}{1.56\sqrt{13H}}} \le T_P \le \frac{\sqrt{30H}}{1+\frac{V\cdot\cos\theta}{1.56\sqrt{30H}}} \qquad \text{s}$$

Where: V - ship's speed, in m/s;

θ - the angle between ship's heading and sea direction, in degree;

H - significant wave height, in m.

3.4 Effects of free surface

3.4.1 When the motion response analysis is carried out, the reduction of metacentric height (GM) due to free surface corrections is not to be taken into consideration.

3.5 Effects of cargo immersion

3.5.1 When the motion response analysis is carried out, the increase of GM and damping value due to cargo immersion is to be taken into consideration.

CHAPTER 4 SHIP'S STABILITY

4.1 General provisions

4.1.1 The transportation manual is to include the ballast plan during the ship's voyage and cargo handling process, and the relevant stability calculation report.

4.1.2 Other requirements of the competent authorities of the relevant waters, if any, are to prevail.

4.2 During the voyage

4.2.1 The intact stability is to meet the applicable requirements of Chapter 2.2 and Chapter 2.3, Part A in 2008 IS Code. The deck cargo is to be taken into account for the windage area calculation of the loading conditions.

4.2.2 Where the characteristics of the vessel are defined to be inoperable in accordance with Chapter 2.2, Part A in 2008 IS Code, the alternative criteria of maximum capsizing level in the note of 2008 IS Code may be used.

4.2.3 The buoyancy of cargo may be included in the calculation of intact stability. The watertightness of cargoes is to be defined and taken into account in the calculation.

4.2.4 The damage stability of self-propelled semi-submersible vessel is to meet the requirements of Chapter II-1 in SOLAS or Reg. 27 of ICLL 1966 (including IACS UI LL65).

4.3 During the semi-submerged operation

4.3.1 The stability of semi-submersible vessels in semi-submerged operation mode is to meet the requirements of 1.9.5, Section 9, Chapter 1, PART TWO in the CCS Rules for Classification of Sea-going Steel Ships.

4.4 During the extra ballast operation

4.4.1 With the consent of the competent authority, the extra ballast operation can only be conducted when the semi-submersible vessels meeting the relevant requirements of Section 4, Chapter 18, PART EIGHT of the CCS Rules for Classification of Sea-going Steel Ships have been assigned with the maximum allowable draft waterline mark for such operation.

CHAPTER 5 HULL STRENGTH

5.1 General provisions

5.1.1 The transportation manual is to include the longitudinal strength and relevant local strength calculation reports.

5.2 Longitudinal strength

5.2.1 The ship's longitudinal strength is to meet the requirements of 15.2.2, Section 2, Chapter 15, PART TWO in the CCS Rules for Classification of Sea-going Steel Ships.

5.3 Local strength

5.3.1 The deck load is to be determined according to the arrangement of the cargo intended to transport and the cribbing, and is generally not to exceed the allowable value of the deck load.

5.3.2 In the case that local deck load exceeds the allowable value, the stress of the deck and its associated structures may be determined by direct calculation so as not to exceed the followings:

Shear stress: 0.4ReH

Von Mises stress: 0.88ReH

Where: ReH – yield stress of material, in N/mm^2.

CHAPTER 6　SECURING

6.1　Loads calculation

6.1.1　The transverse and longitudinal design loads for securing arrangements are to be determined based on the motion response analysis stipulated in Chapter 3 of this Guidelines.

6.1.2　The worst working condition combination of the following loads is to be considered:

(1)　Static loadings caused by gravity;

(2)　Loadings caused by wind heel and trim angle;

(3)　Loadings caused by surge and sway acceleration;

(4)　Loadings caused by direct wind;

(5)　Loadings caused by heave acceleration (including the tilt component of pitch and roll).

6.1.3　Considering that the maximum loads individually caused by wind and wave will not occur at the same time, the load combination stipulated in 6.1.2 may be reduced by 10%.

6.1.4　The example of load calculation may refer to Appendix 1.

6.2　Friction force

6.2.1　The friction force of the cargoes may be included in the seafastening calculation, and the friction force that can be included is to be determined according to the weight of cargoes and the degree of overhang. See Table 6.2.1 for details. After the friction force is taken into account, the total seafastening force is not to be less than the minimum value listed in the table.

