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CONSIDERATION OF DRAFT ANNEX I OF THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973

Segregated ballast oil tankers

Note by the French delegation

Introduction

This paper deals in turn with three points connected with draft Regulation 13 of the Convention:

1. Examination of paragraph 2 and correlated paragraph 5 (Navigational conditions);

2. Examination of the comparability or redundancy of the criteria in paragraph 3 on minimum forward and after draughts and minimum displacement (or draught);

3. Assessment of the relative severity of these two criteria.

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Examination of the balance of the ship when loaded and in ballast.

1. Paragraphs 2 and 5 of Regulation 13 read as follows:

"(2) The capacity of the segregated ballast tanks shall be so determined that the ship may operate safely on ballast voyages under weather and sea conditions it may normally be expected to encounter having regard to its draught, freeboard, stability and manoeuvrability without recourse to the use of oil tanks for water ballast."

"(5) Where abnormally severe weather conditions render it necessary to carry additional water ballast in oil tanks, such ballast water shall be processed and disposed of in accordance with the requirements of Regulation 15 of this Annex, and entry shall be made in the Oil Record Book referred to in Regulation 21 of this Annex."

The crucial words in these two paragraphs are "normally" and "abnormally". It is clear that in the practical interpretation of the Convention by various administrations, the text so worded will lead to differences in its assessment which may be considerable. Such distortions connected inevitably with the subjective character of the words "normally" and "abnormally" (or any periphrasis that one might be tempted to adopt to make those words less specific) must be avoided. On the one hand such a result is contrary to the aim of any international Convention which is uniformity of application and on the other hand it might have a negative effect on safety.

One example will demonstrate the risks involved. The very interesting study submitted by the Netherlands in MP/CONF/8/6/Add.1 compares the criteria proposed for ballasted conditions with the probability of bow emergence in given weather conditions. It might seem justifiable to choose as a reference point a 10% probability in a sea corresponding to a Beaufort Scale Force 5 wind in the North Atlantic; but other probability values or wind forces (20% probability or Force 8, for instance) might be equally reasonable. An examination of graphs on sea conditions in Force 5 and Force 8 shows that the corresponding displacements in ballast are 35% and 50% for a 250,000 tdwt ship. The very size of this differential throws doubt on the credibility of a rule implicitly authorizing such divergencies.

It might also be considered that the weather conditions found on one day at most on a 30-day voyage from Europe to the Persian Gulf are abnormal, even if they are found on almost every voyage, and hence systematically involve the same amount of pollution through dirty ballast on each voyage.

It seems necessary, therefore, to adopt a slightly different approach to the whole of Regulation 13 and particularly paragraphs 2 and 5. This would mean (a) specifying a conventional segregated ballast capacity (the level of which could be negotiated so as to correspond to "normal" conditions, but without any mention of that consideration in the text) and (b) specifying what should be done to any supplementary ballast made by the Master of the vessel for safety reasons, of which he must remain the sole judge at all times.

2. Present paragraph 3 specifies on the one hand a minimum forward draught and an adequate after draught and on the other a minimum (average) draught or a minimum displacement in ballast conditions, which comes to the same thing.

It is easy to demonstrate that these two criteria are not independent and that the numerical values adopted mean either that one is less strict than the other and hence useless, or that the two are equivalent and hence one is redundant. Two applications of this point are given in the Annex, for 280,000 and 410,000 dwdt ships respectively. These are representative of ships currently on order.

The first point worth noting is that data relating to a forward draught in the ballast condition (0.025 L) and an "adequate" after draught (in practice, this vague term would equate with propeller immersion of roughly 0.1 D, where D is the diameter - and in any case it would lie between 0.05 D and 0.15 D) determine displacement in the ballast condition, and accordingly that the first criteria proposed would determine the second.

Similarly, forward and after draughts were wholly determined by the ratio of displacement in the ballast condition to displacement in the loaded condition, from the moment the cargo's specific weight was stated (which indeed is the case, as ships were designed with values of the order of 0.82 to 0.84).

In practice, for a vessel of a given deadweight tonnage (or a given displacement in the loaded condition, the light weight of the vessel, directly related to its size being known almost exactly once the deadweight is fixed), and of a given displacement in the ballast condition, the following are known:

(i) the volume of the cargo

(ii) the fixed segregated ballast volume

(iii) the position of the centre of gravity, and the centre of volume, of the cargo from the elementary balance in the loaded condition with zero trim.

On the natural assumption[1/] that we are attempting to build a ship with no spaces other than cargo or ballast tank spaces, once we know the volume of the ballast and cargo spaces and the centre of the cargo volume, we also know the centre of volume of the ballast tanks.

This means that the weight of a vessel in the ballast condition is wholly determined, both as to displacement and trim (or forward and after draughts).

3. The actual figures attached in Annex show that the choice of a forward draught of 0.025 L and an after draught of about 0.10 D leads to a ballast to loaded displacement ratio of approximately 46% and 45%.

These findings confirm the figures given by Japan in PCMP/4/23, the table of which is given in Annex: the 29 results lie between 47.7% and 42.6%; with the exception of one figure of 49.9% and one other of 41.6%, and with the exception of one markedly different result of 34.7%.

Moreover, a closer look at this particular figure, namely 34.7%, is very instructive, as it is due to the unusual proportions of the ship, the 477,000 dwt "Globtik Tokyo". This vessel is short in comparison with conventional ships (in respect of which a forward draught in proportion to the ship's length gives a relatively low value), and which also has a relatively small propeller (with the result that the after draught given by the propeller immersion criteria is relatively small).

The interesting lesson of this particular instance is that it shows that the adoption of a regulation specifying a forward draught proportional to the ship's length leads to the construction of a shorter ship than at present,

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1/ However, an attempt might be made to construct a vessel with minimum depth, by placing the ballast tanks further forward, where their moment would have a greater effect on the forward draught, and correspondingly by providing empty spaces aft. The calculations show the difference to be insignificant.

just as the adoption of a rule specifying an after draught as a function of the propeller's diameter may lead to the provision of propulsion units in which the propellers are smaller (and faster) than at present.

In order to avoid these somewhat artificial constructions and the emergence of "paragraph tankers", it seems desirable to adopt the criterion which provides the greatest possible degree of design freedom: the ratio of ballasted to loaded displacement (or of average ballast to loaded draught) seems best to meet this requirement. If this criterion were accepted, it is evident that very precise rules for loading conditions would be necessary (e.g. loading conditions of slop tanks, peaks, etc.).

SHIP NO	TYPE OF MAIN ENG	D.W.T.	LPP	DF	ΔF	BALLAST CONDITION				ΔB/ΔF	
						df	da	Trim	ΔB		
1	Turbine	123,886	256.00	15.832	142,778	6.400	9.230	2.830	67,300	0.471	TANKER
2	Turbine	209,167	300.00	19.036	242,473	7.500	10.148	2.648	107,100	0.442	"
3	Turbine	231,723	305.00	19.537	266,205	7.625	11.130	3.505	121,100	0.455	"
4	Turbine	252,059	320.00	19.588	289,232	8.000	11.550	3.550	138,000	0.477	"
5	Diesel	94,465	237.05	14.483	112,346	5.926	7.665	1.739	50,200	0.447	Combinati
6		477,000	360.00	28.00	547,302	9.00	11.86	2.86	189,780	0.347	TANKER
7		370,000	340.00	22.60	-	8.50	12.15	3.65	-	0.43	"
8	-	272,000	320.00	21.00	312,292	8.00	11.19	3.19	135,520	0.434	"
9	Diesel	91,162	240.00	14.684	108,322	6.000	8.160	2.160	49,500	0.457	"
10	Turbine	127,224	256.00	16.200	146,693	6.400	9.193	2.793	66,100	0.451	"
11	Diesel	131,813	260.00	17.030	155,359	6.500	8.640	2.140	64,688	0.416	"
12	Turbine	180,585	285.00	18.000	20[illegible],658	7.125	10.624	3.499	95,027	0.460	"
13	Turbine	237,333	304.00	19.837	271,391	7.600	10.855	3.255	110,148	0.435	
14	"	262,041	314.00	20.588	299,663	7.850	11.048	3.198	129,700	0.433	
15	-	99,541	246.00	14.573	117,002	6.15	8.35	2.20	55,752	0.475	
16	-	103,354	246.00	15.031	121,639	6.15	8.24	2.09	55,302	0.455	
17	-	121,453	265.00	15.033	142,820	6.62	8.45	1.83	68,131	0.477	