Maximum friction force and minimum seafastening force　　　Table 6.2.1

Maximum cargo overhang length	Weight of cargo，W/t						
	W <100	100≤ W <1000	1000≤ W <5000	5000≤ W <10000	10000≤ W <20000	20000≤ W <40000	W ≥40000
	Maximum allowable coefficient of friction						
None	0	0.1	0.2	0.2	0.2	0.2	0.2
＜15m	0	0	0.1	0.2	0.2	0.2	0.2
15-25m	0	0	0	0.1	0.2	0.2	0.2
25-35m	0	0	0	0	0.1	0.2	0.2
35-45m	0	0	0	0	0	0.1	0.1
＞45m	0	0	0	0	0	0	0
Percentage of minimum required seafastening force in weight of cargo, %							
Transverse	15%		Interpolation by weight	10%		Interpolation by weight	5%
Longitudinal	10%		Interpolation by weight	5%		Interpolation by weight	3%

6.2.2　In the friction force calculation, when the pressure increases due to the heave motion of the ship, the total friction force is to be reduced by 10%. However, when the pressure is reduced due to the heave motion of the ship, the reduction is not considered.

6.2.3 The friction force may be included only when the cargoes are supported by wood dunnage or cribbing, but is not allowed for steel to steel interfaces.

6.3 Cribbing

6.3.1 Where cribbing is laid between the semi-submersible vessel and cargo, the cribbing is to be so arranged to ensure that the loads of cargo may be evenly transmitted to the semi-submersible vessel as far as possible

6.3.2 The cribbing is to have the sufficient strength to withstand the weight of cargo and loads caused by ship's motion. In general, the pressure on the cribbing is not to exceed 2 N/mm^2 for softwood. In the case of a herring-bone layout, the cribbing pressure is not to exceed 1 N/mm^2.

Figure 6.3.2 Diagram of herring-bone layout

6.3.3 In the process of calculation, the pressures of cribbing farthest distanced from the center of cribbing in transverse and longitudinal directions are to be calculated respectively so as to take the uneven distribution into consideration.

6.3.4 The height of cribbing is normally not less than 150mm, and a minimum clearance not less than 75mm is to be maintained between the lowest protrusion of the cargo and the deck of the semi-submersible vessel.

6.3.5 The example of cribbing pressure calculation may refer to Appendix 2.

6.4 Fasteners

6.4.1 The arrangement and strength of fasteners are to be capable of ensuring that the cargoes will not slide or overturn transversely and longitudinally during the transportation. For relevant calculation, please refer to the CCS Guidelines for Preparation of Cargo Securing Manual.

6.4.2 Standard fasteners are to hold certificates to indicate their safe working load. The non-standard fasteners are to be proved that their structural strength meets the requirements of safe working load, and the stress of fasteners under the expected load may be determined by direct calculation so as not to exceed the followings:

Shear stress: 0.58ReH

Von Mises stress: 0.88ReH

Where: ReH – yield stress of material, in N/mm^2.

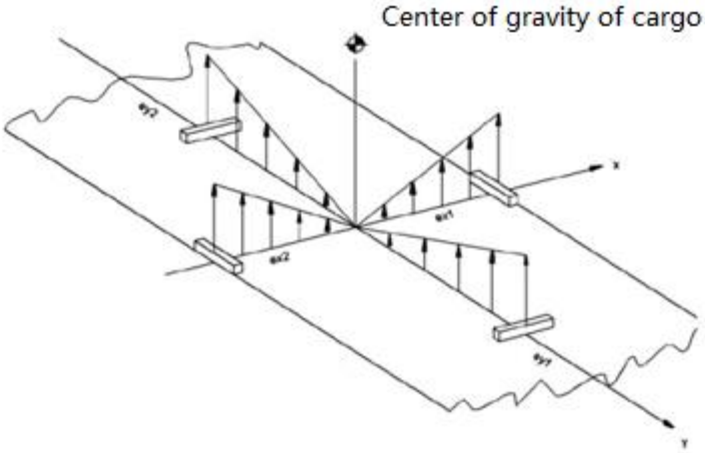
6.4.3 For the fasteners connected with semi-submersible vessel by welding, the calculated von Mises stress of throat at weld joint is not to exceed 0.9 times of yield stress of welding material, and the calculated shear stress is not to exceed 0.55 times of yield stress of welding material.

APPENDIX 1　EXAMPLE OF SEAFASTENING LOAD CALCULATION

	Direction			
	Transverse		Longitudinal	
Longitudinal acceleration (m/s^2)	—		1.472	
Transverse acceleration (m/s^2)	2.453		—	
Vertical acceleration (m/s^2)	1.77		0.98	
Roll angle (°)	10		—	
Pitch angle (°)	—		5	
Wind heal angle (°)	1.00		—	
Wind trim angle (°)	—		0.00	
Direct head wind force (t)	—		100	
Direct wind beam force (t)	100		—	
Weight of cargo (t)	8000			
Maximum overhang length (m)	10			
Coefficient of friction (-)	0.2		0.2	
Minimum SF force / weight of cargo	10%		5%	
	Transverse		Longitudinal	
	Positive heave	Negative heave	Positive heave	Negative heave
Sway / Surge (m/s^2)	2.453		1.472	
(Weight + heave）×sin(wind heel / trim angle) (m/s^2）	（1+1.77÷9.81）×9.81×sin（1°）=0.202	（1-1.77÷9.81）×9.81×sin（1°）=0.14	（1+0.98÷9.81）×9.81×sin（0°）=0	（1-0.98÷9.81）×9.81×sin（0°）=0
Heave ×sin (roll / pitch angle) (m/s^2)	1.77×sin(10°)=0.307	-1.77×sin（10°）=-0.307	0.98×sin（5°）=0.085	-0.98×sin（5°）=-0.085
Wind force equivalent acceleration (m/s^2)	100÷8000×9.81=0.123		100÷8000×9.81=0.123	
Lateral force: sub total (m/s^2）	2.453+0.202+0.307+0.123=3.084	2.453+0.14-0.307+0.123=2.409	1.472+0+0.085+0.123=1.68	1.472+0-0.085+0.123=1.509
Reduction (10%)	3.084×10%=0.308	2.409×0%=0	1.68×10%=0.168	1.509×0%=0
Total combined acceleration (m/s^2)	3.084-0.308=2.775	2.409-0=2.409	1.68-0.168=1.512	1.509-0=1.509

Total combined acceleration (g)	2.775÷9.81=0.283	2.409÷9.81 =0.246	1.512÷9.81 =0.154	1.509÷9.81 =0.154
Seafastening force (t)	8000×0.283 =2264	8000×0.246 =1968	8000×0.154 =1232	8000×0.154 =1232
Friction force (pressure reduced by10%) (t)	（ 9.81+1.77 ）÷9.81×8000×0.2×（1-10%）×cos（10°）=1674	（ 9.81-1.77 ）÷9.81×8000×0.2×cos（10°）=1291	（ 9.81+0.98 ）÷9.81×8000×0.2×（1-10%）×cos（5°）=1578	（ 9.81-0.98 ）÷9.81×8000×0.2×cos（5°）=1434
Calculated seafastening load (t)	2264-1674=590	1968-1291=677	1232-1578=-346	1232-1434=-202
Design seafastening load (or minimum seafastening force) (t)	Max（677,8000×10%）=800		Max（-202,8000×5%）=400	

APPENDIX 2 EXAMPLE OF CRIBBING PRESSURE CALCULATION



2.1 Cribbing's parameters

Based on the dimension and location of cribbing, the parameters of cribbing arrangement may be calculated as follows:

Calculation of cribbing's parameters			
Total area A (m^2)	444.37		
Transverse		Longitudinal	
Horizontal coordinate of the center of cribbing (m) x_0 = horizontal coordinate of each cribbing × area of each cribbing / total area of cribbing	0	Vertical coordinate of the center of cribbing (m) y_0 = vertical coordinate of each cribbing × area of each cribbing / total area of cribbing	0
Transverse moment of inertia of cribbing I_{xx} (m^4)	20022	Longitudinal moment of inertia of cribbing I_{yy} (m^4)	759510
Maximum transverse eccentricity (m) ex1=max x- x_0	12.28	Maximum longitudinal eccentricity (m) ey1=max y- y_0	77.24
Minimum transverse eccentricity (m) ex2=min x- x_0	-12.28	Minimum longitudinal eccentricity (m) ey2=min y- y_0	-83.67