18	Turbine	195,120	298.00	17.836	224,214	7.45	9.72	227	101,631	0.453	
19	-	180,452	285.00	18.035	208,658	7.13	10.62	3.49	98,093	0.470	
20	-	222,139	313.00	19.868	254,850	7.82	10.74	2.92	113,712	0.446	
21	"	232,339	305.00	19.50	266,205	7.625	11.030	3.405	120,441	0.452	TANKER
22	"	195,235	298.00	17.80	224,217	7.700	9.465	1.765	101,572	0.453	"
23	"	189,476	302.00	17.90	220,029	7.550	10.638	3.088	109,604	0.499	"
24	Diesel	156,109	290.00	17.40	188,060	7.250	9.602	2.352	87,100	0.463	ore/oil
25	Diesel	157,618	275.00	17.93	187,022	6.875	9.501	2.626	81,334	0.434	"
26	"	135,000	265.00	16.50	161,453	6.625	8.810	2.185	71,391	0.442	"
27	"	118,498	260.00	15.50	140,265	6.500	8.723	2.223	65,581	0.468	TANKER
28	"	124,851	255.00	15.47	146,572	6.375	8.558	2.183	62,474	0.426	"
29	"	103,929	246.00	15.00	121,639	6.150	8.240	2.090	55,450	0.456	"

ANNEX

A - BASIC ASSUMPTIONS SELECTED FOR THE STUDY

1. Two vessels, representing "standard" vessels currently in service or on order, were studied:

- an oil tanker of approximately 280,000 tdwt: Lpp ...... 330.7 m
  B .... 51.8 m
  Loaded draught .... 21.8 m

- an oil tanker of approximately 410,000 tdwt: Lpp ...... 350.0 m
  B .... 70.0 m
  Loaded draught .... 23.0 m

2. The displacements in ballast condition envisaged were:

- for the vessel of 280,000 t : 40 and 55% of the load displacement:
- for the vessel of 410,000 t : 35 and 50% of the load displacement.

These ballastings roughly represent the IMCO minima and the "normal" values used by vessels in service (figures resulting from analyses of ships' registers).

3. The densities and load coefficients chosen were:

- for oil .... 0.82 to 98% of load
- for ballast water .... 1.025 to 100% of load

4. The "fixed weights", including fuel oil, fresh water, oil, provisions, crew, etc., ... were taken as being equal respectively to 8,500 t for the oil tanker of 280,000 t and 9,500 t for the oil tanker of 410,000 t.

5. It was assumed that the vessel in loaded condition had a zero trim.

6. There were no volumes that were not used either for cargo or for ballasting.

B - OIL TANKER OF 280,000 T

1. <u>40% Segregated ballast</u>:

1.1 Assumptions:

- the vessel has a depth of approximately 30.8 m
- the tip of the propeller is 11 m above base line
- light displacement 47,000 t, centre of gravity at 175.2 m from the BPF
- centre of gravity of "fixed weights" (8,500 t) at 296.8 m from the BPF
- total volume of cargo plus ballast 414,135 m^3, centre at 149.5 m from the BPF

- cargo volume of 340,000 m^3 (i.e., a cargo weight of 273,224 t)
- volume of segregated ballast of 74,135 m^3 (i.e., a ballast weight of 75,989 t)
- centre of keel, with draught of 22 m (zero trim) at 157.6 m from the BPF (2.3% of L forward of the midship section) for a displacement of 328,724 t

1.2 The equilibrium conditions with the ship loaded, zero trim, produce a centre of gravity of the cargo situated at 150.2 m from the BPF; i.e.:

	Weight (t)	cdg/BPF (m)	Moment/BPF
Total	328 724	157.6	51 806 902
Fixed weight	8 500	296.8	2 522 800
Light condition	47 000	175.2	8 234 400
Remainder of cargo	273,224	150.2	41 049 702

1.3 Taking into account that the total volume available for cargo and ballast is 414,135 m^3 to 149.5 m from the BPF, the volume remaining for ballastage will have a centre of gravity of a length of 146.3 m in relation to the BPF, given by:

	Volume (m^3)	cdg/BPF (m)	Moment/BPF
Total	414 135	149.5	61 913 182
Cargo	340 000	150.2	51 068 000
Ballast	74 135	146.3	10 845 182

1.4 The ballasting condition will then be given by:

	Weight (t)	cdg/BPF (m)	Moment/BPF
Fixed weight	8 500	296.8	2 522 800
Light condition	47 000	175.2	8 234 400
Ballast	75 988	146.3	11 117 044
Total	131 488	166.3	21 874 244

1.5 In these conditions, the draught and trim in the ballast condition are 9.55 m and 5.5 m respectively, which produces a forward draught of 6.80 m (below the limit draught of 330.7 x 0 x 025 = 8.27 m), the after draught is 12.30 m.

the freeboard in loaded condition = 30.8 - 22 = 8.8 m

" " " ballast condition = 30.8 - 9.55 = 21.25 m

2. 55% Segregated ballast

2.1 Assumptions:

- the vessel has a depth of approximately 34 m
- the tip of the propeller is 11 m above the base line
- light displacement of 49,000 t, centre of gravity at 175 m from the BPF
- total volume of cargo plus ballast 461.364 m^3 centre at 149.5 m from the BPF
- volume of cargo 340,000 m^3 (i.e., a cargo weight of 273,224 t)
- volume of segregated ballast 121,364 m^3 (i.e., a ballast weight of 124,398 t)
- centre of keel at draught of 22 m (zero trim) at 157.7 m from the BPF (2.3% of L forward of midship section) for a displacement of 330,724 t
- centre of keel at a draught of 13 m (zero trim) at 154 m from the BPF for a displacement of 185,908 t

2.2 The equilibrium condition, ship loaded, zero trim, produces a centre of gravity of the cargo situated at 150.3 m from BPF; i.e.:

	Weight (t)	cdg/BPF (m)	Moment/BPF
Total	330 724	157.7	52 155 175
Fixed weight	8 500	296.8	2 582 800
Light condition	49 000	175.0	8 575 000
Remainder of cargo	273 224	150.3	41 057 375

2.3 Taking into account that the total volume available for the cargo and ballast is 461,364 m^3 to 149.5 m from the BPF, the volume remaining for ballasting will have a centre of gravity in length at 147.3 m in relation to the BPF, given by:

	Volume (m^3)	cdg/BPF (m)	Moment/BPF
Total	461 364	149.5	68 973 918
Cargo	340 000	150.3	51 102 000
Ballast	121 364	147.3	17 871 918

2.4 The ballasting condition will thus be given by:

	Weight (t)	cdg/BPF (m)	Moment/BPF
Fixed weights	8 500	296.8	2 522 800
Light condition	49 000	175.0	8 575 000
Ballast	124 398	147.3	18 323 825
Total	181 898	161.7	29 421 625

2.5 Under those conditions, the draught and trim in ballast condition are 12.8 m and 4.5 m respectively, which produces a forward draught of 10.55 m (higher than the draught limit of 8.27 m).

The after draught is 15.05 m

The freeboard in loaded condition = 34 - 22 = 12 m
in ballast condition= 34 - 12.8 = 21.2 m

3. Ballasting giving a forward draught of 2.5% L:

If we assume a linear variation of the characteristics of the vessel in the area studied, we find that the displacement in the ballast condition corresponding to a forward draught of 8.27 m is approximately 46%.

For this case:

- the depth of the ship is .... 32.0 m approx.
- the volume of segregated ballast is .... 92,500 m^3 approx.
- the average draught in the ballast condition is... 10.8 m approx.
- the trim in the ballast condition is .... 5.0 m approx.
- the after draught in the ballast condition is .... 13.3 m approx.
- Immersion of the point of the propeller in ballast condition .... 2.3 m approx.
- the freeboard in the loaded condition is .... 9.8 m approx.
- the freeboard in the ballast condition is .... 21.2 m approx.

It can therefore be seen that, simply by determining the minimal forward draught, we may arrive at a minimum volume of ballastage which, solely through the considerations of the centre of gravity of the volume and equilibrium of the vessel, must *a priori* exceed the minima indicated in paragraph 3(b)(i) of Regulation 13.

C. OIL TANKER OF 410,000 T.

1. 35% Segregated Ballast:

1.1 Assumptions

- the vessel has a depth of approximately 31.8 m
- the tip of the propeller is 11 m above the base line
- light displacement 67,000 t, centre of gravity at 184 m from BPF
- total volume of cargo plus ballast 597 956 m^3 centre at 160 m from BPF.
- volume of cargo 500,000 m^3 (i.e. a cargo weight of 401,800 t)
- volume of segregated ballast 97,956 m^3 (i.e. a ballast weight of 100,405 t)
- centre of keel at draught of 22.90 m (zero trim) at 166.2 m from BPF (2.5% of L forward of midship section) for a displacement of 478,300 t
- centre of keel at a draught of 9 m (zero trim) at 162,8 m from BPF for a displacement of 178,600 t.

1.2 The equilibrium condition, ship loaded, zero trim, produces a centre of gravity of the cargo situated at 159.7 m from BPF; i.e:

	Weight (t)	c.d.g./BPF (m)	Moment/BPF
Total	478 300	166.2	79 494 460
Fixed weight	9 500	316.5	3 006 750
Light condition	67 000	184.0	12 328 000
Remainder of cargo	401 800	159.7	64 158 710

1.3 Taking into account the fact that the total volume available for the cargo and ballast is 597,965 m^3 to 160.0 m from the BPF, the volume remaining for ballasting will have a centre of gravity in length at 161.5 m in relation to the BPF given by:

	Volume (m^3)	c.d.g./BPF (m)	Moment/BPF
Total	597 965	160.0	95 674 400
Cargo	500 000	159.7	79 850 000
Ballast	97 965	161.5	15 824 400

1.4 The ballast condition will then be given by:

	Weight (t)	c.d.g./BPF (m)	Moment/BPF
Fixed weight	9 500	316.5	3 006 750
Light condition	67 000	184.0	12 328 000
Ballast	100 405	161.5	16 215 391
Total	176 905	178.3	31 550 141

1.5 **Under these conditions, the draught and trim in the ballast conditions** are 9.10 m and 6.3 m respectively, which produces a forward draught of 5.95 m (below the limit draught of 8.75 m).
The after draught is 12.25 m.
The freeboard in the loaded condition = 31.8 - 22.90 = 8.90 m.

" " " " ballast condition = 31.8 - 9.10 = 22.70 m

2. 50% Segregated ballast

2.1 Hypotheses:

- the ship has a depth of the order of 35 m
- the tip of the propeller is 11 m above the base line
- light displacement 69,000 t, centre of gravity at 183.5 m from the BPF
- total volume cargo + ballast 657,707 m^3, centre at 160.0 m from the BPF
- volume of cargo 500,000 m^3 (i.e. a cargo weight of 401,800 t)
- volume of segregated ballast 157,703 m^3 (i.e. a ballast weight of 161,650 t)
- centre of keel with a draught of 23 m (zero trim) at 166.2 m from the BPF (2.5% of L forward of the midships section) for a displacement of 480,300 t
- centre of keel with a draught of 12.5 m (zero trim) at 163 m from the BPF for a displacement of 251,920 t

2.2 Equilibrium conditions, with the ship loaded, zero trim, lead to a centre of gravity of the cargo situated at 159.7 m from the BPF; in fact:

	Weight (t)	cdg/BPF (m)	Moment/BPF
Total	480 300	166.2	79 825 860
Fixed weight	9 500	316.5	3 006 750
Light condition	69 000	183.5	12 661 500
Cargo remaining	401 800	159.7	64 157 610

2.3 Taking into account the fact that the total volume available for the cargo and the ballast is 666,975 m^3 at 160.0 m from the BPF, the volume remaining for ballasting will have a centre of gravity in length at 160.9 m in relation to the BPF given by:

	Volume (m^3)	cdg/BPF (m)	Moment/BPF
Total	657 707	160.0	105 233 120
Cargo	500 000	159.7	79 850 000
Ballast	157 707	160.9	25 383 120

2.4 The ballast condition will then be given by:

	Weight (t)	cdg/BPF (m)	Moment/BPF
Fixed weight	9 500	316.5	3 006 750
Light condition	69 000	183.5	12 661 500
Ballast	161 650	160.9	26 009 485
Total	240 150	173.5	41 677 735

2.5 In these conditions, the draught and trim in the ballast condition are 12.1 m and 4.5 m respectively, which leads to a forward draught of 9.85 m (greater than the maximum draught of 8.75 m)

The after draught is 14.35 m

The freeboard (loaded) = 35 - 23 = 12 m

" " (ballast condition) = 35 - 12.1 = 22.9 m

3. Ballasting giving a forward draught of 2.5% L:

If one assumes a linear variation of the characteristics of the ship in the zone studied, one finds that the displacement in the ballast condition corresponding to a forward draught of 8,75 m is about 45%:

For this case:

- the depth of the ship is .... 34.0 m approx.
- the volume of the segregated ballast is .... 137,000 m^3 approx.
- the average draught in the ballast condition ..... 11.2 m approx.
- the trim in the ballast condition .... 4.9 m approx.
- the after draught in the ballast condition .... 13.65 m approx.
- immersion of the point of the propeller in the ballast condition .... 2,65 m approx.
- the freeboard in the loaded condition .... 11,0 m approx.
- the freeboard in the ballast condition .... 22,8 m approx.

In this case too, by taking into consideration the centre of gravity, the volume and the stability of the ship only, it can be seen that the single datum of the forward draught determines a minimum volume of ballast which satisfies all the requirements of Regulation 13.

D. POSSIBLE REDUCTION OF THE NECESSARY PERCENTAGE

1. It has been assumed above that the volume of cargo and ballast was completely utilized and one then perceives that, in order to ensure the condition of zero trim in the loaded condition, the cargo takes up a part of available volume, centred in such a way that the volume remaining for ballasting cannot be brought forward sufficiently to reduce the trim.

2. Setting aside a priori the case in which ballast tanks "exterior" to the tank space were available (for example: ballast tanks forward on the upper deck, which would reduce the visibility forward of the bow), one can, nevertheless, suppose that, if an excess volume is available in the tank space, it is possible both to reduce the displacement in the ballast condition and to have a sufficient forward draught.

3. For a 410,000 t ship, the working hypotheses would be as follows:

- forward draught to be obtained : 8.75 m
- after draught for a propeller immersion of roughly 0.1 D (1 m) : 12.0 m

This case corresponds to a displacement of 205,000 t (or 43% of the loaded displacement) and to a centre of keel situated 171.7 m from the BPF.

4. Assuming that it is desired to take advantage of this slight improvement in the displacement ratio (as shown in (3), theoretically this would be 45%), what we would need would be a ballasting volume of 123,414 m^3 centred 154.4 m from the BPF.

	Weight (t)	c.d.g./BPF (m)	Moment/BPR
Total	205 000	171.7	35 198 500
Fixed Weight	9 500	316.5	3 006 750
Light condition	69 000	183.5	12 661 500
Ballast	126 500	154.4	19 530 250

5. Let us now assume that the centre of gravity of the "tank" volume (cargo + ballast + available space) is always 160 m from the PPAV and that the tank spaces are parallelepipedical and placed 295 m and 25 m from the BPF.

The volume of a cargo with its centre 159.7 m from the BPF may for all practical purposes be treated as being the centre of the tank, and as a first approximation, we may express this by saying that the centre of gravity of the available space should be situated 289.4 m from the BPF.

The length of the space available is 11.2 m, which corresponds to an unusable volume of 5,341 m^3, giving a total volume of ballast + unusable space of 128,755 m^3 compared with 137,000 m^3 found in C.3.

It can be seen that the gain in volume is very slight and would be reduced still further if a more severe criterion as regards the immersion of the point of the propeller had been chosen (0.2 D for example).