Modulus of transverse section 1 (m^3) $W_{x1} = I_{xx} / ex_1$	20022÷12.28 =1630.46	Modulus of longitudinal section 1 (m^3) $W_{y1} = I_{yy} / ey_1$	759510÷77.24 =9833.12
Modulus of transverse section 2 (m^3) $W_{x2} = I_{xx} / ex_2$	20022÷12.28 =1630.46	Modulus of longitudinal section 2 (m^3) $W_{y2} = I_{yy} / ey_2$	759510÷83.67 =9077.45

2.2 Load calculation

Load calculation			
Weight (W) (t)	4500		
Height of center of gravity (h) (m)	11.2		
Centroid height of windage area (h1) (m)	11.2		
Mean wind heel moment (t.m) sin (mean wind heel angle)×h×W	sin（0.074°）×11.2×45000=657		
Extreme wind heel moment (t.m) sin (extreme wind heel angle)×h×W	sin（0.139°）×11.2×45000=1222		
Vertical load (t) Vertical acceleration ×weight	0.179×45000=8055		
Transverse		Longitudinal	
Rolling radius (m) k_{xx}	6.71	Pitching radius (m) k_{yy}	41.34
Transverse eccentricity of cargoes (m) xcargo	0	Longitudinal eccentricity of cargoes (m) ycargo	-3.73
Transverse eccentric moment (t.m) （xcarco-x_0）×W	（0-0）×45000 =0	Longitudinal eccentric moment (t.m) （ycarco-y_0）×W	（-3.73-0） ×45000 =-167850
Transverse acceleration moment (t.m) (Transverse acceleration × h + k_{xx}^2 ×rolling acceleration) ×W	（0.281×11.2 +6.71^2×0.0082） ×45000 =158237.9	Longitudinal acceleration moment (t.m) (Longitudinal acceleration ×h + k_{xx}^2 × pitching acceleration) × W	（0.111×11.2 +41.34^2×0.004） ×45000 =363563.2
Mean transverse wind load moment (t.m) Mean transverse wind load ×h1	245.5×11.2 =2750	Mean longitudinal wind load moment (t.m) Mean longitudinal wind load × h1	35.8×11.2=401
Extreme transverse wind load	1.21^2×2750	Extreme longitudinal wind load	1.21^2×401

moment (t.m) 1.21^2 × Mean transverse wind load moment	=4026.3	moment (t.m) 1.21^2 × Mean longitudinal wind load moment	=587.1

2.3 Pressure component calculation

Note: In the example, the pressure is the value per unit area, hence the unit is t/m^2.

Pressure component calculation (t/m^2)			
Static pressure W/A	45000÷444.37=101.267		
Heave pressure Vertical load/A	8055÷444.37=18.13		
Transverse		Longitudinal	
Transverse eccentric pressure at ex1 Transverse eccentric moment / W_{x1}	0÷1630.46=0	Longitudinal eccentric pressure at ey1 Longitudinal eccentric moment / W_{y1}	167850÷9833.12 =-17.07
Transverse eccentric pressure at ex2 Transverse eccentric moment / W_{x2}	0÷1630.46=0	Longitudinal eccentric pressure at ey2 Longitudinal eccentric moment / W_{y2}	167850÷9077.45 =18.49
Rolling pressure at ex1 Transverse acceleration moment / W_{x1}	158237.9÷ 1630.46=97.05	Pitching pressure at ey1 Longitudinal acceleration moment / W_{y1}	363563.2÷9833.12 =36.97
Rolling pressure at ex2 Transverse acceleration moment / W_{x2}	158237.9÷ 1630.46=97.05	Pitching pressure at ey2 Longitudinal acceleration moment / W_{y2}	363563.2÷9077.45=40.05
Mean wind heel pressure at ex1 Mean wind heel moment / W_{x1}	657÷1630.46 =0.40	Extreme wind heel pressure at ex1 Extreme wind heel moment / W_{x1}	1222÷1630.46 =0.75
Mean wind heel pressure at ex2 Mean wind heel moment / W_{x2}	657÷1630.46= 0.40	Extreme wind heel pressure at ex2 Extreme wind heel moment / W_{x2}	1222÷1630.46 =0.75
Mean transverse wind pressure at ex1 Mean transverse wind load	2750÷1630.46 =1.69	Mean longitudinal wind pressure at ey1 Mean longitudinal wind load	401÷9833.12 =0.04

moment / W_{x1}		moment / W_{y1}	
Mean transverse wind pressure at ex2 Mean transverse wind load moment / W_{x2}	2750÷1630.46 =1.69	Mean longitudinal wind pressure at ey2 Mean longitudinal wind load moment / W_{y2}	401÷9077.45 =0.04
Extreme transverse wind pressure at ex1 Extreme transverse wind load moment / W_{x1}	4026.3÷ 1630.46=2.47	Extreme longitudinal wind pressure at ey1 Extreme longitudinal wind load moment / W_{y1}	587.1÷9833.12 =0.06
Extreme transverse wind pressure at ex2 Extreme transverse wind load moment / W_{x2}	4026.3÷ 1630.46=2.47	Extreme longitudinal wind pressure at ey2 Extreme longitudinal wind load moment / W_{y2}	587.1÷9077.45 =0.06

2.4 Maximum pressure calculation

Maximum static pressure (t/m^2)	
At ex1: Static pressure + eccentric pressure at ex1	101.267+0=101.267
At ex2: Static pressure + eccentric pressure at ex2	101.267+0=101.267
At ey1: Static pressure + eccentric pressure at ex1	101.267-17.07=84.20
At ey2: Static pressure + eccentric pressure at ex1	101.267+18.49=119.76
Maximum static + dynamic pressure (t/m^2)	
AT ex1: Static pressure + eccentric pressure at ex1 + mean wind heel pressure at ex1+ mean transverse wind pressure at ex1 + ((heave pressure)^2 + (rolling pressure at ex1)^2 +(extreme wind heel pressure at ex1- mean wind heel pressure at ex1 + extreme transverse wind pressure at ex1- mean transverse wind pressure at ex1)^2)$^{1/2}$	101.267+0+0.40+1.69+18.13^2+97.05^2+0.75-0.40+2.47-1.69）^{2}）$^{1/2}$=202.09
At ex2: Static pressure + eccentric pressure at ex2 + mean wind heel pressure at ex2 + mean transverse wind pressure at ex2 + ((heave pressure)^2 +(rolling pressure at ex2)^2 + (extreme wind heel pressure at ex2 – mean wind heel pressure at ex2 + extreme transverse wind pressure at ex2 – mean transverse wind pressure at ex2)^2)$^{1/2}$	101.267+0+0.40+1.69+18.13^2+97.05^2+0.75-0.40+2.47-1.69）^{2}）$^{1/2}$=202.09
At ey1: Static pressure + eccentric pressure at ey1 + mean longitudinal wind pressure at ey1 + ((heave pressure)^2 + (pitching pressure at	101.267-17.07+0.04+（18.13^2+36.97^2+（0.06-0.04）^{2}）$^{1/2}$=125.42

ey1)^2 + (extreme longitudinal wind pressure at ey1 – mean longitudinal wind pressure at ey1)^2)$^{1/2}$	
At ey2: Static pressure + eccentric pressure at ey2 + mean longitudinal wind pressure at ey2 + ((heave pressure)^2 +(pitching pressure at ey2)^2 +(extreme longitudinal wind pressure at ey2 - mean longitudinal wind pressure at ey2)^2)$^{1/2}$	101.267+18.49+0.04+18.13^2+40.05^2+（0.06-0.04）^{2}）$^{1/2}$=163.76

APPENDIX 3 CERTIFICATE OF COMPLIANCE (TEMPLATE)

It is hereby declared that the Transportation Manual (No. or version No.) prepared for the (name of semi-submersible vessel) carrying with (name of cargo) from (place of departure) to (destination) complies with the requirements of Guidelines for Preparation of Semi-submersible Vessel Transportation Manual upon the CCS approval.

Issued by:

Stamped by the unit: