標題

MEPC 70 の審議結果の紹介

ClassNK
テクニカル
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2016 年 10 月 24 日から 28 日にかけて開催された IMO の第 70 回海洋環境保護委員会（MEPC 70）での情報及び審議結果について、次の通りお知らせいたします。

1. バラスト水管理条約関連
船舶のバラスト水の移送による海洋生態系への悪影響を防止するため、バラスト水管理条約が 2004 年に採択されています。同条約では、船舶に対して沖合におけるバラスト水交換を実施するか、バラスト水排出基準を満足するバラスト水処理装置を使用したバラスト水交換が要求されています。
同条約は、フィンランドの批准により 2016 年 9 月 8 日に発効要件を満たしたため、2017 年 9 月 8 日に発効いたします。

(1) 条約の批准状況
フィンランドの批准の後、パナマ、ニュージーランドが批准しており、批准国数は 54 ヶ国、合計商船船腹量に対する比率は 53.30%となっています。

(2) バラスト水処理装置の搭載時期見直し
2013 年に開催された第 28 回 IMO 総会において、バラスト水処理装置の現存船に対する搭載義務期限を、条約発効後に行われる最初の IOPP 更新検査まで延長することを認める総会決議 A.1088(28)が採択されました。前回の MEPC 69 でこの内容を反映したバラスト水管理条約 B-3 規則の改正案が承認されており、条約発効後の 2018 年春に開催される MEPC 72 で採択される予定となっています。
今回の会合で、インドとリベリアは、修繕ドックの容量不足等を鑑み、現存船への搭載義務期限を前述の改正案よりも更に延長することを提案しました。審議の結果、前述の改正案通りの搭載義務期限を維持すべきとの意見と、IOPP 更新検査以降の適切な時期まで更なる延長が必要との意見に分かれました。
このため、前回会合の結論である前述の改正案の内容を維持する一方、インドとリベリアの提案を基に関係国が提示した代替案も含めて、次回 MEPC 71 で更なる審議を行うことが合意されました。

（次頁に続く）

(3) バラスト水処理装置の型式承認のための G8 ガイドラインの改正
現行の G8 ガイドラインに従って型式承認されたバラスト水処理装置が、使用環境によっては処理水の中に基準値以上の生物濃度が検出される懸念が指摘されてきました。このため、2014 年に行われた MEPC 66 より試験条件強化のための G8 ガイドラインの見直しが行われていました。
今回の会合で審議の結果、同ガイドラインの改正が承認されました。今回承認された「改正 G8 ガイドライン」の主な変更点は以下の通りです。
（添付 4. Resolution MEPC.279(70)参照）

- 同一型式の装置の中で最大処理容量の装置を使用した船上試験の実施
- 処理装置の運転条件に影響のある設計仕様制限の明確化
- 陸上・船上試験期間中における処理装置の仕様変更の禁止
- 海水・汽水・淡水のすべての塩分濃度での陸上試験の実施
- 試験水の塩分濃度区分の変更

(4) 改正 G8 ガイドラインの適用日
2018 年 10 月 28 日以降に型式承認を受けるバラスト水処理装置は、改正 G8 ガイドラインを満足する必要があります。
現行の G8 ガイドラインに従って型式承認を取得したバラスト水処理装置の船舶への搭載は、2020 年 10 月 27 日まで認められ、2020 年 10 月 28 日以降に船舶に搭載されるバラスト水処理装置は、改正 G8 ガイドラインに従って型式承認を取得した装置とする必要があります。
なお、2020 年 10 月 27 日以前に搭載されたバラスト水処理装置を継続して使用する限り、改正 G8 ガイドラインに従って型式承認された装置への換装が要求されることはありません。

(5) バラスト水処理装置の承認
MEPC 69 以降、4 件のバラスト水処理装置が現行の G8 ガイドラインに従って型式承認を取得したことが報告されました。この結果、型式承認を取得し船舶に搭載可能な装置の数は 69 件になりました。承認された装置のリストは、IMO のウェブサイトで公開されています。
http://www.imo.org/OurWork/Environment/BallastWaterManagement/Pages/BWMTechnologies.aspx

（次頁に続く）

2. 温室効果ガス(GHG)関連

国際海運からの温室効果ガス(GHG)排出の抑制対策は IMO で検討が進められており、現在までにエネルギー効率設計指標(EEDI)及びエネルギー効率管理計画(SEEMP)による規制が導入されています。

(1) EEDI 規制に関する技術開発状況レビュー

MARPOL 条約 附属書 VI 第 21.6 規則で、フェーズ 1 の開始時点及びフェーズ 2 の中間点において、EEDI の改善に寄与する技術の開発動向をレビューし、要すれば、フェーズの開始時期、関連船種のリファレンスライン算定パラメータ及び削減率を見直すことが規定されています。2014 年に行われた MEPC 67 において、日本をコーディネータとする通信部会が設置され、今回の会合でその最終報告が提出されました。

審議の結果、ro-ro 貨物船とro-ro 旅客船以外の船種については、フェーズ2の削減率等を維持することが合意されました。また、フェーズ 3 の早期実施やフェーズ 4 導入の可能性を検討するために、フェーズ 3 に対するレビューを可能な限り早い時期に開始することも合意されました。一方、フェーズ 2 を達成することが難しいと指摘されている ro-ro 貨物船と ro-ro 旅客船については、関心国に対し更なる検討と具体的な提案を行うよう要請し、次回 MEPC 71 で審議を行うことが合意されました。

なお、EEDI レビューのための情報収集を目的とした EEDI データベースに関して、次の三項目を新たに追加することが合意されました。

- 革新技術の概要
- 主要目
- 参照船速 V_{ref}と主機出力 P_{ME}

(2) 最低推進出力ガイドラインの改正

EEDI 規制値への適合が要求される船舶の、荒天下における操船性を維持するため、MEPC 65 において最低推進出力ガイドラインが策定されました。同ガイドラインでは、レベル 1 及びレベル 2 の評価手法が規定されており、2015 年に開催された MEPC 68 において、レベル 1 の要件を強化する最低推進出力ガイドラインの一部改正が採択されました。レベル 2 の評価手法については、欧州と日本で実施されている研究開発プロジェクトの成果が報告される 2016 年後半以降に、要件を見直すことが合意されています。本件に関しましては、先に発行しました ClassNK テクニカル・インフォメーション No.TEC-1039 を併せてご参照下さい。

今回の会合では、日本と関係国より、SHOPERA(欧州)と JASNAOE(日本)で実施された研究開発プロジェクトの成果に基づいて開発された改正ガイドライン案の概要が紹介されました。次回 MEPC 71 で改正ガイドライン案に対する審議が行われる予定です。

(次頁に続く)

(3) EEDI 計算ガイドラインの改正
2014 年に開催された MEPC 67 において、二元燃料機関を搭載した船舶の EEDI を計算するために、EEDI 計算ガイドラインが改正されました。一方、同ガイドラインでは、ガス燃料を主燃料とする船舶の EEDI 計算方法が規定されているものの、ガス燃料を主燃料としない船舶に対する規定がないことから、中国より、EEDI 計算方法の改正提案がありました。
審議の結果、ガス燃料を主燃料としない船舶においても、ガス燃料使用による効果を EEDI に反映することが合意されました。

また、木材チップ運搬船は、EEDI 規制上、ばら積貨物船に分類されますが、比重が小さな木材チップを運ぶため、EEDI 値が一般的なばら積貨物船に比べて不利な値となります。このため、日本より EEDI の計算式に修正係数を導入することを提案しました。
審議の結果、日本の提案通り、EEDI の計算式に載貨重量と貨物倉容積の比率に基づく修正係数を導入することが合意されました。
（添付 6.及び 10. Resolution MEPC.281(70)/MEPC.1/Circ.866 参照）

(4) 燃料消費実績報告制度
2013 年 5 月に行われた MEPC 65 において、国際海運からの更なる GHG 排出削減策として、現存船を含めた船舶に対し、燃料消費量等データの収集、報告及び認証を課す燃料消費実績報告制度（Data Collection System）を検討することが合意されました。同制度について、2014 年 4 月に行われた MEPC 66 から本格的な審議が行われています。
前回の MEPC 69 では、収集するデータについて実貨物量の代わりに載貨重量トン数（DWT）を使用し、船舶からの報告データを年間燃料消費量、年間航海距離及び年間稼働時間とすることが合意されました。この合意を受け、燃料消費実績報告制度を義務要件とする MARPOL 条約 附属書 VI の改正案が承認されております。
今回の会合では、MARPOL 条約 附属書 VI の改正、及び SEEMP ガイドラインの改正が採択されました。これらの改正は 2018 年 3 月 1 日に発効し、2019 年より燃料消費量及び関連データの収集・報告義務が課されることになります。
（添付 3.及び 7. Resolution MEPC.278(70)/MEPC.282(70)参照）

また、データ検証ガイドライン案及びデータ管理ガイドライン案は、日本をコーディネータとする通信部会を設置して、引き続き検討することが合意されました。

(5) 船舶からの GHG 排出削減目標の設定
MEPC 69 において、国際海運からの GHG 排出削減目標の設定、若しくは同目標の設定に向けた検討スケジュールを策定することが提案され、MEPC 70 において引き続き検討することが合意されました。
今回の会合では、燃料消費実績報告制度の施行に関する 3 ステップアプローチ（データ収集、データ分析、意思決定）に基づき、国際海運からの GHG 排出削減に関する IMO 戦略策定に向けた以下のロードマップ（作業計画）が承認されました。

（次頁に続く）

ロードマップの概要

MEPC 72 (2018 年春予定)	GHG 排出削減のための IMO 戦略計画を採択
2019 年 1 月	燃料消費実績報告制度による燃料消費量データの収集開始（フェーズ 1）
MEPC 76 (2020 年秋予定)	燃料消費量データの分析開始（フェーズ 2）
MEPC 78 (2022 年春予定)	GHG 排出削減のための意思決定（フェーズ 3）
MEPC 80 (2023 年秋予定)	GHG 排出削減のための IMO 戦略計画の見直し

次回 MEPC 71 の前週に中間会合を開催して、GHG 排出削減目標と IMO 戦略計画の指針、排出シナリオ、排出削減時期等の検討を行うことが合意されました。

3. 大気汚染防止関連

(1) 燃料油の硫黄分規制

MARPOL 条約 附属書 VI 第 14.8 規則では、燃料油中の硫黄分濃度を 0.5%に強化する前に、規制値に適合した低硫黄燃料油が十分に供給可能であるかをレビューすることが規定されています。同レビューの結果により、規制強化の開始時期を 2020 年、若しくは 2025 年に決定することが規定されています。MEPC 68 でレビュー実施のための運営委員会が設置され、2015 年 9 月 1 日よりレビューが開始されました。今回の会合ではレビュー結果の報告が行われました。

審議の結果、一般海域で使用する燃料油の硫黄分濃度を、2020 年から 0.5%に強化することが合意されました。（添付 5. Resolution MEPC.280(70)参照）

また、適切な規制実施を促進するために必要な追加措置の策定に係る作業計画の範囲を 2017 年 1 月開催の汚染防止・対応小委員会（PPR 4）で検討することが合意されました。

(2) 船上における燃料油のサンプリング

SOx 排出規制海域（ECA）における 2015 年からの硫黄分規制強化を受け、寄港国検査(PSC)等において船上での燃料油サンプリングを実施する場合があるため、統一的で安全な船上サンプリングに関するガイドラインが必要とされていました。

今回の会合では、PPR 3 にて作成された燃料油の船上サンプリングのためのガイドラインが承認されました。（添付 8. MEPC.1/Circ.864 参照）

（次頁に続く）

(3) NOx 排出規制海域の追加

MARPOL 条約 附属書 VI 第 13 規則では、船舶に搭載されているディーゼル機関からの窒素酸化物（NOx）の排出量を規制しており、NOx 三次規制が適用される排出規制海域として、北米沿岸及び米国カリブ海海域が指定されています。

今回の会合では、バルト海及び北海海域の沿岸国が、これらの海域を NOx 排出規制海域として新たに指定する提案を行いました。

審議の結果、バルト海及び北海海域を新たに NOx 排出規制海域に指定するための、MARPOL 条約 附属書 VI 第 13.6 規則の改正案が承認されました。2021 年 1 月 1 日以降に起工し当該海域を航行する船舶に NOx 三次規制が適用される予定です。また、NOx 排出規制海域内の造船所において二元燃料エンジン搭載船や二次規制適合エンジン搭載船を建造・改造・保守・修繕が行われる場合等に、NOx 三次規制からの一時的な適用除外を認める規定を追加する改正案も承認されました。今般承認された改正案は次回の MEPC 71 において採択される予定です。

(4) 燃料油供給証明書の書式改正

MARPOL 条約 附属書 VI 第 18 規則では、船舶に燃料を搭載する際、燃料油の供給者により発行された燃料油供給証明書（Bunker Delivery Note）を備え付けることが要求されています。

今回の会合で、排ガス洗浄装置（スクラバ）を使用する船舶に対応するための同証明書の書式改正が承認されました。次回の MEPC 71 で採択される予定です。

(5) NOx テクニカルコードの統一解釈

選択触媒還元脱硝装置（Selective Catalytic Reduction, SCR）と共に搭載されるエンジンに対する NOx 認証を統一的に行うために、NOx テクニカルコードの統一解釈が承認されました。（添付 9. MEPC.1/Circ.865 参照）

4. 採択された強制要件

今回の会合で採択された主な強制要件は以下の通りです。

(1) IOPP 証書の追補 Form B の改正（添付 1. Resolution MEPC.276(70)参照）

クリーンバラストタンク（CBT）の要件が適用されるタンカーのフェーズアウトに合わせた、IOPP 証書の追補 Form B の記載項目を変更するための証書書式の改正

発効日：2018 年 3 月 1 日

(2) 船舶からの廃物による汚染防止（添付 2. Resolution MEPC.277(70)参照）

穀類を除く固体ばら積み貨物に対して、荷送人が貨物海洋環境に有害な物質(HME)の有無を分析し結果を宣言することを義務付ける MARPOL 条約 附属書 V の改正

発効日：2018 年 3 月 1 日

（次頁に続く）

(3) G8 ガイラインの改正（1.(3)及び(4)項参照）
バラスト水処理装置の型式承認のための G8 ガイラインの改正

発効日：2018 年 10 月 28 日

(4) 燃料消費実績報告制度（2.(4)項参照）
燃料消費実績報告制度を強制化するための MARPOL 条約附属書 VI の改正。

発効日：2018 年 3 月 1 日

MEPC 70 の審議概要につきましては IMO ホームページにも掲載されていますのでご参照下さい。
http://www.imo.org/MediaCentre/MeetingSummaries/MEPC/Pages/Default.aspx

なお、本件に関してご不明な点は、以下の部署にお問い合わせください。

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添付：

1. Resolution MEPC.276(70)
2. Resolution MEPC.277(70)
3. Resolution MEPC.278(70)
4. Resolution MEPC.279(70)
5. Resolution MEPC.280(70)
6. Resolution MEPC.281(70)
7. Resolution MEPC.282(70)
8. MEPC.1/Circ.864
9. MEPC.1/Circ.865
10. MEPC.1/Circ.866

ANNEX 1

RESOLUTION MEPC.276(70)
(Adopted on 28 October 2016)

AMENDMENTS TO THE ANNEX OF THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973, AS MODIFIED BY THE PROTOCOL OF 1978 RELATING THERETO

Amendments to MARPOL Annex I

(Form B of the Supplement to the International Oil Pollution Prevention Certificate)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

NOTING article 16 of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL), which specifies the amendment procedure and confers upon the appropriate body of the Organization the function of considering and adopting amendments thereto,

HAVING CONSIDERED, at its seventieth session, proposed amendments to appendix II of MARPOL Annex I concerning the Supplement to the International Oil Pollution Prevention Certificate,

1 ADOPTS, in accordance with article 16(2)(d) of MARPOL, amendments to appendix II of MARPOL Annex I, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article 16(2)(f)(iii) of MARPOL, that the amendments shall be deemed to have been accepted on 1 September 2017 unless prior to that date, not less than one third of the Parties or Parties the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet, have communicated to the Organization their objection to the amendments;

3 INVITES the Parties to note that, in accordance with article 16(2)(g)(ii) of MARPOL, the said amendments shall enter into force on 1 March 2018 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article 16(2)(e) of MARPOL, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Parties to MARPOL;

5 REQUESTS FURTHER the Secretary-General to transmit copies of the present resolution and its annex to Members of the Organization which are not Parties to MARPOL.

ANNEX

AMENDMENTS TO MARPOL ANNEX I
(Form B of the Supplement to the International Oil Pollution Prevention Certificate)

ANNEX I

REGULATIONS FOR THE PREVENTION OF POLLUTION BY OIL

Appendix II

Form of IOPP Certificate and Supplements

Form B of the Supplement to the International Oil Pollution Prevention Certificate

RECORD OF CONSTRUCTION AND EQUIPMENT FOR OIL TANKERS

Section 1 – Particulars of ship

1 Paragraphs 1.11.8 and 1.11.9 are deleted.

Section 5 – Construction (regulations 18, 19, 20, 21, 22, 23, 26, 27, 28 and 33)

2 Paragraph 5.1 is replaced with the following:

"5.1 In accordance with the requirements of regulation 18, the ship is qualified as a segregated ballast tanker in compliance with regulation 18.9 ……………………………………………………………..□"

3 Existing paragraphs 5.1.1 to 5.1.6 are deleted.

4 Paragraph 5.2 is replaced with the following:

"5.2 Segregated ballast tanks (SBT) in compliance with regulation 18 are distributed as follows:

Tank	Volume (m^3)	Tank	Volume (m^3)
		Total volume………………..……..m^3	

"

5 Existing paragraphs 5.2.1 to 5.2.3, 5.3 and 5.3.1 to 5.3.5 are deleted.

6 Existing paragraphs 5.4 and 5.4.1 to 5.4.4 are renumbered as 5.3 and 5.3.1 to 5.3.4.

7 Existing paragraphs 5.5 and 5.5.1 to 5.5.2 are deleted.

8 All subsequent paragraphs in section 5 are renumbered accordingly.

***

ANNEX 2

RESOLUTION MEPC.277(70)
(Adopted on 28 October 2016)

AMENDMENTS TO THE ANNEX OF THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973, AS MODIFIED BY THE PROTOCOL OF 1978 RELATING THERETO

Amendments to MARPOL Annex V

(HME substances and Form of Garbage Record Book)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

NOTING article 16 of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL), which specifies the amendment procedure and confers upon the appropriate body of the Organization the function of considering and adopting amendments thereto,

HAVING CONSIDERED, at its seventieth session, proposed amendments to MARPOL Annex V concerning substances that are harmful to the marine environment (HME) and Form of Garbage Record Book,

1 ADOPTS, in accordance with article 16(2)(d) of MARPOL, amendments to MARPOL Annex V, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article 16(2)(f)(iii) of MARPOL, that the amendments shall be deemed to have been accepted on 1 September 2017 unless prior to that date, not less than one third of the Parties or Parties the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet, have communicated to the Organization their objection to the amendments;

3 INVITES the Parties to note that, in accordance with article 16(2)(g)(ii) of MARPOL, the said amendments shall enter into force on 1 March 2018 upon their acceptance in accordance with paragraph 2 above;

4 REQUESTS the Secretary-General, for the purposes of article 16(2)(e) of MARPOL, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Parties to MARPOL;

5 REQUESTS FURTHER the Secretary-General to transmit copies of the present resolution and its annex to Members of the Organization which are not Parties to MARPOL.

ANNEX

AMENDMENTS TO MARPOL ANNEX V
(HME substances and Form of Garbage Record Book)

ANNEX V

REGULATIONS FOR THE PREVENTION OF POLLUTION BY GARBAGE FROM SHIPS

Regulation 4
Discharge of garbage outside special areas

1 In the second sentence of paragraph 1.3, the words "taking into account guidelines developed by the Organization" are replaced with the words "in accordance with the criteria set out in appendix I of this Annex".

2 A new paragraph 3 is added as follows:

> "3 Solid bulk cargoes as defined in regulation VI/1-1.2 of the International Convention for the Safety of Life at Sea (SOLAS), 1974 , as amended, other than grain, shall be classified in accordance with appendix I of this Annex, and declared by the shipper as to whether or not they are harmful to the marine environment*."

3 The existing paragraph 3 is renumbered as paragraph 4.

Regulation 6
Discharge of garbage within special areas

4 Paragraph 1.2.1 is replaced with the following:

> ".1 Cargo residues contained in hold washing water do not include any substances classified as harmful to the marine environment according to the criteria set out in appendix I of this Annex;"

5 A new paragraph 1.2.2 is added as follows:

> ".2 Solid bulk cargoes as defined in regulation VI/1-1.2 of the International Convention for the Safety of Life at Sea (SOLAS), 1974 , as amended, other than grain, shall be classified in accordance with appendix I of this Annex, and declared by the shipper as to whether or not they are harmful to the marine environment*;"

6 A new paragraph 1.2.3 is added as follows:

> ".3 Cleaning agents or additives contained in hold washing water do not include any substances classified as harmful to the marine environment taking into account guidelines developed by the Organization;"

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* For ships engaged in international voyages, reference is made to section 4.2.3 of the International Maritime Solid Bulk Cargoes (IMSBC) Code; for ships not engaged in international voyages, other means of declaration may be used, as determined by the Administration.

7 The existing paragraphs 1.2.2 to 1.2.4 are renumbered as paragraphs 1.2.4 to 1.2.6. The renumbered paragraph 1.2.6 is amended to read as follows:

> ".6 Where the conditions of subparagraphs .2.1 to .2.5 of this paragraph have been fulfilled, discharge of cargo hold washing water containing residues shall be made as far as practicable from the nearest land or the nearest ice shelf and not less than 12 nautical miles from the nearest land or the nearest ice shelf."

Regulation 10
Placards, garbage management plans and garbage record-keeping

8 In the chapeau of paragraph 3, the words "the appendix" is replaced with the words "appendix II".

9 Paragraph 3.2 is replaced with the following:

> ".2 The entry for each discharge into the sea under regulations 4, 5, 6 or section 5.2 of chapter 5 of part II-A of the Polar Code shall include date and time, position of the ship (latitude and longitude), category of the garbage and the estimated amount (in cubic metres) discharged. For discharge of cargo residues the discharge start and stop positions shall be recorded in addition to the foregoing;"

10 After the existing paragraph 3.2, new paragraphs 3.3 and 3.4 are inserted as follows:

> ".3 The entry for each completed incineration shall include date and time and position of the ship (latitude and longitude) at the start and stop of incineration, categories of garbage incinerated and the estimated amount incinerated for each category in cubic metres;
>
> .4 The entry for each discharge to a port reception facility or another ship shall include date and time of discharge, port or facility or name of ship, categories of garbage discharged, and the estimated amount discharged for each category in cubic metres;"

11 The existing paragraph 3.3 is renumbered as 3.5 and between the words "Book" and "shall", the words "along with receipts obtained from reception facilities" are inserted.

12 The existing paragraph 3.4 is renumbered as 3.6 and is replaced with the following:

> ".6 In the event of any discharge or accidental loss referred to in regulation 7 of this Annex an entry shall be made in the Garbage Record Book, or in the case of any ship of less than 400 gross tonnage, an entry shall be made in the ship's official log-book of the date and time of occurrence, port or position of the ship at time of occurrence (latitude, longitude and water depth if known), the reason for the discharge or loss, details of the items discharged or lost, categories of garbage discharged or lost, estimated amount for each category in cubic metres, reasonable precautions taken to prevent or minimize such discharge or accidental loss and general remarks."

13 A new appendix I is added as follows and the existing appendix is renumbered as appendix II:

"Appendix I

Criteria for the classification of solid bulk cargoes as harmful to the marine environment

For the purpose of this Annex, cargo residues are considered to be harmful to the marine environment (HME) if they are residues of solid bulk cargoes which are classified according to the criteria of the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS) meeting the following parameters[1]:

.1 Acute Aquatic Toxicity Category 1; and/or

.2 Chronic Aquatic Toxicity Category 1 or 2; and/or

.3 Carcinogenicity[2] Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or

.4 Mutagenicity[2] Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or

.5 Reproductive Toxicity[2] Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or

.6 Specific Target Organ Toxicity Repeated Exposure[2] Category 1 combined with not being rapidly degradable and having high bioaccumulation; and/or

.7 Solid bulk cargoes containing or consisting of synthetic polymers, rubber, plastics, or plastic feedstock pellets (this includes materials that are shredded, milled, chopped or macerated or similar materials)."

Appendix II

Form of Garbage Record Book

14 Section 3 of the renumbered appendix II is replaced with the following:

"3 Description of the garbage

Garbage is to be grouped into categories for the purposes of recording in parts I and II of the Garbage Record Book (or ship's official log-book) as follows:

[1] The criteria are based on UN GHS. For specific products (e.g. metals and inorganic metal compounds) guidance available in UN GHS, annexes 9 and 10 is essential for proper interpretation of the criteria and classification and should be followed.

[2] Products that are classified for Carcinogenicity, Mutagenicity, Reproductive Toxicity or Specific Target Organ Toxicity Repeated Exposure for oral and dermal hazards or without specification of the exposure route in the hazard statement.

Part I

A Plastics
B Food wastes
C Domestic wastes
D Cooking oil
E Incinerator ashes
F Operational wastes
G Animal carcasses
H Fishing gear
I E-waste

Part II

J Cargo residues (non-HME)
K Cargo residues (HME)"

15 The Record of Garbage Discharges in the renumbered appendix II is replaced with the following:

"RECORD OF GARBAGE DISCHARGES

PART I
For all garbage other than cargo residues as defined in regulation 1.2 (Definitions)

(All ships)

Ship's name	Distinctive number or letters	IMO number

Garbage categories

A-Plastics	**B-**Food waste	**C-**Domestic wastes	**D-**Cooking oil	
E-Incinerator ashes	**F-**Operational wastes	**G-**Animal carcasses	**H-**Fishing gear	**I**–E-waste

Discharges under MARPOL Annex V regulations 4 (Discharge of garbage outside special areas), 5 (Special requirements for discharge of garbage from fixed or floating platforms) or 6 (Discharge of garbage within special areas) or chapter 5 of part II-A of the Polar Code

Date/ Time	Position of the ship (latitude/longitude) **or** port if discharged ashore **or** name of ship if discharged to another ship	Category	Estimated amount discharged		Estimated amount incinerated (m^3)	Remarks: (e.g. start/stop time and position of incineration; general remarks)	Certification/ Signature
			Into sea (m^3)	To reception facilities or to another ship (m^3)			
/ :							

/ :							
/ :							
/ :							

Exceptional discharge or loss of garbage under regulation 7 (Exceptions)

Date/ Time	Port or position of the ship (latitude/ longitude and water depth if known)	Category	Estimated amount lost or discharged (m^3)	Remarks on the reason for the discharge or loss and general remarks (e.g. reasonable precautions taken to prevent or minimize such discharge or accidental loss and general remarks)	Certification/ Signature
/ :					
/ :					

Master's signature:___________________________ Date: _____________________

PART II
For all cargo residues as defined in regulation 1.2 (Definitions)

(Ships that carry solid bulk cargoes)

Ship's name	Distinctive number or letters	IMO number

Garbage categories

J- Cargo residues (non-HME)	**K-** Cargo residues (HME)

Discharges under regulations 4 (Discharge of garbage outside special areas) and 6 (Discharge of garbage within special areas)

Date/ Time	Position of the ship (latitude/ longitude) or port if discharged ashore	Category	Estimated amount discharged		Start and stop positions of the ship for discharges into the sea	Certification/ Signature
			Into sea (m^3)	To reception facilities or to another ship (m^3)		

/ :						
/ :						
/ :						
/ :						

Master's signature:_________________________ Date: ______________________"

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ANNEX 3

RESOLUTION MEPC.278(70)
(Adopted on 28 October 2016)

AMENDMENTS TO THE ANNEX OF THE PROTOCOL OF 1997 TO AMEND THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973, AS MODIFIED BY THE PROTOCOL OF 1978 RELATING THERETO

Amendments to MARPOL Annex VI

(Data collection system for fuel oil consumption of ships)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

NOTING article 16 of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto (MARPOL), which specifies the amendment procedure and confers upon the appropriate body of the Organization the function of considering and adopting amendments thereto,

HAVING CONSIDERED, at its seventieth session, proposed amendments to MARPOL Annex VI concerning the data collection system for fuel oil consumption,

1 ADOPTS, in accordance with article 16(2)(d) of MARPOL, amendments to MARPOL Annex VI, the text of which is set out in the annex to the present resolution;

2 DETERMINES, in accordance with article 16(2)(f)(iii) of MARPOL, that the amendments shall be deemed to have been accepted on 1 September 2017 unless prior to that date, not less than one third of the Parties or Parties the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet, have communicated to the Organization their objection to the amendments;

3 INVITES the Parties to note that, in accordance with article 16(2)(g)(ii) of MARPOL, the said amendments shall enter into force on 1 March 2018 upon their acceptance in accordance with paragraph 2 above;

4 INVITES FURTHER the Parties to consider the application of the aforesaid amendments to Annex VI of MARPOL as soon as possible to ships entitled to fly their flag;

5 ENCOURAGES the Organization to establish as soon as possible the IMO Ship Fuel Oil Consumption Database;

6 REQUESTS the Secretary-General, for the purposes of article 16(2)(e) of MARPOL, to transmit certified copies of the present resolution and the text of the amendments contained in the annex to all Parties to MARPOL;

7 REQUESTS FURTHER the Secretary-General to transmit copies of the present resolution and its annex to Members of the Organization which are not Parties to MARPOL.

ANNEX

AMENDMENTS TO MARPOL ANNEX VI

(Data collection system for fuel oil consumption of ships)

ANNEX VI

REGULATIONS FOR THE PREVENTION OF AIR POLLUTION FROM SHIPS

Regulation 1
Application

1 The reference to "regulations 3, 5, 6, 13, 15, 16, 18, 19, 20, 21 and 22" is replaced with "regulations 3, 5, 6, 13, 15, 16, 18, 19, 20, 21, 22 and 22A".

Regulation 2
Definitions

2 After existing paragraph 47, new paragraphs 48, 49 and 50 are added as follows:

"48 *Calendar year* means the period from 1 January until 31 December inclusive.

49 *Company* means the owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the owner of the ship and who on assuming such responsibility has agreed to take over all the duties and responsibilities imposed by the *International Management Code for the Safe Operation of Ships and for Pollution Prevention*, as amended.

50 *Distance travelled* means distance travelled over ground."

Regulation 3
Exceptions and exemptions

3 In the chapeau of paragraph 2, between existing sentences 2 and 3, a new sentence is added as follows:

"A permit issued under this regulation shall not exempt a ship from the reporting requirement under regulation 22A and shall not alter the type and scope of data required to be reported under regulation 22A."

Regulation 5
Surveys

4 At the end of paragraph 4.3, after the words "on board", new text is added as follows:

"and for a ship to which regulation 22A applies, has been revised appropriately to reflect a major conversion in those cases where the major conversion affects data collection methodology and/or reporting processes"

and the word "and" following the semicolon at the end of the paragraph is deleted.

5 In paragraph 4.4, the full stop at the end of the paragraph is replaced by "; and".

6 After the existing paragraph 4.4, a new paragraph 4.5 is added as follows:

".5 The Administration shall ensure that for each ship to which regulation 22A applies, the SEEMP complies with regulation 22.2 of this Annex. This shall be done prior to collecting data under regulation 22A of this Annex in order to ensure the methodology and processes are in place prior to the beginning of the ship's first reporting period. Confirmation of compliance shall be provided to and retained on board the ship."

Regulation 6
Issue or endorsement of Certificates and Statements of Compliance related to fuel oil consumption reporting

7 In the title of regulation 6, the words "and Statements of Compliance related to fuel oil consumption reporting" are inserted following the word "Certificates".

8 After existing paragraph 5, new paragraphs 6 and 7 are added as follows:

"**Statement of Compliance – Fuel Oil Consumption Reporting**

6 Upon receipt of reported data pursuant to regulation 22A.3 of this Annex, the Administration or any organization duly authorized by it* shall determine whether the data has been reported in accordance with regulation 22A of this Annex and, if so, issue a Statement of Compliance related to fuel oil consumption to the ship no later than five months from the beginning of the calendar year. In every case, the Administration assumes full responsibility for this Statement of Compliance.

7 Upon receipt of reported data pursuant to regulations 22A.4, 22A.5 or 22A.6 of this Annex, the Administration or any organization duly authorized by it* shall promptly determine whether the data has been reported in accordance with regulation 22A and, if so, issue a Statement of Compliance related to fuel oil consumption to the ship at that time. In every case, the Administration assumes full responsibility for this Statement of Compliance."

Regulation 8
Form of Certificates and Statements of Compliance related to fuel oil consumption reporting

9 In the title of regulation 8, the words "and Statements of Compliance related to fuel oil consumption reporting" are inserted following the word "Certificates".

* Refer to the Guidelines for the authorization of organizations acting on behalf of the Administration, adopted by the Organization by resolution A.739(18), as may be amended by the Organization, and the Specifications on the survey and certification functions of recognized organizations acting on behalf of the Administration, adopted by the Organization by resolution A.789(19), as may be amended by the Organization.

10 After existing paragraph 2, a new paragraph 3 is added as follows:

"**Statement of Compliance – Fuel Oil Consumption Reporting**

3 The Statement of Compliance pursuant to regulations 6.6 and 6.7 of this Annex shall be drawn up in a form corresponding to the model given in appendix X to this Annex and shall be at least in English, French or Spanish. If an official language of the issuing Party is also used, this shall prevail in case of a dispute or discrepancy."

Regulation 9
Duration and validity of Certificates and Statements of Compliance related to fuel oil consumption reporting

11 In the title of regulation 9, the words "and Statements of Compliance related to fuel oil consumption reporting" are inserted following the word "Certificates".

12 After existing paragraph 11, a new paragraph 12 is added as follows:

"**Statement of Compliance – Fuel Oil Consumption Reporting**

12 The Statement of Compliance pursuant to regulation 6.6 of this Annex shall be valid for the calendar year in which it is issued and for the first five months of the following calendar year. The Statement of Compliance pursuant to regulation 6.7 of this Annex shall be valid for the calendar year in which it is issued, for the following calendar year, and for the first five months of the subsequent calendar year. All Statements of Compliance shall be kept on board for at least the period of their validity."

Regulation 10
Port State control on operational requirements

13 In paragraph 5, the words "Statement of Compliance related to fuel oil consumption reporting and" are inserted before the words "International Energy Efficiency Certificate".

Regulation 22
Ship Energy Efficiency Management Plan (SEEMP)

14 After existing paragraph 1, a new paragraph 2 is inserted as follows and the existing paragraph 2 is renumbered as paragraph 3:

"2 On or before 31 December 2018, in the case of a ship of 5,000 gross tonnage and above, the SEEMP shall include a description of the methodology that will be used to collect the data required by regulation 22A.1 of this Annex and the processes that will be used to report the data to the ship's Administration."

15 After existing regulation 22, a new 22A is inserted as follows:

"Regulation 22A
Collection and reporting of ship fuel oil consumption data

1 From calendar year 2019, each ship of 5,000 gross tonnage and above shall collect the data specified in appendix IX to this Annex, for that and each subsequent calendar year or portion thereof, as appropriate, according to the methodology included in the SEEMP.

2 Except as provided for in paragraphs 4, 5 and 6 of this regulation, at the end of each calendar year, the ship shall aggregate the data collected in that calendar year or portion thereof, as appropriate.

3 Except as provided for in paragraphs 4, 5 and 6 of this regulation, within three months after the end of each calendar year, the ship shall report to its Administration or any organization duly authorized by it*, the aggregated value for each datum specified in appendix IX to this Annex, via electronic communication and using a standardized format to be developed by the Organization†.

4 In the event of the transfer of a ship from one Administration to another, the ship shall on the day of completion of the transfer or as close as practical thereto report to the losing Administration or any organization duly authorized by it*, the aggregated data for the period of the calendar year corresponding to that Administration, as specified in appendix IX to this Annex and, upon prior request of that Administration, the disaggregated data.

5 In the event of a change from one Company to another, the ship shall on the day of completion of the change or as close as practical thereto report to its Administration or any organization duly authorized by it*, the aggregated data for the portion of the calendar year corresponding to the Company, as specified in appendix IX to this Annex and, upon request of its Administration, the disaggregated data.

6 In the event of change from one Administration to another and from one Company to another concurrently, paragraph 4 of this regulation shall apply.

7 The data shall be verified according to procedures established by the Administration, taking into account guidelines to be developed by the Organization.

8 Except as provided for in paragraphs 4, 5 and 6 of this regulation, the disaggregated data that underlies the reported data noted in appendix IX to this Annex for the previous calendar year shall be readily accessible for a period of not less than 12 months from the end of that calendar year and be made available to the Administration upon request.

9 The Administration shall ensure that the reported data noted in appendix IX to this Annex by its registered ships of 5,000 gross tonnage and above are transferred to the IMO Ship Fuel Oil Consumption Database via electronic communication and using a standardized format to be developed by the Organization not later than one month after issuing the Statements of Compliance of these ships.

10 On the basis of the reported data submitted to the IMO Ship Fuel Oil Consumption Database, the Secretary-General of the Organization shall produce an annual report to the Marine Environment Protection Committee summarizing the data collected, the status of missing data, and such other relevant information as may be requested by the Committee.

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* Refer to the *Guidelines for the authorization of organizations acting on behalf of the Administration*, adopted by the Organization by resolution A.739(18), as may be amended by the Organization, and the *Specifications on the survey and certification functions of recognized organizations acting on behalf of the Administration*, adopted by the Organization by resolution A.789(19), as may be amended by the Organization.

† Refer to the *2016 Guidelines for the development of a Ship Energy Efficiency Management Plan* (SEEMP Guidelines) *(*resolution MEPC.282(70)).

11 The Secretary-General of the Organization shall maintain an anonymized database such that identification of a specific ship will not be possible. Parties shall have access to the anonymized data strictly for their analysis and consideration.

12 The IMO Ship Fuel Oil Consumption Database shall be undertaken and managed by the Secretary-General of the Organization, pursuant to guidelines to be developed by the Organization."

16 After existing appendix VIII, new appendices IX and X are inserted as follows:

"Appendix IX

Information to be submitted to the IMO Ship Fuel Oil Consumption Database

Identity of the ship
IMO number

Period of calendar year for which the data is submitted
Start date (dd/mm/yyyy)
End date (dd/mm/yyyy)

Technical characteristics of the ship
Ship type, as defined in regulation 2 of this Annex or other (to be stated)
Gross tonnage (GT)[1]
Net tonnage (NT)[2]
Deadweight tonnage (DWT)[3]
Power output (rated power[4]) of main and auxiliary reciprocating internal combustion engines over 130 kW (to be stated in kW)
EEDI (if applicable)
Ice class[5]

Fuel oil consumption, by fuel oil type[6] in metric tonnes and methods used for collecting fuel oil consumption data

Distance travelled
Hours underway

1 Gross tonnage should be calculated in accordance with the International Convention on Tonnage Measurement of Ships, 1969.

2 Net tonnage should be calculated in accordance with the International Convention on Tonnage Measurement of Ships, 1969. If not applicable, note "N/A".

3 DWT means the difference in tonnes between the displacement of a ship in water of relative density of 1025 kg/m^3 at the summer load draught and the lightweight of the ship. The summer load draught should be taken as the maximum summer draught as certified in the stability booklet approved by the Administration or an organization recognized by it.

4 Rated power means the maximum continuous rated power as specified on the nameplate of the engine.

5 Ice class should be consistent with the definition set out in the *International Code for ships operating in polar waters (Polar Code*), (resolutions MEPC.264(68) and MSC.385(94)). If not applicable, note "N/A".

6 As defined in the *2014 Guidelines on the method of calculation of the Attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.245(66), as amended) or other (to be stated).

Appendix X

Form of Statement of Compliance – Fuel Oil Consumption Reporting

STATEMENT OF COMPLIANCE – FUEL OIL CONSUMPTION REPORTING

Issued under the provisions of the Protocol of 1997, as amended, to amend the International Convention for the Prevention of Pollution by Ships, 1973, as modified by the Protocol of 1978 related thereto (hereinafter referred to as "the Convention") under the authority of the Government of:

. . . .

(full designation of the Party)

by . . . .

(full designation of the competent person or organization authorized under the provisions of the Convention)

Particulars of ship[1]

Name of ship . . . .

Distinctive number or letters. . . . .

IMO Number[2] . . . .

Port of registry . . . .

Gross tonnage. . . . .

THIS IS TO DECLARE:

1. That the ship has submitted to this Administration the data required by regulation 22A of Annex VI of the Convention, covering ship operations from (dd/mm/yyyy) through (dd/mm/yyyy); and

2. The data was collected and reported in accordance with the methodology and processes set out in the ship's SEEMP that was in effect over the period from (dd/mm/yyyy) through (dd/mm/yyyy).

This Statement of Compliance is valid until (dd/mm/yyyy). . . . .

Issued at: . . . .

(place of issue of Statement)

Date (dd/mm/yyyy) . . . .

(date of issue)   *(signature of duly authorized official issuing the Statement)*

(seal or stamp of the authority, as appropriate) "

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[1] Alternatively, the particulars of the ship may be placed horizontally in boxes.

[2] In accordance with the *IMO Ship Identification Number Scheme*, adopted by the Organization by resolution A.1078(28).

ANNEX 5

RESOLUTION MEPC.279(70)
(Adopted on 28 October 2016)

2016 GUIDELINES FOR APPROVAL OF
BALLAST WATER MANAGEMENT SYSTEMS (G8)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by the international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that the International Conference on Ballast Water Management for Ships held in February 2004 adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (the Ballast Water Management Convention) together with four conference resolutions,

NOTING that regulation D-3 of the annex to the Ballast Water Management Convention provides that ballast water management systems used to comply with the Convention must be approved by the Administration, taking into account the guidelines developed by the Organization,

NOTING ALSO resolution MEPC.125(53) by which the Committee adopted the *Guidelines for approval of ballast water management systems* (the Guidelines (G8)), and resolution MEPC.174(58), by which the Committee adopted a revision to the Guidelines (G8),

NOTING FURTHER that, by resolution MEPC.174(58), the Committee resolved to keep Guidelines (G8) under review in the light of experience gained,

RECALLING the provisions for non-penalization of early movers contained in the *Roadmap for the implementation of the BWM Convention,* agreed at its sixty-eighth session (MEPC 68/WP.8, annex 2),

NOTING the Organization's established practice with regard to the validity of type approval certification for marine products (MSC.1/Circ.1221) that the Type Approval Certificate itself has no influence on the operational validity of existing ballast water management systems accepted and installed on board a ship and manufactured during the period of validity of the relevant Type Approval Certificate, meaning that the system need not be renewed or replaced due to expiration of such Certificate,

HAVING CONSIDERED, at its seventieth session, the outcome of the Intersessional Working Group on the Review of Guidelines (G8),

1 ADOPTS the *2016 Guidelines for approval of ballast water management systems* (G8), as set out in the annex to this resolution (the 2016 Guidelines (G8));

2 AGREES to keep the 2016 Guidelines (G8) under review in the light of experience gained with their application;

3 RECOMMENDS that Administrations apply the 2016 Guidelines (G8) when approving ballast water management systems as soon as possible, but not later than 28 October 2018;

4 AGREES that ballast water management systems installed on ships on or after 28 October 2020 should be approved taking into account the 2016 Guidelines (G8);

5 AGREES that ballast water management systems installed on board ships prior to 28 October 2020 should be approved taking into account either the Guidelines (G8) as adopted by resolution MEPC.174(58), or preferably the 2016 Guidelines (G8) set out in the annex to this resolution;

6 AGREES that, for the purpose of operative paragraphs 4 and 5 of this resolution, the word "installed" means the contractual date of delivery of the ballast water management system to the ship. In the absence of such a date, the word "installed" means the actual date of delivery of the ballast water management system to the ship;

7 AGREES that the dates referenced in this resolution will be considered in the reviews carried out in accordance with regulation D-5 of the Ballast Water Management Convention, to determine whether a sufficient number of appropriate technologies are approved and available, taking into account the 2016 Guidelines (G8);

8 SUPERSEDES the *Guidelines for approval of ballast water management systems* (G8) adopted by resolution MEPC.174(58).

ANNEX

2016 GUIDELINES FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS (G8)

Contents

2016 GUIDELINES FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS (G8)

1 INTRODUCTION

General

1.1 The 2016 Guidelines for approval of ballast water management systems (G8) are aimed primarily at Administrations, or their designated bodies, in order to assess whether ballast water management systems meet the standard as set out in regulation D-2 of the "International Convention for the Control and Management of Ships' Ballast Water and Sediments," hereafter referred to as "the Convention". In addition, these guidelines can be used as guidance for manufacturers and shipowners on the evaluation procedure that equipment will undergo and the requirements placed on ballast water management systems. These Guidelines should be applied in an objective, consistent and transparent way and their application should be evaluated periodically by the Organization.

1.2 Articles and regulations referred to in these Guidelines are those contained in the Convention.

1.3 The Guidelines include general requirements concerning design and construction, technical procedures for evaluation, the procedure for issuance of the Type Approval Certificate of the ballast water management system, and reporting to the Organization.

1.4 These Guidelines are intended to fit within an overall framework for evaluating the performance of systems that includes the experimental shipboard evaluation of prototype systems under the provisions of regulation D-4, approval of ballast water management systems and associated systems that comply fully with the requirements of the Convention, and port State control sampling for compliance under the provisions of article 9 of the Convention.

1.5 The requirements of regulation D-3 stipulate that ballast water management systems used to comply with the Convention must be approved by the Administration, taking into account these Guidelines. In addition to such ballast water management system approval, as set forth in regulation A-2 and regulation B-3, the Convention requires that discharges of ballast water from ships must meet the regulation D-2 performance standard on an on-going basis. Approval of a system is intended to screen-out management systems that would fail to meet the standards prescribed in regulation D-2 of the Convention. Approval of a system, however, does not ensure that a given system will work on all ships or in all situations. To satisfy the Convention, a discharge must comply with the D-2 standard throughout the life of the ship.

1.6 The operation of ballast water management systems should not impair the health and safety of the ship or personnel, nor should it present any unacceptable harm to the environment or to public health.

1.7 Ballast water management systems are required to meet the standards of regulation D-2 and the conditions established in regulation D-3 of the Convention. These Guidelines serve to evaluate the safety, environmental acceptability, practicability and biological effectiveness of the systems designed to meet these standards and conditions. The cost effectiveness of type-approved equipment will be used in determining the need for revisions of these Guidelines.

1.8 These Guidelines contain recommendations regarding the design, installation, performance, testing, environmental acceptability and approval of ballast water management systems.

1.9 To achieve consistency in its application, the approval procedure requires that a uniform manner of testing, analysis of samples, and evaluation of results is developed and applied. These Guidelines should be applied in an objective, consistent, and transparent way; and their suitability should be periodically evaluated and revised as appropriate by the Organization. New versions of these Guidelines should be duly circulated by the Organization. Due consideration should be given to the practicability of the ballast water management systems.

Goal and purpose

1.10 The goal of these Guidelines is to ensure uniform and proper application of the standards contained in the Convention. As such the Guidelines are to be updated as the state of knowledge and technology may require.

1.11 The purpose of these Guidelines is to provide a uniform interpretation and application of the requirements of regulation D-3 and to:

.1 define test and performance requirements for the approval of ballast water management systems;

.2 assist Administrations in determining appropriate design, construction and operational parameters necessary for the approval of ballast water management systems;

.4 provide guidance to Administrations, equipment manufacturers and shipowners in determining the suitability of equipment to meet the requirements of the Convention and of the environmental acceptability of treated water; and

.5 assure that ballast water management systems approved by Administrations are capable of achieving the standard of regulation D-2 in land-based and shipboard evaluations and do not cause unacceptable harm to the ship, crew, the environment or public health.

Applicability

1.12 These Guidelines apply to the approval of ballast water management systems in accordance with the Convention.

1.13 These Guidelines apply to ballast water management systems intended for installation on board all ships required to comply with regulation D-2.

2 BACKGROUND

2.1 The requirements of the Convention relating to approval of ballast water management systems used by ships are set out in regulation D-3.

2.2 Regulation D-2 stipulates that ships meeting the requirements of the Convention by meeting the ballast water performance standard must discharge:

.1 less than 10 viable organisms per cubic metre greater than or equal to 50 micrometres in minimum dimension;

.2 less than 10 viable organisms per millilitre less than 50 micrometres in minimum dimension and greater than or equal to 10 micrometres in minimum dimension; and

.3 less than the following concentrations of indicator microbes, as a human health standard:

  .1 Toxicogenic *Vibrio cholerae* (serotypes O1 and O139) with less than 1 Colony Forming Unit (cfu) per 100 millilitres or less than 1 cfu per 1 gramme (wet weight) of zooplankton samples;

  .2 *Escherichia coli* less than 250 cfu per 100 millilitres; and

  .3 Intestinal Enterococci less than 100 cfu per 100 millilitres.

3 DEFINITIONS

For the purpose of these Guidelines:

3.1 *Active Substance* means a substance or organism, including a virus or a fungus, that has a general or specific action on or against harmful aquatic organisms and pathogens.

3.2 *Ballast water management system* (BWMS) means any system which processes ballast water such that it meets or exceeds the ballast water performance standard in regulation D-2. The BWMS includes ballast water treatment equipment, all associated control equipment, piping arrangements as specified by the manufacturer, control and monitoring equipment and sampling facilities. For the purpose of these guidelines, BWMS does not include the ship's ballast water fittings, which may include piping, valves, pumps, etc., that would be required if the BWMS was not fitted.

3.3 *Ballast water management plan* means the document referred to in regulation B-1 of the Convention describing the ballast water management process and procedures implemented on board individual ships.

3.4 *Control and monitoring equipment* means the equipment installed for the effective operation and control of the BWMS and the assessment of its effective operation.

3.5 *The Convention* means the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004.

3.6 *Failed test cycle* is a valid test cycle in which the performance of the BWMS resulted in treated water that is determined to be non-compliant with the standard set within regulation D-2. A failed test cycle interrupts the required consecutive test cycles and terminates the test.

3.7 *Invalid test cycle* is a test cycle in which, due to circumstances outside the control of the BWMS, the requirements for a valid test cycle are not met. When a test cycle is invalid, it does not count as one of the required consecutive test cycles in a test and the test can be continued.

3.8 *Land-based testing* means a test of the BWMS carried out in a laboratory, equipment factory or pilot plant including a moored test barge or test ship, according to Parts 2 and 3 of the annex to these Guidelines, to confirm that the BWMS meets the standard described in regulation D-2 of the Convention.

3.9 *Major components* means those components that directly affect the ability of the system to meet the ballast water performance standard described in regulation D-2.

3.10 *Representative sampling* means sampling that reflects the relative concentrations (chemicals) and numbers and composition of the populations (organisms) in the volume of interest. Samples should be taken in a time-integrated manner and the sampling facility should be installed in accordance with the annex, Part 1 of the *Guidelines on ballast water sampling* (G2).

3.11 *Sampling facilities* refers to the means provided for sampling treated or untreated ballast water as needed in these Guidelines and in the *Guidelines for ballast water sampling (G2)* developed by the Organization.

3.12 *Shipboard testing* means a full-scale test of a complete BWMS carried out on board a ship according to Part 2 of the annex to these Guidelines, to confirm that the system meets the standards set by regulation D-2 of the Convention.

3.13 *Successful test cycle* means a valid test cycle where the BWMS functions to its specifications and treated water is determined to meet the performance standard described in regulation D-2.

3.14 *System Design Limitations* of a BWMS means the water quality and operational parameters, determined in addition to the required type approval testing parameters, that are important to its operation, and, for each such parameter, a low and/or a high value for which the BWMS is designed to achieve the performance standard of regulation D-2. The System Design Limitations should be specific to the processes being employed by the BWMS and should not be limited to parameters otherwise assessed as part of the type approval process. The System Design Limitations should be identified by the manufacturer and validated under the supervision of the Administration in accordance with these Guidelines.

*3.*15 *Test cycle* refers to one testing iteration (to include uptake, treatment, holding and discharge as appropriate) under a given set of requirements used to establish the ability of a BWMS to meet the set standards.

3.16 *Test* means the set of required test cycles.

3.17 *Treatment Rated Capacity (TRC)* means the maximum continuous capacity expressed in cubic metres per hour for which the BWMS is type approved. It states the amount of ballast water that can be treated per unit time by the BWMS to meet the standard in regulation D-2 of the Convention. The TRC is measured at the inlet of the BWMS.

3.18 *Valid test cycle* means a test cycle in which all the required test conditions and arrangements, including challenge conditions, test control, and monitoring arrangements (including piping, mechanical and electrical provisions) and test analytical procedures were achieved by the testing organisation

3.19 *Viable organisms* mean organisms that have the ability to successfully generate new individuals in order to reproduce the species.

4 TECHNICAL SPECIFICATIONS

4.1 This section details the general technical requirements which a BWMS should meet in order to obtain type approval.

General principles for operation

4.2 A BWMS should be effective in meeting the D-2 standard on short voyages and long voyages (i.e. short and long intervals between treatment and discharge), regardless of temperature, unless the system is intentionally constructed for use in specific waters.

4.3 Ballast water discharged following treatment should be safe for the environment on short voyages and long voyages (i.e. short and long intervals between treatment and discharge), regardless of temperature.

4.4 The design of the BWMS should account for the fact that, regardless of the BWMS technology employed, viable organisms remaining after treatment may reproduce in the interval between treatment and discharge.

Ballast water management systems

4.5 The BWMS should be designed and constructed:

.1 for robust and suitable operation in the shipboard environment;

.2 for the service for which it is intended;

.3 to mitigate any danger to persons on board when installed. Equipment that could emit dangerous gases/liquids shall have at least two independent means of detection and shutdown of the BWMS (i.e. hazardous gas level reaching lower explosive limits (LEL) or level of toxic concentrations that can result in severe effects on human health); and

.4 with materials compatible for the substances used, purpose which it is intended, the working conditions to which it will be subjected and the environmental conditions on board.

4.6 The BWMS should not contain or use any substance of a dangerous nature, unless adequate risk mitigation measures are incorporated for storage, application, installation, and safe handling, acceptable to the Administration.

4.7 In case of any failure compromising the proper operation of the BWMS, audible and visual alarm signals should be given in all stations from which ballast water operations are controlled.

4.8 All working parts of the BWMS that are liable to wear or to be damaged should be easily accessible for maintenance. The routine maintenance of the BWMS and troubleshooting procedures should be clearly defined by the manufacturer in the operation, maintenance and safety manual. All maintenance and repairs should be recorded.

4.9 To avoid interference with the BWMS, the following items should be included:

.1 every access of the BWMS beyond the essential requirements of paragraph 4.8, should require the breaking of a seal;

.2 if applicable, the BWMS should be so constructed that a visual indication is always activated whenever the BWMS is in operation for purposes of cleaning, calibration, or repair, and these events should be recorded by the control and monitoring equipment; and

.3 the BWMS should be provided with the necessary connections to ensure that any bypass of the BWMS will activate an alarm, and that the bypass event is recorded by the control and monitoring equipment.

4.10 Facilities should be provided for checking, at the renewal surveys and according to the manufacturer's instructions, the performance of the BWMS components that take measurements. A calibration certificate certifying the date of the last calibration check, should be retained on board for inspection purposes. Only the manufacturer or persons authorized by the manufacturer should perform the accuracy checks.

4.11 The BWMS should be provided with simple and effective means for its operation and control. It should be provided with a control system that should be such that the services needed for the proper operation of the BWMS are ensured through the necessary arrangements.

4.12 The BWMS should, if intended to be fitted in hazardous area locations, comply with the relevant safety regulations for such spaces. Any electrical equipment that is part of the BWMS should be based in a non-hazardous area, or should be certified by the Administration as safe for use in a hazardous area. Any moving parts, which are fitted in hazardous areas, should be arranged so as to avoid the formation of static electricity.

4.13 The BWMS should not endanger the health and safety of the crew, interact negatively with the ship's systems and cargo or produce any adverse environmental effects. The BWMS should not create long term impacts on the safety of the ship and crew through corrosive effects in the ballast system and other spaces.

4.14 It should be demonstrated by using mathematical modelling and/or calculations, that any up or down scaling of the BWMS will not affect the functioning and effectiveness on board a ship of the type and size for which the equipment will be certified. In doing so, the manufacturer of the equipment should take into account the relevant guidance developed by the Organization.

4.15 Scaling information should allow the Administration to verify that any scaled model is at least as robust as the land-based-tested model. It is the responsibility of the Administration to verify that the scaling used is appropriate for the operational design of the BWMS.

4.16 At a minimum, the shipboard test unit should be of a capacity that allows for further validation of the mathematical modelling and/or calculations for scaling, and preferably selected at the upper limit of the rated capacity of the BWMS, unless otherwise approved by the Administration.

Control and monitoring equipment

4.17 Administrations should ensure that type approved BWMS have a suitable control and monitoring system that will automatically monitor and record sufficient data to verify correct operation of the system. The control and monitoring equipment should record the proper functioning or failure of the BWMS. Where practical, system design limitation parameters should be monitored and recorded by the BWMS to ensure proper operation.

4.18 The BWMS should incorporate control equipment that automatically monitors and adjusts necessary treatment dosages or intensities or other aspects of the BWMS of the ship, which while not directly affecting treatment, are nonetheless required for proper administration of the necessary treatment.

4.19 The equipment should be able to produce (e.g. display, print or export) a report of the applicable self-monitoring parameters in accordance with Part 5 of the annex for official inspections or maintenance, as required.

4.20 To facilitate compliance with regulation B-2, the control and monitoring equipment should also be able to store data for at least 24 months, In the event the control and monitoring equipment is replaced, means should be provided to ensure the data recorded prior to replacement remains available on board for 24 months.

4.21 For BWMS that could emit dangerous gases, a means of gas detection by redundant safety systems is to be fitted in the space of the BWMS, and an audible and visual alarm is to be activated at a local area and at a manned BWMS control station in case of leakage. The gas detection device is to be designed and tested in accordance with IEC 60079-29-1, or other recognized standards acceptable to the Administration. Monitoring measures for dangerous gases with independent shutdown is to be provided on the BWMS.

4.22 All software changes introduced to the system after the pre-test evaluation shall be done according to a change handling procedure ensuring traceability.

5 TYPE APPROVAL PROCESS

5.1 The type approval requirements for BWMS are as described below.

5.2 The manufacturer of the equipment should submit information regarding the design, construction, operation and functioning of the BWMS in accordance with Part 1 of the annex including information regarding the water quality and operational parameters that are important to the operation of the system. This information should be the basis for a first evaluation of suitability by the Administration.

5.3 Following the Administration's pre-test evaluation, the BWMS should undergo land-based, shipboard, and other tests in accordance with the procedures described in Parts 2 and 3 of the annex. The BWMS tested for type approval should be a final and complete product that meets the requirements of section 4 and it should be constructed using the same materials and procedures that will be used to construct production units.

5.4 Successful fulfilment of the requirements and procedures outlined in Parts 2 and 3 of the annex, as well as all other requirements of these guidelines, should lead to the issuance of a Type Approval Certificate by the Administration in accordance with section 6.

5.5 The limitations of the BWMS, in addition to the required type approval testing parameters identified in paragraphs 2.4.20 and 2.5.1 of the annex, as submitted by its manufacturer and validated by the Administration, should be documented on the Type Approval Certificate. These design limitations do not determine if the equipment may be type approved or not, but provide information on the conditions beyond the type approval testing parameters under which proper functioning of the equipment can be expected.

5.6 When a type approved BWMS is installed on board, an installation survey according to section 8 should be carried out.

5.7 The documentation submitted for approval should include at least the following:

.1 a description and diagrammatic drawings of the BWMS;

.2 operation, maintenance and safety manual;

.4 hazard identification;

.5 environmental and public health impacts; and

.6 System Design Limitations.

6 APPROVAL AND CERTIFICATION PROCEDURES

6.1 A BWMS which in every respect fulfils the requirements of these Guidelines may be approved by the Administration for fitting on board ships. The approval should take the form of a Type Approval Certificate of BWMS, specifying the main particulars of the BWMS and validated System Design Limitations. Such certificate should be issued in accordance with Part 7 of the annex in the format shown in appendix 1.

6.2 A BWMS that in every respect fulfils the requirements of these Guidelines, except that it has not been tested at all the temperatures and salinities set out in Part 2 of the annex, should only be approved by the Administration if corresponding limiting operating conditions are clearly stated on the issued Type Approval Certificate with the description "Limiting Operating Conditions". For the limiting values, the System Design Limitations should be consulted.

6.3 A Type Approval Certificate of BWMS should be issued for the specific application for which the BWMS is approved, e.g. for specific ballast water capacities, flow rates, salinity or temperature regimes, or other limiting operating conditions or circumstances as appropriate.

6.4 A Type Approval Certificate of BWMS should be issued by the Administration based on satisfactory compliance with all the requirements described in Parts 1, 2, 3 and 4 of the annex.

6.5 The System Design Limitations should be specified on the Type Approval Certificate in a table that identifies each water quality and operational parameter together with the validated low and/or high parameter values for which the BWMS is designed to achieve the ballast water performance standard described in regulation D-2.

6.6 An Administration may issue a Type Approval Certificate of BWMS based on testing already carried out under supervision by another Administration.

6.7 A Type Approval Certificate should only be issued to a BWMS that has been determined by the Administration to make use of an Active Substance after it has been approved by the Organization in accordance with regulation D-3.2. In addition, the Administration should ensure that any recommendations that accompanied the Organization's approval have been taken into account before issuing the Type Approval Certificate.

6.8 The Type Approval Certificate should be issued taking into account circular MSC.1/Circ.1221 on *Validity of type approval certification for marine products*.

6.9 An approved BWMS may be type approved by other Administrations for use on their ships. Should a BWMS approved by one country fail type approval in another country, then the two countries concerned should consult one another with a view to reaching a mutually acceptable agreement.

6.10 An Administration approving a BWMS should promptly provide a type approval report to the Organization in accordance with Part 6 of the annex. Upon receipt of a type approval report, the Organization should promptly make it available to the public and Member States by an appropriate means.

6.11 In the case of a type approval based entirely on testing already carried out under supervision by another Administration, the type approval report should be prepared and kept on file and the Organization should be informed of the approval.

6.12 In the case of a BWMS that was previously type-approved by an Administration taking into account the revised Guidelines (G8) adopted by resolution MEPC.174(58), the manufacturer, in seeking a new type approval under these Guidelines, should only be requested to submit to the Administration the additional test reports and documentation set out in these Guidelines.

7 INSTALLATION REQUIREMENTS FOLLOWING TYPE APPROVAL

7.1 The BWMS should be accompanied by sampling facilities as described in *Guidelines on ballast water sampling* (G2), so arranged in order to collect representative samples of the ship's ballast water discharge.

7.2 Suitable bypasses or overrides to protect the safety of the ship and personnel should be installed and used in the event of an emergency and these should be connected to the BWMS so that any bypass of the BWMS should activate an alarm. The bypass event should be recorded by the control and monitoring equipment and within the ballast water record book.

7.3 The requirement in paragraph 7.2 does not apply to internal transfer of ballast water within the ship (e.g. anti-heeling operations). For BWMS that transfer water internally which may affect compliance by the ship with the standard described in regulation D-2 (i.e. circulation or in-tank treatment) the recording in paragraph 7.2 shall identify such internal transfer operations.

8 INSTALLATION SURVEY AND COMMISSIONING PROCEDURES FOLLOWING TYPE APPROVAL

8.1 The additional information outlined in the paragraphs below is intended to facilitate ship operations and inspections and assist ships and Administrations in preparing for the procedures set out in the *Survey Guidelines for the purpose of the International Convention for the Control and Management of Ships' Ballast Water and Sediments under the Harmonized System of Survey and Certification*[1], developed by the Organization, which describe the examination of plans and designs and the various surveys required under regulation E-1 of the Convention.

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[1] Refer to resolution A.1104(29) on *Survey Guidelines under the harmonized system of survey and certification (HSSC) 2015*, as amended.

8.2 The Administration issuing the International Ballast Water Management Certificate should verify that the following documentation is on board in a suitable format:

.1 for the purpose of information, a copy of the Type Approval Certificate of BWMS;

.2 the operation, maintenance and safety manual of the BWMS;

.3 the ballast water management plan of the ship;

.4 installation specifications, e.g. installation drawing, Piping and Instrumentation diagrams, etc.; and

.5 installation commissioning procedures.

8.3 Prior to issuance of the International Ballast Water Management Certificate, following the installation of a BWMS, the Administration should verify that:

.1 the BWMS installation has been carried out in accordance with the technical installation specification referred to in paragraph 8.2.4;

.2 the BWMS is in conformity with the relevant Type Approval Certificate of BWMS;

.3 the installation of the complete BWMS has been carried out in accordance with the manufacturer's equipment specification;

.4 any operational inlets and outlets are located in the positions indicated on the drawing of the pumping and piping arrangements;

.5 the workmanship of the installation is satisfactory and, in particular, that any bulkhead penetrations or penetrations of the ballast system piping are to the relevant approved standards; and

.6 the installation commissioning procedures have been completed.

ANNEX

PART 1 – SPECIFICATIONS FOR PRE-TEST EVALUATION OF SYSTEM DOCUMENTATION

1.1 Adequate documentation should be prepared and submitted to the Administration and be shared with the testing organization as part of the approval process well in advance of the intended approval testing of a BWMS. Approval of the submitted documentation should be a pre-requisite for carrying out independent approval tests.

1.2 Documentation should be provided by the manufacturer/developer for two primary purposes: evaluating the readiness of the BWMS for undergoing approval testing, and evaluating the manufacturer's proposed System Design Limitations and validation procedures.

Documentation

1.3 The documentation to be submitted as a part of the readiness evaluation should include at least the following:

.1 a BWMS technical specification, including at least:

.1 a description of the BWMS and treatment processes it employs and details of any required permits;

.2 adequate information including descriptions and diagrammatic drawings of the pumping and piping arrangements, electrical/electronic wiring, monitoring system, waste streams and sampling points. Such information should enable fault finding;

.3 details of major components and materials used (including certificates where appropriate);

.4 an equipment list showing all components subject to testing including specifications, materials and serial numbers;

.5 an installation specification in accordance with manufacturers installation criteria requirements for the location and mounting of components, arrangements for maintaining the integrity of the boundary between safe and hazardous spaces and the arrangement of the sample piping;

.6 information regarding the characteristics and arrangements in which the system is to be installed, including scope of the ships (sizes, types and operation) for which the system is intended. This information may form the link between the system and the ship's ballast water management plan; and

.7 a description of BWMS side streams (e.g. filtered material, centrifugal concentrate, waste or residual chemicals) including a description of the actions planned to properly manage and dispose of such wastes;

.2 operation, maintenance and safety manuals – These should at least include:

.1 instructions for the correct operation of the BWMS, including procedures for the discharge of untreated water in the event of malfunction of the ballast water treatment equipment;

.2 instructions for the correct arrangement of the BWMS;

.3 maintenance and safety instructions and the need to keep records;

.4 trouble shooting procedures;

.5 emergency procedures necessary for securing the ship;

.6 any supplementary information considered necessary for the safe and efficient operation of the BWMS, e.g. documentation provided for approval under the *Procedure (G9) for approval of ballast water management systems that make use of Active Substances*; and

.7 calibration procedures;

.3 information on any hazard identification conducted to identify potential hazards and define appropriate control measures, if the BWMS or the storage tanks for processing chemicals could emit dangerous gases or liquids;

.4 information regarding environmental and public health impacts including:

.1 identification of potential hazards to the environment based on environmental studies performed to the extent necessary to assure that no harmful effects are to be expected;

.2 in the case of BWMS that make use of Active Substances or Preparations containing one or more Active Substances, the dosage of any Active Substances used and the maximum allowable discharge concentrations;

.3 in the case of BWMS that do not make use of Active Substances or Preparations, but which could reasonably be expected to result in changes to the chemical composition of the treated water such that adverse impacts to receiving waters might occur upon discharge, the documentation should include results of toxicity tests of treated water as described in paragraph 2.4.11 of these Guidelines; and

.4 sufficient information to enable the test organization to identify any potential health or environmental safety problems, unusual operating requirements (labour or materials), and any issues related to the disposal of treatment by products or waste streams;

.5 information regarding System Design Limitations including:

.1 the identification of all known parameters to which the design of the BWMS is sensitive;

.2 for each parameter the manufacturer should claim a low and/or a high value for which the BWMS is capable of achieving the performance standard of regulation D-2; and

.3 the proposed method for validating each claimed system design limitation should be set out, together with information on the source, suitability and reliability of the method;

.6 software change handling and revision control document including:

.1 all software changes introduced to the system after the pre-test evaluation shall be done according to a change handling procedure ensuring traceability. Therefore, the manufacturer shall present a procedure describing how changes are to be handled and how revision control is maintained. As a minimum for a modification request, the following types of information should be produced and logged:

.1 reason for modification;

.2 specification of the proposed change;

.3 authorization of modification; and

.4 test record;

.7 functional description including a textual description with necessary supporting drawings, diagrams and figures to cover:

.1 system configuration and arrangement;

.2 scope of supply;

.3 system functionality covering control, monitoring, alarm and safety functions;

.4 self-diagnostics and alarming functionalities; and

.5 safe states for each function implemented.

1.4 The documentation may include specific information relevant to the test set-up to be used for land-based testing according to these Guidelines. Such information should include the sampling needed to ensure proper functioning and any other relevant information needed to ensure proper evaluation of the efficacy and effects of the equipment. The information provided should also address general compliance with applicable environment, health and safety standards during the type approval procedure.

Readiness evaluation

1.5 During the readiness evaluation, the Administration should ensure that each technical specification set out in section 4 of the body of these Guidelines has been met, other than those that will be assessed during later testing.

1.6 The readiness evaluation should examine the design and construction of the BWMS to determine whether there are any fundamental problems that might constrain the ability of the BWMS to manage ballast water as proposed by the manufacturer, or to operate safely, on board ships.

1.7 Administrations should ensure adequate risk assessments including the implementation of preventative actions, have been undertaken relating to the safe operation of BWMS.

1.8 As a first step the manufacturer should provide information regarding the requirements and procedures for installing, calibrating, and operating (including maintenance requirements) the BWMS during a test. This evaluation should help the test organization to identify any potential health or environmental safety problems, unusual operating requirements (labour or materials), and any issues related to the disposal of treatment by-products or waste streams.

1.9 The test facility should have a procedure to deal with deviations that occur prior to testing and an evaluation process which includes an assessment and validation process to address any unforeseen deviations that may occur during testing. Deviations from the testing procedure should be fully reported.

1.10 During the readiness evaluation the major components of the BWMS should be identified. Major components are considered to be those components that directly affect the ability of the system to meet the performance standard described in regulation D-2. Upgrades or changes to major components should not take place during type approval testing. A change to a major component should require a new submission of the test proposal and should involve a new evaluation and repeating of the land-based and shipboard tests.

1.11 The Administration may allow replacements of non-major components of equivalent specification (independently approved to a recognized and equal operational standard) during type approval. Replacements of non-major components during testing should be reported.

1.12 Upgrades of the BWMS that relate to the safe operation of that system may be allowed during and after type approval and should be reported. If such safety upgrades directly affect the ability of the system to meet the standard described in regulation D-2, it should be treated as a change of a major component, as per paragraph 1.10 above.

1.13 The evaluation should identify consumable components in the BWMS. The Administration may allow replacement of like for like consumable components, during type approval testing and all replacements should be reported.

System Design Limitation evaluation

1.14 The System Design Limitation evaluation should be undertaken by the Administration. It should assess the basis for the manufacturer's claim that the System Design Limitations include all known water quality and operational parameters to which the design of the BWMS is sensitive that are important to its ability to achieve the performance standard described in regulation D-2.

1.15 The Administration should also evaluate the suitability and reliability of the methods proposed for validating the claimed low and/or high values for each System Design Limitation. These methods may include tests to be undertaken during land-based, shipboard or bench-scale testing and/or the use of appropriate existing data and/or models.

PART 2 – TEST AND PERFORMANCE SPECIFICATIONS FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS

The Administration decides the sequence of land-based and shipboard testing. The BWMS used for testing must be verified by the Administration to be the same as the BWMS described under Part 1 of the annex with major components as described in paragraphs 1.3.1.3 and 1.3.1.4.

2.1 Quality Assurance and Quality Control Procedures

2.1.1 The testing facility should demonstrate its competency in conducting valid type approval tests in two ways: (1) have implemented a rigorous quality control/quality assurance program, approved, certified and audited by an independent accreditation body, or to the satisfaction of the Administration, and (2) be able to demonstrate its ability to conduct valid test cycles with appropriate challenge water, sample collection, sample analysis, and method detection limits. It is the responsibility of the Administration, or its authorized delegate, to determine the acceptability of the test facility.

2.1.2 The test facility's quality control/quality assurance program should consist of:

.1 a Quality Management Plan (QMP), which addresses the quality control management structure and policies of the testing body (including subcontractors and outside laboratories);

.2 a Quality Assurance Project Plan (QAPP), which defines the methods, procedures, and quality assurance and quality control (QA/QC) protocols used by the test facility for testing BWMS in general. It identifies the test team members, and it includes all relevant standard operating procedures (SOPs), typically as appendices; and

.3 a Test/Quality Assurance Plan (TQAP), that provides specific details for conducting a test of a given BWMS at a given site and time. The TQAP includes detailed plans for commissioning the BWMS, the experimental plan, decommissioning, and reporting the results. The TQAP identifies all organizations involved in the test and includes the BWMS vendor's documentation and performance claims. The TQAP also identifies the data to be recorded, operational and challenge parameters that define a valid test cycle, data analyses to be presented in the verification report, and a schedule for testing. Appropriate statistical distributions should be considered and used to analyse data.

2.1.3 The testing facility performing the BWMS tests should be independent. It should not be owned or affiliated with the manufacturer or vendor of any BWMS, by the manufacturer or supplier of the major components of that equipment.

2.2 Avoiding sampling bias

The sampling protocol must ensure organism mortality is minimized, e.g. by using appropriate valves and flow rates for flow control in the sampling facility, submerging nets during sampling collection, using appropriate sampling duration and handling times, and appropriate concentrating methodology. All methods should be validated to the satisfaction of the Administration.

2.3 Shipboard tests

2.3.1 A shipboard test cycle includes:

.1 the uptake of ballast water of the ship;

.2 treatment of the ballast water in accordance with paragraph 2.3.3.4 by the BWMS;

.3 the storage of ballast water on the ship during a voyage; and

.4 the discharge of ballast water from the ship.

2.3.2 Shipboard testing of BWMS should be conducted by the test facility, independent of the BWMS manufacturer, with the system being operated and maintained by the ships' crew as per the operational manual.

Success criteria for shipboard testing

2.3.3 In evaluating the performance of BWMS installation(s) on a ship or ships, the following information and results should be supplied to the satisfaction of the Administration:

.1 test plan to be provided prior to testing;

.2 documentation that an inline BWMS is of a capacity to reflect the flow rate of the ballast water pump for the full rated capacity range of the BWMS;

.3 documentation that an in-tank BWMS is of a capacity to reflect the ballast water volume that it is intended to treat within a specified period of time;

.4 the amount of ballast water tested in the test cycle on board should be consistent with the normal ballast operations of the ship and the BWMS should be operated at the treatment rated capacity for which it is intended to be approved;

.5 documentation showing that the discharge of each valid test cycle was in compliance with regulation D-2;

.6 for a test to be valid, the uptake water for the ballast water to be treated should contain a density of viable organisms exceeding 10 times the maximum permitted values in regulation D-2.1;

.7 sampling regime and volumes for analysis:

.1 for the enumeration of viable organisms greater than or equal to 50 micrometres or more in minimum dimension:

.1 influent water should be collected over the duration of uptake as one, time-integrated sample. The sample should be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. The total sample volume should be at least one cubic metre. If smaller volume is validated to ensure representative sampling of organisms, it may be used;

.2 treated discharged water should be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. The total sample volume should be at least three cubic metres;

.3 if samples are concentrated for enumeration, the organisms should be concentrated using a mesh with holes no greater than 50 micrometres in the diagonal dimension. Only organisms greater than 50 micrometres in minimum dimension should be enumerated; and

.4 the full volume of the sample should be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method.

.2 for the enumeration of viable organisms greater than or equal to 10 micrometres and less than 50 micrometres in minimum dimension:

.1 influent water should be collected over the duration of uptake as one, time-integrated sample. The sample should be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. A sample of at least 10 litres should be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 litre. A minimum of three, 1-millilitre sub-samples should be analysed in full to enumerate organisms;

.2 treated discharged water should be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. A sample of at least 10 litres should be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 litre. A minimum of six, 1-millilitre sub-samples should be analysed in full to enumerate organisms;

.3 the sample may not be concentrated for analysis unless the procedure is validated. Only organisms greater than 10 micrometres and less than 50 micrometres in minimum dimension should be enumerated; and

.4 the full volume of the sample should be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method.

.3 for the evaluation of bacteria:

.1 for the influent and discharge samples, the minimum 10-litre sample referred to in paragraph 2.3.3.7.2.2, or another sample at least 10 litres in volume and collected in a similar manner, a sub-sample of minimum 1 litre may be transferred to a sterile container for analysis;

.2 a minimum of three, subsamples of appropriate volume taken from the 1 litre subsample described above should be analysed for colony forming units of bacteria listed in regulation D-2; and

.3 the toxicogenic test requirements should be conducted in an appropriately approved laboratory. If no approved laboratory is available, the analysis method may be validated to the satisfaction of the Administration.

.8 the test cycles including invalid test cycles are to span a period of not less than six months;

.9 the applicant is requested to perform three consecutive test cycles in compliance with regulation D-2. Any invalid test cycle does not affect the consecutive sequence;

.10 the six-month shipboard test period starts and ends with the completion of a successful test cycle or invalid test cycle that meets the D-2 standard. The three consecutive and valid test cycles that are required in paragraph 2.3.3.9 must be suitably separated across the six-month period;

.11 the source water for test cycles shall be characterized by measurement of salinity, temperature, particulate organic carbon, total suspended solids and dissolved organic carbon;

.12 for system operation throughout the test period, the following information should also be provided:

.1 documentation of all ballast water operations including volumes and locations of uptake and discharge, and if heavy weather was encountered and where;

.2 documentation that the BWMS was operated continuously throughout the test period for all ballasting and deballasting of the ship;

.3 documentation detailing water quality parameters identified by the testing organisation, should be measured as appropriate and practicable;

.4 the possible reasons for an unsuccessful test cycle, or a test cycle discharge failing the D-2 standard should be investigated and reported to the Administration;

.5 documentation of scheduled maintenance performed on the system during the test period;

.6 documentation of unscheduled maintenance and repair performed on the system during the test period;

.7 documentation of engineering parameters monitored as appropriate to the specific system; and

.8 a report detailing the functioning of the control and monitoring equipment.

2.4 Land-based testing

2.4.1 The land-based testing provides data to determine the biological efficacy and environmental acceptability of the BWMS under consideration for type approval. The approval testing aims to ensure replicability and comparability to other treatment equipment.

2.4.2 Any limitations imposed by the BWMS on the testing procedure described here should be duly noted and evaluated by the Administration.

2.4.3 The test set-up including the BWMS should operate as described in the provided operation, maintenance and safety manual during at least five consecutive successful test cycles in each salinity.

2.4.4 A land-based test cycle should include the uptake of ballast water by pumping, the storage of ballast water, treatment of ballast water within the BWMS (except in control tanks), and the discharge of ballast water by pumping. The order will be dependent on the BWMS.

2.4.5 At least two test cycles in each salinity should be conducted in order to evaluate compliance with the D-2 standard at the minimum holding time specified by the BWMS manufacturer.

2.4.6 In accordance with the *Procedure for approval of ballast water management systems that make use of Active Substances* (G9), test facilities carrying out identification of Relevant Chemicals and toxicity testing of the treated ballast water from test cycles with a storage time which is shorter or longer than five days, should ensure that sufficient volumes of treated water are collected after five days or are reserved after the efficacy testing to permit the requirements of Procedure (G9) to be assessed for at least one test cycle per salinity.

2.4.7 Land-based testing of BWMS should be independent of the system manufacturer.

2.4.8 Testing should occur using different water conditions sequentially as provided for in paragraphs 2.4.20 and 2.4.22.

2.4.9 The BWMS should be tested at its rated capacity or as given in paragraphs 2.4.16 to 2.4.19 for each test cycle. The equipment should function to specifications during this test.

2.4.10 The analysis of treated water discharge from each test cycle should determine if the treated discharge meets regulation D-2 of the Convention.

2.4.11 The analysis of treated water discharge from the relevant test cycle(s) should also be used to evaluate the formation of Relevant Chemicals as well as the toxicity of the discharged water for BWMS that make use of Active Substances. The same evaluation should be conducted for those BWMS that do not make use of Active Substances or Preparations but which could reasonably be expected to result in changes to the chemical composition of the treated water such that adverse impacts to receiving waters might occur upon discharge. Toxicity tests of the treated water discharge should be conducted in accordance with paragraphs 5.2.3 to 5.2.7 of the *Procedure for approval of ballast water management systems that make use of Active Substances* (G9), as revised.

Land-based testing set-up

2.4.12 The test set-up for approval tests should be representative of the characteristics and arrangements of the types of ships in which the equipment is intended to be installed. The test set-up should therefore include at least the following:

.1 the complete BWMS to be tested;

.2 piping and pumping arrangements; and

.3 the storage tank that simulates a ballast tank, constructed such that the water in the tank should be completely shielded from light.

2.4.13 The control and treated simulated ballast tanks should each include:

.1 a minimum capacity of 200 m^3;

.2 normal internal structures, including lightening and drainage holes;

.3 standard industry practices for design and construction for ships; surface coatings should be in accordance with Performance standard for protective coatings of dedicated seawater ballast tanks on all new ships and of double-sided skin spaces of bulk carriers (PSPC); and

.4 the minimum modifications required for structural integrity on land.

2.4.14 The test set-up should be pressure-washed with tap water, dried and swept to remove loose debris, organisms and other matter before starting testing procedures, and between test cycles.

2.4.15 The test set-up will include facilities to allow sampling as described in paragraphs 2.4.31 and 2.4.32 and provisions to supply influents to the system, as specified in paragraphs 2.4.20, 2.4.21, 2.4.24 and 2.4.25. The installation arrangements should conform in each case with those specified and approved under the procedure outlined in section 7 of the main body to these Guidelines.

Ballast water management system scaling

2.4.16 Scaling of the BWMS should be in accordance with the *Guidance on scaling of ballast water management systems* developed by the Organization. The Administration should verify that the scaling used is appropriate for the operational design of the BWMS.

2.4.17 BWMS with at least one model with a TRC equal to or smaller than 200 m^3/h should not be downscaled.

2.4.18 For BWMS with at least one model that has a higher capacity than 200 m^3/h or 1000 m^3/h the following must be observed for land-based testing. In-line treatment equipment may be downsized for land-based testing, but only when the following criteria are taken into account:

.1 BWMS with at least one model with a TRC larger than 200 m^3/h but smaller than 1,000 m^3/h may be downscaled to a maximum of 1:5 scale, but may not be smaller than 200 m^3/h; and

.2 BWMS with at least one model with a TRC equal to, or larger than, 1,000 m^3/h may be downscaled to a maximum of 1:100 scale, but may not be smaller than 200 m^3/h.

2.4.19 In-tank treatment equipment should be tested on a scale that allows verification of full-scale effectiveness. The suitability of the test set-up should be evaluated by the manufacturer and approved by the Administration.

Land-based test design – inlet and outlet criteria

2.4.20 For any given set of test cycles (five are considered a set) a salinity range should be chosen for each cycle. Given the salinity of the test set up for a test cycle in fresh, brackish and marine water, each should have dissolved and particulate content in one of the following combinations:

	Salinity		
	Marine 28 – 36 PSU	Brackish 10 – 20 PSU	Fresh < 1 PSU
Dissolved Organic Carbon (DOC)	> 1 mg/l	> 5 mg/l	> 5 mg/l
Particulate Organic Carbon (POC)	> 1 mg/l	> 5 mg/l	> 5 mg/l
Total Suspended Solids (TSS)	> 1 mg/l	> 50 mg/l	> 50 mg/l

2.4.21 Test water should be natural water. Any augmentation of test water with dissolved organic carbon (DOC), particulate organic carbon (POC) or total suspended solids (TSS) to achieve the minimum required content should be validated and approved by the Administration. As natural DOC constituents are complex and primarily of aromatic character, the type of added DOC is particularly critical to the evaluation of BWMS performance. The validation should ensure that relevant properties of the augmented water (such as the oxidant demand/TRO decay and UV absorption in the range of 200 to 280 nm, the production of disinfectant by-products and the particle size distribution of suspended solids) are equivalent, on a mg/L basis, to that of natural water that would quantitatively meet the challenge conditions. In addition, the validation should ensure that augmentation does not bias a test for or against any specific treatment process. The test report should include the basis for the selection, use and validation of augmentation.

2.4.22 The BWMS must be tested in conditions for which it will be approved. For a BWMS to achieve an unlimited Type Approval Certificate with respect to salinity, one set of test cycles should be conducted within each of the three salinity ranges with the associated dissolved and particulate content as prescribed in paragraph 2.4.20. Tests under adjacent salinity ranges in the above table should be separated by at least 10 PSU.

2.4.23 Use of standard test organisms (STO):

.1 the use of standard test organisms (STO) is permissible if the challenge levels in naturally occurring water at the test facility require supplementation. The use of STO should not be considered standard practice and the Administration should in every case review that the selection, number and use of supplementary STOs ensures that the challenge posed to the BWMS provides an adequately robust test. The use of STOs should not bias a test for or against any specific treatment process. They should be locally isolated to ensure that the risk to the local environment is minimised; non indigenous organisms which have the potential to cause harm to the environment should not be used;

.2 procedures, processes and guidance for the use of STO should be based on the most relevant and up to date available scientific data. Such procedures, processes and guidance should form a part of the testing facilities quality assurance regimes; and

.3 the use of STO, including concentrations and species, should be recorded within the test report. The test report should include information pertaining to the evaluation and justification for the use of STO, an assessment of the impact of their use on other test parameters and potential impacts on the test being undertaken. The information contained within the report should reflect both the positive and negative impacts of the use of STO.

2.4.24 The influent water should include:

.1 test organisms of greater than or equal to 50 micrometres or more in minimum dimension should be present in a total density of preferably 10^6 but not less than 10^5 individuals per cubic metre, and should consist of at least 5 species from at least 3 different phyla/divisions;

.2 test organisms greater than or equal to 10 micrometres and less than 50 micrometres in minimum dimension should be present in a total density of preferably 10^4 but not less than 10^3 individuals per millilitre, and should consist of at least 5 species from at least 3 different phyla/divisions;

.3 heterotrophic bacteria should be present in a density of at least 10^4 living bacteria per millilitre; and

.4 the variety of organisms in the test water should be documented according to the size classes mentioned above regardless if natural organism assemblages or cultured organisms were used to meet the density and organism variety requirements.

2.4.25 The following bacteria do not need to be added to the influent water, but should be measured at the influent and at the time of discharge:

.1 coliform;

.2 Enterococcus group;

.3 *Vibrio cholerae*; and

.4 heterotrophic bacteria.

2.4.26 If cultured test organisms are used, then it should be ensured that local applicable quarantine regulations are taken into account during culturing and discharge.

Land-based monitoring and sampling

2.4.27 Change of numbers of test organisms by treatment and during storage in the simulated ballast tank should be measured using methods described in Part 4 of the annex, paragraphs 4.5 to 4.7.

2.4.28 It should be verified that the treatment equipment performs within its specified parameters, such as power consumption and flow rate, during the test cycle.

2.4.29 The range of operational flow rates that a BWMS is expected to achieve in service, at the maximum and minimum operational flow rates (where it is appropriate for that technology), should be verified after the filter on the discharge side of the pump. The range of flow rate may be derived from empirical testing or from computational modelling. Where appropriate for the technology, demonstration of system efficacy at low flow rates should reflect the need for flow reduction during the final stages of ballast operations.

2.4.30 Environmental parameters such as pH, temperature, salinity, dissolved oxygen, TSS, DOC, POC and turbidity (NTU)[2] should be measured at the same time that the samples described are taken.

2.4.31 Samples during the test for the purposes of determining biological efficacy should be taken at the following times and locations: immediately before the treatment equipment, immediately after the treatment equipment and upon discharge after the appropriate holding time.

2.4.32 The control and treatment cycles may be run simultaneously or sequentially. Control samples are to be taken in the same manner as the equipment test as prescribed in paragraph 2.4.31 and upon influent and discharge.

2.4.33 Facilities or arrangements for sampling should be provided to ensure representative samples of treated and control water can be taken that introduce as little adverse effects as possible on the organisms.

2.4.34 Samples described in paragraphs 2.4.31 and 2.4.32 should be collected with the following sampling regime and volumes for analysis:

.1 for the enumeration of viable organisms greater than or equal to 50 micrometres or more in minimum dimension:

.1 influent water should be collected over the duration of uptake as one, time-integrated sample. The sample should be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. The total sample volume should be at least one cubic metre. If smaller volume is validated to ensure representative sampling of organisms, it may be used;

2 NTU=Nominal Turbidity Unit.

.2 control and treated discharged water should be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. The total sample volume should be at least three cubic metres;

.3 if samples are concentrated for enumeration, the organisms should be concentrated using a mesh with holes no greater than 50 micrometres in the diagonal dimension. Only organisms greater than 50 micrometres in minimum dimension should be enumerated; and

.4 the full volume of the sample should be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method;

.2 for the enumeration of viable organisms greater than or equal to 10 micrometres and less than 50 micrometres in minimum dimension:

.1 influent water should be collected over the duration of uptake as one, time-integrated sample. The sample should be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. A sample of at least 10 litres should be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 litre. A minimum of three, 1-millilitre sub-samples should be analysed in full to enumerate organisms.

.2 control and treated discharged water should be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. A sample of at least 10 litres should be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 litre. A minimum of six, 1-millilitre sub-samples should be analysed in full to enumerate organisms.

.3 the sample may not be concentrated for analysis unless the procedure is validated. Only organisms greater than 10 micrometres and less than 50 micrometres in minimum dimension should be enumerated;

.4 the full volume of the sample should be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method;

.3 for the evaluation of bacteria:

.1 for the influent and discharge samples, a minimum 10-litre sample referred to in paragraph 2.3.3.7.2.2, or another sample at least 10 litres in volume and collected in a similar manner, a sub-sample of minimum 1 litre may be transferred to a sterile container for analysis;

.2 a minimum of three, subsamples of appropriate volume taken from the 1 litre subsample described above should be analysed for colony forming units of bacteria listed in regulation D-2; and

.3 the toxicogenic test requirements should be conducted in an appropriately approved laboratory. If no approved laboratory is available, the analysis method may be validated to the satisfaction of the Administration.

2.4.35 The samples should be analysed as soon as possible after sampling, and analysed live within six hours or treated in such a way so as to ensure that proper analysis can be performed.

2.4.36 If in any test cycle the discharge results from the control water is a concentration less than or equal to 10 times the values in regulation D-2.1, the test cycle is invalid.

2.5 Temperature

2.5.1 The effective performance of BWMS through a ballast water temperature range of 0°C to 40°C (2°C to 40°C for fresh water) and a mid-range temperature of 10°C to 20°C should be the subject of an assessment verified by the Administration.

2.5.2 This assessment may include:

.1 testing during land-based, shipboard, laboratory or bench-scale testing; and/or

.2 the use of existing data and/or models, provided that their source, suitability and reliability is reported.

2.5.3 The report submitted to the Administration should contain all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the temperature assessment. The report should include at least the information identified in paragraph 2.7.2 of this annex.

2.6 Evaluation of regrowth

2.6.1 The evaluation of the regrowth of organisms should be undertaken to the satisfaction of the Administration in land-based and/or shipboard testing in at least two test cycles in each salinity.

2.6.2 In the case of land-based testing being performed with a holding time of less than five days, a sufficient volume of treated uptake water should be held under conditions similar to conditions in the relevant holding tank. In the case of shipboard testing, water should be retained on board for the evaluation of regrowth during a shipboard test cycle. Additional bench-scale testing may be used to supplement the land-based and/or shipboard testing.

2.6.3 In the case of a BWMS that includes mechanical, physical, chemical, and/or biological processes intended to kill, render harmless, or remove organisms within ballast water at the time of discharge or continuously between the time of uptake and discharge, regrowth should be assessed in accordance with section 2.3 or 2.4 of this annex with a holding time of at least five days.

2.6.4 Otherwise, the enumeration of organisms to assess regrowth should be undertaken at least five days after the completion of all of the mechanical, physical, chemical, and/or biological processes intended to kill, render harmless, or remove organisms within ballast water.

2.6.5 Any neutralization of ballast water required by the BWMS should occur at the end of the holding time, and immediately before the enumeration of organisms.

2.6.6 The evaluation of regrowth is not intended to evaluate contamination in ballast tanks or piping, such as may arise from the presence of untreated water or residual sediments.

2.6.7 A report should be submitted to the Administration containing all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the evaluation of regrowth. The report should include at least the information identified in paragraph 2.7.2 of this annex.

2.7 Reporting of test results

2.7.1 After approval tests have been completed, a report should be submitted to the Administration. This report should include information regarding the test design, methods of analysis and the results of these analyses for each test cycle (including invalid test cycles), BWMS maintenance logs and any observed effects of the BWMS on the ballast system of the ship (e.g. pumps, pipes, tanks, valves). Shipboard test reports should include information on the total and continuous operating time of the BWMS.

2.7.2 The reports submitted in accordance with paragraph 2.7.1 should contain at least the following information:

1 the name and address of the laboratory performing or supervising the inspections, tests or evaluations, and its national accreditation or quality management certification, if appropriate;

.2 the name of the manufacturer;

.3 the trade name, product designation (such as model numbers), and a detailed description of the equipment or material inspected, tested or evaluated;

.4 the time, date, and place of each approval inspection, test or evaluation;

.5 the name and title of each person performing, supervising, and witnessing the tests and evaluations;

.6 executive summary;

.7 introduction and background;

.8 for each test cycle, inspection or evaluation conducted, summary descriptions of:

.1 experimental design;

.2 methods and procedures;

.3 results and discussion, including a description of any invalid test cycle (in the case of a report referred to in Part 2 of this annex) and a comparison to the expected performance; and

.4 in the case of land-based testing, test conditions including details on challenge water preparation in line with paragraph 2.4.21;

.9 a description or photographs of the procedures and apparatus used in the inspections, tests or evaluation, or a reference to another document that contains an appropriate description or photographs;

.10 at least one photograph that shows an overall view of the equipment or material tested, inspected or evaluated and other photographs that show:

.1 design details; and

.2 each occurrence of damage or deformation to the equipment or material that occurred during the approval tests or evaluations;

.11 the operational safety requirements of the BWMS and all safety related findings that have been made during the inspections, tests or evaluations

.12 an attestation that the inspections, tests or evaluations were conducted as required and that the report contains no known errors, omissions, or false statements. The attestation must be signed by:

.1 the manufacturer or manufacturer's representative, if the inspection, tests or evaluations are conducted by the manufacturer; or

.2 the chief officer of the laboratory, or the chief officer's representative, if the Inspection or tests were conducted by an independent laboratory;

.13 appendices, including:

.1 the complete test plan and the data generated during tests and evaluations reported under subparagraph 2.7.2.8 above, including at least:

.1 for land-based tests, whether ambient, cultured or a mixture of test organisms have been used (including a species-level identification for cultured organisms, and an identification to the lowest possible taxonomic level for ambient organisms);

.2 for shipboard tests, the operating parameters of the system during successful treatment operations (e.g. dosage rates, ultraviolet intensity and the energy consumption of the BWMS under normal or tested Treatment Rated Capacity, if available);

.3 for System Design Limitations, details of all procedures, methods, data, models, results, explanations and remarks, leading to validation; and

.4 invalid test information;

.2 the QMP, the QAPP and Quality Assurance and Quality Control records;

.3 maintenance logs including a record of any consumable components that were replaced; and

.4 relevant records and tests results maintained or created during testing.

2.7.3 The results of biological efficacy testing of the BWMS should be accepted if during the land-based and shipboard testing conducted as specified in sections 2.3 and 2.4 of this annex it is shown that the system has met the standard in regulation D-2 and that the uptake water quality requirements were met in all individual test cycles as provided in paragraph 4.7 below.

2.7.4 The test report shall include all test runs during land-based and shipboard tests, including failed and invalid tests with the explanation required in paragraph 2.3.3.12.4 for both shipboard and land-based tests.

2.7.5 The Administration should identify and redact commercially sensitive information (information that is proprietary and not related to the BWMS performance) and make all other information available to interested parties and the Organization. The information should include all of the test reports, including failed tests from both land-based and shipboard testing.

PART 3 – SPECIFICATION FOR ENVIRONMENTAL TESTING FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS

3.1 The electrical and electronic sections of the BWMS in the standard production configuration should be subject to the relevant tests specified in paragraph 3.3 below at a laboratory approved for the purpose by the Administration or by the accreditation body of the laboratory, where the scope of the accreditation covers ISO/IEC 17025 and the relevant test standards.

3.2 Evidence of successful compliance with the environmental tests below should be submitted to the Administration by the manufacturer together with the application for type approval.

3.3 Equipment is to be tested in accordance with IACS UR E10, Rev.6, October 2014 – Test Specification for Type Approval.

3.4 A report on environmental tests should be submitted to the Administration in accordance with paragraph 2.7.2.

PART 4 – SAMPLE ANALYSIS METHODS FOR THE DETERMINATION OF BIOLOGICAL CONSTITUENTS IN BALLAST WATER

Sample processing and analysis

4.1 Samples taken during testing of BWMS are likely to contain a wide taxonomic diversity of organisms, varying greatly in size and susceptibilities to damage from sampling and analysis.

4.2 When available, widely accepted standard methods for the collection, handling (including concentration), storage, and analysis of samples should be used. These methods should be clearly cited and described in test plans and reports. This includes methods for detecting, enumerating, and determining minimum dimension of and identifying organisms and for determining viability (as defined in these Guidelines).

4.3 When standard methods are not available for particular organisms or taxonomic groups, methods that are developed for use should be described in detail in test plans and reports. The descriptive documentation should include any experiments needed to validate the use of the methods.

4.4 Given the complexity in samples of natural and treated water, the required rarity of organisms in treated samples under regulation D-2, and the expense and time requirements of current standard methods, it is likely that several new approaches will be developed for the analyses of the composition, concentration, and viability of organisms in samples of ballast water. Administrations/Parties are encouraged to share information concerning methods for the analysis of ballast water samples, using existing scientific venues, and papers distributed through the Organization.

Sample analysis for determining efficacy in meeting the discharge standard

4.5 Sample analysis is meant to determine the species composition and the number of viable organisms in the sample. Different samples may be taken for determination of viability and for species composition.

4.6 The viability of organisms should be determined using a method that has been accepted by the Organization as appropriate to the ballast water treatment technology being tested. Acceptable methods should provide assurance that organisms not removed from ballast water have been killed or rendered harmless to the environment, human health, property and resources. Viability may be established by assessing the presence of one or more essential characteristics of life, such as structural integrity, metabolism, reproduction, motility, or response to stimuli.

4.7 A treatment test cycle should be deemed successful if:

.1 it is valid in accordance with paragraph 2.3.3.6 (shipboard) or 2.4.20, 2.4.21, 2.4.24 and 2.4.36 (land-based testing) as appropriate;

.2 the density of organisms greater than or equal to 50 micrometres in minimum diameter in the replicate samples is less than 10 viable organisms per cubic metre;

.3 the density of organisms less than 50 micrometres and greater than or equal to 10 micrometres in minimum diameter in the replicate samples is less than 10 viable organisms per millilitre;

.4 the density of *Vibrio cholerae* (serotypes O1 and O139) is less than 1 cfu per 100 millilitres, or less than 1 cfu per 1 gramme (wet weight) zooplankton samples;

.5 the density of *E. coli* in the replicate samples is less than 250 cfu per 100 millilitres;

.6 the density of intestinal Enterococci in the replicate samples is less than 100 cfu per 100 millilitres; and

.7 no averaging of test runs, or the discounting of failed test runs has occurred.

4.8 It is recommended that a non-exhaustive list of standard methods and innovative research techniques be considered[3].

Sample analysis for determining eco-toxicological acceptability of discharge

4.9 Toxicity tests of the treated water discharge should be conducted in accordance with paragraphs 5.2.3 to 5.2.7 of the *Procedure for approval of ballast water management systems that make use of Active Substances* (G9) as revised.

PART 5 – SELF MONITORING

Introduction

5.1 BWMS should monitor and store a minimum number of parameters for detailed evaluation. In addition, all system indications and alerts should be stored and available for inspection. Data storage and retrieval should follow common standards. This Part gives an overview of the minimum required self-monitoring parameters.

Monitoring of parameters

5.2 The applicable self-monitoring parameters listed below should be recorded for every BWMS[4]. Any additional parameters that are necessary to ascertain system performance and safety should be determined by the Administration and stored in the system. If a parameter is not applicable due to the particulars of the system, the Administration may waive the requirement to record that parameter. Limiting operating conditions on the operation of the BWMS should be determined by the manufacturer and approved by the Administration.

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[3] Suggested sources may include but not be limited to:

.1 The Handbook of Standard Methods for the Analysis of Water and Waste Water.
.2 ISO standard methods.
.3 UNESCO standard methods.
.4 World Health Organization.
.5 American Society of Testing and Materials (ASTM) standard methods.
.6 United States EPA standard methods.
.7 Research papers published in peer-reviewed scientific journals.
.8 MEPC documents.

[4] Associated guidance for a template on technical details of the monitoring parameters and record intervals to be developed by the Organization.

General information for all systems

5.3 The information and applicable self-monitoring parameters to be recorded for all systems should include, inter alia:

1. general information: ship name, IMO number, BWMS manufacturer and type designation, BWMS serial number, date of BWMS installation on ship, BWMS treatment rated capacity (TRC), principle of treatment (in-line/in-tank);

2. operational parameters: all recorded parameters should be time tagged if applicable: BWMS operational modes and any transition modes, including bypass operations (e.g. uptake, discharge, warming-up, cleaning and start up), Ballast water pump in operation (yes/no – if information is available from ship), flow-rate at system outlet, Indication of the ballast water tank that is involved in the ballast water operation when practicable;

3. it is recommended that positional information on ballast water operations and on the holding time should be recorded automatically. Otherwise it should be entered manually in the ballast water record book as appropriate. Administrations are encouraged to apply automatic position information recording to ships which install BWMS during ship's building to the greatest extent possible;

4. system alerts and indications: all systems should have an alert regime. Every alert should be logged and time stamped. To assist the inspections it would be helpful to record an alert summary after each ballast water operation automatically, if possible;

5. general alerts include: shutdown of system while in operation, when maintenance is required, BWMS bypass valve status, status of BWMS valves representing system operational mode as appropriate;

6. operational alerts: whenever a relevant parameter exceeds the acceptable range approved by the Administration, the system should give an alert. In addition, an alert should be logged and time stamped also when a combination of relevant parameters exceeds system specifications, even if each single parameter does not exceed its approved range. If a safety relevant parameter (safety for crew, cargo and/or the ship) related to the BWMS exceeds approved limits, an alert/alarm should be mandatory (e.g. hydrogen level at appropriate measurement point(s));

7. the Administration may require additional alerts depending on the design of the system and for future developments; and

8. the System Design Limitation parameters and their corresponding data such as e.g. range, alarm limit, alert delay etc. be password protected on a level above what is required for normal operation and maintenance, i.e. on a system administrator level. Change of any data or parameters which are password protected and interruption of the measurement (wire break, signal out of range) shall be automatically logged and retrievable on a maintenance access level.

Data storage and retrieval

5.4 Storage of data should follow the requirements taking into account paragraphs 4.17 to 4.21 in the main body of these Guidelines. The equipment should be able to store a minimum number of self-monitoring parameters following common standards determined by the Organization.

5.5 The control and monitoring equipment should automatically record the proper functioning or failure of a BWMS without user interaction and add a time stamp to every entry. Additionally, the system should have a tool to produce summary text files for each ballast water operation on demand to support inspections work.

5.6 The system should store the required data in an acceptable format to be able to display, print or export the data for official inspections. An acceptable format could be:

.1 an internationally standardized readable format (e.g. text format, pdf, MS Excel); or

.2 the extensible mark-up language (xml).

5.7 The equipment should be so designed that, as far as is practical, it will not be possible to manipulate either the data being stored by the system or the data which has already been recorded. Any attempt to interfere with the integrity of the data should be recorded.

5.8 Permanent deletion of recordings should not be possible. The system should be capable of storing recorded data for at least 24 months to facilitate compliance with regulation B-2 of the BWM Convention. Where navigation equipment is connected to the monitoring system to provide data for recording, the interfaces should comply with applicable parts of International Standard IEC 61162.

PART 6 – VALIDATION OF SYSTEM DESIGN LIMITATIONS

6.1 The objective of the System Design Limitations approach is twofold. First, it ensures that the performance of the BWMS has been transparently assessed with respect to the known water quality and operational parameters that are important to its operation, including those that may not be specifically provided for in these Guidelines. Second, it provides transparent oversight of manufacturer BWMS performance claims that may go beyond specific criteria in these Guidelines. Although the validation of System Design Limitations yields transparent information that is reported on the Type Approval Certificate, this information does not affect the eligibility of a BWMS to receive type approval.

6.2 The low and/or high parameter values for each system design limitation should be validated to the satisfaction of the Administration as follows:

.1 the validation should be overseen by the Administration and should consist of a rigorous evidence-based assessment of a specific claim by the BWMS manufacturer that the equipment will operate as intended between pre-stated parameter values;

.2 tests to validate System Design Limitations should be undertaken in accordance with section 2.1 of this annex. Such tests may be combined with land-based and/or shipboard testing if the QAPP establishes that the validation tests will not interfere with the specific procedures in Part 2 of this annex. Laboratory or bench-scale testing may also be used in the validation of System Design Limitations;

.3 methods other than testing, such as the use of existing data and/or models, may be used in the validation of System Design Limitations. The source, suitability and reliability of such methods should be reported; and

.4 validation is not intended as a stress-test of the BWMS or as a procedure for identifying equipment failure points. Validation should be undertaken independently of the BWMS manufacturer and should be separate from BWMS research and development activities. Data and models may be supplied by manufacturer when appropriate but should be independently assessed.

6.3 Claims of open-ended performance (expressed as the lack of either a low or a high parameter value for a system design limitation) should also be validated.

6.4 BWMS manufacturers may include a margin of error in claiming System Design Limitations. For this reason, System Design Limitations should not necessarily be interpreted as the exact parameter values beyond which the BWMS is incapable of operation. The Administration should take this into account in considering whether to include any additional restrictions on the Type Approval Certificate in connection with the validation of System Design Limitations.

6.5 System Design Limitations should be established for all known parameters to which the design of the BWMS is sensitive that are important to the operation of the BWMS. In the case of system design limitation parameters that are also subject to specific criteria in Part 2 of this annex, the procedure set out in Part 2 should be followed. For such parameters, the approach in paragraph 6.2 may be used only to the extent that the performance claim goes beyond the specific criteria in Part 2.

6.6 A report should be submitted to the Administration containing all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the validation of System Design Limitations. The report should include at least the information identified in paragraph 2.7.2 of this annex.

PART 7 – TYPE APPROVAL CERTIFICATE AND TYPE APPROVAL REPORT

Type Approval Certificate

7.1 The Type Approval Certificate of BWMS should:

.1 identify the type and model of the BWMS to which it applies and identify equipment assembly drawings, duly dated;

.2 identify pertinent drawings bearing model specification numbers or equivalent identification details;

.3 include a reference to the full performance test protocol on which it is based;

.4 identify if it was issued by an Administration based on a Type Approval Certificate previously issued by another Administration. Such a certificate should identify the Administration that supervised conduction of the tests on the BWMS and a copy of the original test results should be attached to the Type Approval Certificate of BWMS;

.5 identify all conditions and limitations for the installation of BWMS on board the ship;

.6 include the System Design Limitations, which should be listed under the heading "This equipment has been designed for operation in the following conditions";

.7 include any restrictions imposed by the Administration due to the minimum holding time or in accordance with paragraph 6.4 of this annex; such restrictions should include any applicable environmental conditions (e.g. UV transmittance, etc.) and/or system operational parameters (e.g. min/max pressure, pressure differentials, min/max Total Residual Oxidants (TRO) if applicable, etc.); and

.8 an appendix containing test results of each land-based and shipboard test run. Such test results should include at least the numerical salinity, temperature, flow rates, and where appropriate UV transmittance. In addition, these test results should include all other relevant variables. The Type Approval Certificate should list any identified system design limitation parameters.

Type approval report

7.2 The type approval report should be submitted to the Organization and made available to the public and Member States by an appropriate means. It should contain at least:

.1 information on the type approval of the BWMS, including:

.1 the approval date;

.2 the name of the Administration;

.3 the name of the manufacturer;

.4 the trade name and product designation (such as model numbers) of the BWMS; and

.5 a copy of the Type Approval Certificate including its appendices, annexes or other attachments;

.2 an executive summary;

.3 a description of the BWMS, including, in the case of BWMS using Active Substances, the following information:

.1 the name of the Active Substance(s) or Preparation employed; and

.2 identification of the specific MEPC report and paragraph number granting Final Approval in accordance with the *Procedure for approval of ballast water management systems that make use of Active Substances* (G9), as revised;

.4 an overview of the process undertaken by the Administration to evaluate the BWMS, including the name and role of each test facility, subcontractor, and test organization involved in testing and approving the BWMS, the role of each report in the type approval decision, and a summary of the Administration's approach to overall quality assurance and quality control;

.5 the executive summary of each test report prepared in accordance with paragraphs 2.5.3, 2.6.7, 2.7.1, 2.7.2, 3.4 and 6.6 of this annex;

.6 the operational safety requirements of the BWMS and all safety related findings that have been made during the type approval process;

.7 a discussion section explaining the Administration's assessment that the BWMS:

  .1 in every respect fulfilled the requirements of these Guidelines, including demonstrating under the procedures and conditions specified for both land-based and shipboard testing that it met the ballast water performance standard of described in regulation D-2;

  .2 is designed and manufactured according to requirements and standards;

  .3 is in compliance with all applicable requirements;

  .4 has been approved taking into account the recommendations provided by the MEPC in the Final Approval of the BWMS, if any;

  .5 operates within the System Design Limitations at the rated capacity, performance, and reliability as specified by the manufacturer;

  .6 contains control and monitoring equipment that operates correctly;

  .7 was installed in accordance with the technical installation specification of the manufacturer for all tests; and

  .8 was used to treat volumes and flow rates of ballast water during the shipboard tests consistent with the normal ballast operations of the ship; and

.8 the following annexes:

  .1 appropriate information on quality control and assurance; and

  .2 each complete test report prepared in accordance with paragraphs 2.5.3, 2.6.7, 2.7.1, 2.7.2, 3.4 and 6.6 of this annex.

7.3 The Administration should redact proprietary information of the manufacturer from the type approval report before submitting it to the Organization.

7.4 The Type Approval Certificate and the type approval report (including their entire contents and all annexes, appendices or other attachments) should be accompanied by a translation into English, French or Spanish if not written in one of those languages.

7.5 Documents should not be incorporated by reference into the Type Approval Certificate. The Administration may incorporate an annex by reference into the type approval report if the reference (e.g. Internet URL) is expected to remain permanently valid. Upon any reference becoming invalid, the Administration should promptly re-submit the type approval report to the Organization and include the referenced document or an updated reference to it; the Organization should promptly make the revised report available to the public and Member States through an appropriate means.

APPENDIX

BADGE OR CIPHER **(Limiting Operating Conditions Apply)**
(delete as appropriate)

NAME OF ADMINISTRATION

TYPE APPROVAL CERTIFICATE OF BALLAST WATER MANAGEMENT SYSTEM

This is to certify that the ballast water management system listed below has been examined and tested in accordance with the requirements of the specifications contained in the Guidelines contained in IMO resolution MEPC.279(70). This certificate is valid only for the Ballast Water Management System referred to below.

Name of Ballast Water Management System: ....

Ballast Water Management System manufactured by: ....

Under type and model designation(s) ....
and incorporating:

To equipment/assembly drawing No.: .... date: ....

Other equipment manufactured by : ....

To equipment/assembly drawing No.: .... date: ....

Treatment Rated Capacity (m^3/h): ....

A copy of this Type Approval Certificate, should be carried on board a ship fitted with this Ballast Water Management System. A reference to the test protocol and a copy of the test results should be available for inspection on board the ship. If the Type Approval Certificate is issued based on approval by another Administration, reference to that Type Approval Certificate shall be made.

Limiting Operating Conditions imposed are described in this document.

(Temperature / Salinity)

Other restrictions imposed include the following:

This equipment has been designed for operation in the following conditions:
(insert System Design Limitations)

Official stamp

Signed ....
Administration of ....
Issued this .... day of .... 20 ......
Valid until this…………day of …………………………….. 20…..

Enc. Copy of the original test results.

***

ANNEX 6

RESOLUTION MEPC.280(70)
(Adopted on 28 October 2016)

EFFECTIVE DATE OF IMPLEMENTATION OF THE FUEL OIL STANDARD IN REGULATION 14.1.3 OF MARPOL ANNEX VI

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that the revised MARPOL Annex VI entered into force on 1 July 2010,

RECALLING FURTHER that regulation 14.1.3 of MARPOL Annex VI stipulates that the sulphur content of any fuel oil used on board ships shall not exceed 0.50% m/m on or after 1 January 2020,

RECALLING that regulations 14.8 to 14.10 of MARPOL Annex VI require that a review shall be completed by 2018 to determine the availability of fuel oil to comply with the fuel oil standard set forth in regulation 14.1.3 of MARPOL Annex VI,

NOTING that an assessment of fuel oil availability has been completed to inform the decision to be taken by the Parties to MARPOL Annex VI in accordance with regulation 14.10 of MARPOL Annex VI,

HAVING CONSIDERED, at its seventieth session, based on the aforementioned assessment of fuel oil availability, whether it is possible for ships to comply with the implementation date in regulation 14.1.3 of MARPOL Annex VI,

1 DECIDES that the fuel oil standard in regulation 14.1.3 of MARPOL Annex VI shall become effective on 1 January 2020;

2 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring this decision to the attention of shipowners, ship operators, refinery industries and any other interested groups;

3 REQUESTS the Secretary-General to notify all Parties to MARPOL Annex VI of the aforementioned decision;

4 REQUESTS ALSO the Secretary-General to notify all Members of the Organization which are not Parties to MARPOL Annex VI of the aforementioned decision.

***

ANNEX 9

RESOLUTION MEPC.281(70)
(Adopted on 28 October 2016)

AMENDMENTS TO THE 2014 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX (EEDI) FOR NEW SHIPS (RESOLUTION MEPC.245(66), AS AMENDED BY RESOLUTION MEPC.263(68))

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee (the Committee) conferred upon it by international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that it adopted, by resolution MEPC.203(62), Amendments to the annex of the Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (inclusion of regulations on energy efficiency for ships in MARPOL Annex VI),

NOTING that the aforementioned amendments to MARPOL Annex VI entered into force on 1 January 2013,

NOTING ALSO that regulation 20 (Attained Energy Efficiency Design Index (attained EEDI)) of MARPOL Annex VI, as amended, requires that the EEDI shall be calculated taking into account the guidelines developed by the Organization,

NOTING the *2012 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships*, adopted by resolution MEPC.212(63), and, the amendments thereto, adopted by resolution MEPC.224(64),

NOTING FURTHER that it adopted, by resolution MEPC.245(66), the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships*, and by resolution MEPC.263(68), amendments thereto,

RECOGNIZING that the aforementioned amendments to MARPOL Annex VI require relevant guidelines for the smooth and uniform implementation of the regulations,

HAVING CONSIDERED, at its seventieth session, proposed amendments to the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships*, as amended,

1 ADOPTS amendments to the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships, as amended*, as set out in the annex to the present resolution;

2 INVITES Administrations to take the aforementioned amendments into account when developing and enacting national laws which give force to and implement provisions set forth in regulation 20 of MARPOL Annex VI, as amended;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the amendments to the attention of shipowners, ship operators, shipbuilders, ship designers and any other interested parties;

4 AGREES to keep these Guidelines, as amended, under review, in the light of experience gained with their implementation.

ANNEX

AMENDMENTS TO THE 2014 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX (EEDI) FOR NEW SHIPS (RESOLUTION MEPC.245(66), AS AMENDED BY RESOLUTION MEPC.263(68))

1 The following text is added after 2.12.3 in the table of contents:

"2.12.4 $f_{c\ bulk\ carriers\ designed\ to\ carry\ light\ cargoes}$; wood chip carriers"

2 Paragraph 2.1 is replaced with the following:

".1 C_F is a non-dimensional conversion factor between fuel consumption measured in g and CO_2 emission also measured in g based on carbon content. The subscripts $_{ME(i)}$ and $_{AE(i)}$ refer to the main and auxiliary engine(s) respectively. C_F corresponds to the fuel used when determining *SFC* listed in the applicable test report included in a Technical File as defined in paragraph 1.3.15 of NO_X Technical Code ("test report included in a NO_X technical file" hereafter). The value of C_F is as follows:

Type of fuel	Reference	Lower calorific value (kJ/kg)	Carbon content	C_F (t-CO_2/t-Fuel)
1 Diesel/Gas Oil	ISO 8217 Grades DMX through DMB	42,700	0.8744	3.206
2 Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	41,200	0.8594	3.151
3 Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	40,200	0.8493	3.114
4 Liquefied Petroleum Gas (LPG)	Propane	46,300	0.8182	3.000
	Butane	45,700	0.8264	3.030
5 Liquefied Natural Gas (LNG)		48,000	0.7500	2.750
6 Methanol		19,900	0.3750	1.375
7 Ethanol		26,800	0.5217	1.913

In case of a ship equipped with a dual-fuel main or auxiliary engine, the C_F-factor for gas fuel and the C_F-factor for fuel oil should apply and be multiplied with the specific fuel oil consumption of each fuel at the relevant EEDI load point. Meanwhile, gas fuel should be identified whether it is regarded as the "primary fuel" in accordance with the formula below:

$$f_{DFgas} = \frac{\sum_{i=1}^{ntotal} P_{total(i)}}{\sum_{i=1}^{ngasfuel} P_{gasfuel(i)}} \times \frac{V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}{\left(\sum_{i=1}^{nLiquid} V_{liquid(i)} \times \rho_{liquid(i)} \times LCV_{liquid(i)} \times K_{liquid(i)} \right) + V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}$$

where,

f_{DFgas} is the fuel availability ratio of gas fuel corrected for the power ratio of gas engines to total engines, f_{DFgas} should not be greater than 1;

V_{gas} is the total net gas fuel capacity on board in m^3. If other arrangements, like exchangeable (specialized) LNG tank-containers and/or arrangements allowing frequent gas refuelling are used, the capacity of the whole LNG fuelling system should be used for V_{gas}. The boil-off rate (BOR) of gas cargo tanks can be calculated and included to V_{gas} if it is connected to the fuel gas supply system (FGSS);

V_{liquid} is the total net liquid fuel capacity on board in m^3 of liquid fuel tanks permanently connected to the ship's fuel system. If one fuel tank is disconnected by permanent sealing valves, V_{liquid} of the fuel tank can be ignored;

ρ_{gas} is the density of gas fuel in kg/m^3;

ρ_{liquid} is the density of each liquid fuel in kg/m^3;

LCV_{gas} is the low calorific value of gas fuel in kJ/kg;

LCV_{liquid} is the low calorific value of liquid fuel in kJ/kg;

K_{gas} is the filling rate for gas fuel tanks;

K_{liquid} is the filling rate for liquid fuel tanks;

P_{total} *is* the total installed engine power, P_{ME} *and* P_{AE} in kW;

$P_{gasfuel}$ *is* the dual fuel engine installed power, P_{ME} *and* P_{AE} in kW;

.1 If the total gas fuel capacity is at least 50% of the fuel capacity dedicated to the dual fuel engines , namely $f_{DFgas} \geq 0.5$, then gas fuel is regarded as the "Primary fuel," and $f_{DFgas} = 1$ and $f_{DFliquid} = 0$ for each dual fuel engine.

.2 If $f_{DFgas} < 0.5$, gas fuel is not regarded as the "primary fuel." The C_F and SFC in the EEDI calculation for each dual fuel engine (both main and auxiliary engines) should be calculated as the weighted average of C_F and SFC for liquid and gas mode, according to f_{DFgas} and $f_{DFliquid}$, such as the original item of $P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}$ in the EEDI calculation is to be replaced by the formula below.

$$P_{ME(i)} \cdot (f_{DFgas(i)} \cdot (C_{FME\ pilot\ fuel(i)} \cdot SFC_{ME\ pilot\ fuel(i)} + C_{FME\ gas(i)} \cdot SFC_{ME\ gas(i)}) + f_{DFliquid(i)} \cdot C_{FME\ liquid(i)} \cdot SFC_{ME\ liquid(i)})$$ "

3 The following sentences are added at the end of existing paragraph 2.7.1:

"Reference lower calorific values of additional fuels are given in the table in paragraph 2.1 of these Guidelines. The reference lower calorific value corresponding to the conversion factor of the respective fuel should be used for calculation."

4 A new paragraph 2.12.4 is added after the existing paragraph 2.12.3 as follows:

".4 For bulk carriers having *R* of less than 0.55 (e.g. wood chip carriers), the following cubic capacity correction factor, fc bulk carriers designed to carry light cargoes, should apply:

$$f_{c\ bulk\ carriers\ designed\ to\ carry\ light\ cargoes} = R^{-0.15}$$

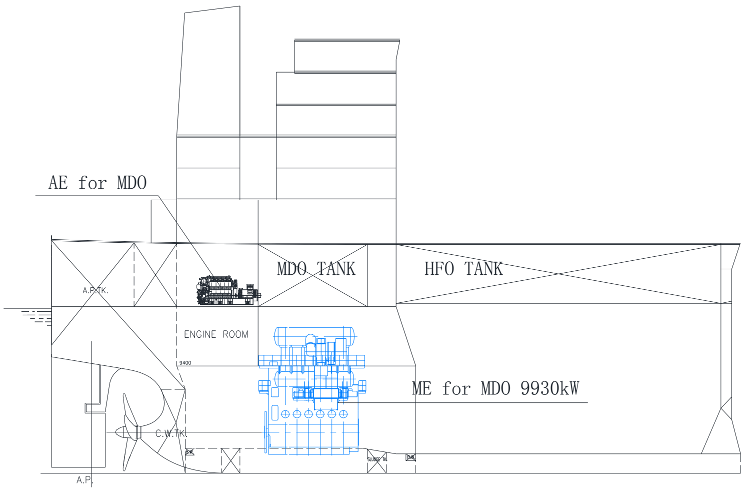
where: *R* is the capacity ratio of the deadweight of the ship (tonnes) as determined by paragraph 2.4 divided by the total cubic capacity of the cargo holds of the ship (m^3)."

5 Appendix 4 is replaced with the following:

"APPENDIX 4

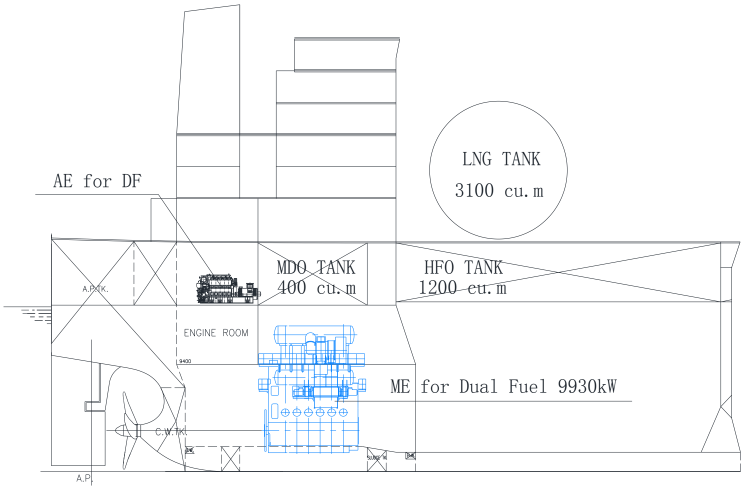
EEDI CALCULATION EXAMPLES FOR USE OF DUAL FUEL ENGINES

Case 1: Standard Kamsarmax ship, one main engine (MDO), standard auxiliary engines (MDO), no shaft generator:



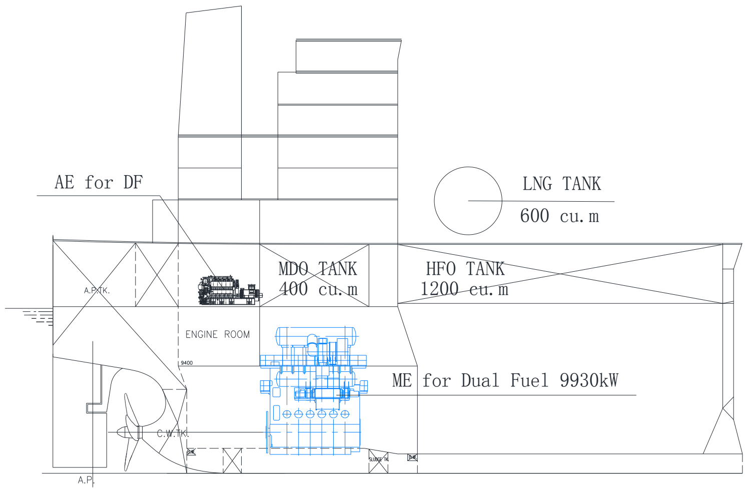
S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	Capacity	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	0.75 x MCR_{ME}	kW	7447.5
5	P_{AE}	0.05 x MCR_{ME}	kW	496.5
6	C_{FME}	C_F factor of Main engine using MDO	-	3.206
7	C_{FAE}	C_F factor of Auxiliary engine using MDO	-	3.206
8	SFC_{ME}	Specific fuel consumption of at P_{ME}	g/kWh	165
9	SFC_{AE}	Specific fuel consumption of at P_{AE}	g/kWh	210
10	EEDI	$((P_{ME} x C_{F\ ME}$ x $SFC_{ME})+(P_{AE}$ x C_{FAE} x $SFC_{AE}))$ / (v_{ref} x *Capacity*)	gCO_2/tnm	3.76

Case 2: LNG is regarded as the "primary fuel" if dual-fuel main engine and dual-fuel auxiliary engine (LNG, pilot fuel MDO; no shaft generator) are equipped with bigger LNG tanks



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	Capacity	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	0.75 x MCR_{ME}	kW	7447.5
5	P_{AE}	0.05 x MCR_{ME}	kW	496.5
6	$CF_{Pilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
7	$CF_{AE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
8	CF_{LNG}	C_F factor of dual fuel engine using LNG	-	2.75
9	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
10	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
11	$SFC_{ME\ LNG}$	Specific fuel consumption of ME using LNG at P_{ME}	g/kWh	136
12	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
13	V_{LNG}	LNG tank capacity on board	m^3	3100
14	V_{HFO}	Heavy fuel oil tank capacity on board	m^3	1200
15	V_{MDO}	Marine diesel oil tank capacity on board	m^3	400
16	ρ_{LNG}	Density of LNG	kg/m^3	450
17	ρ_{HFO}	Density of heavy fuel oil	kg/m^3	991
18	ρ_{MDO}	Density of Marine diesel oil	kg/m^3	900
19	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
20	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
21	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
22	K_{LNG}	Filling rate of LNG tank	-	0.95
23	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
24	K_{MDO}	Filling rate of marine diesel tank	-	0.98
25	f_{DFgas}	$\frac{P_{ME}+P_{AE}}{P_{ME}+P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.5068
26	EEDI	(P_{ME} x ($C_{F\ Pilotfuel}$ x $SFC_{ME\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{ME\ LNG}$) + P_{AE} x ($C_{F\ Pilotfuel}$ x $SFC_{AE\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{AE\ LNG}$)) / (V_{ref} x *Capacity*)	gCO_2/tnm	2.78

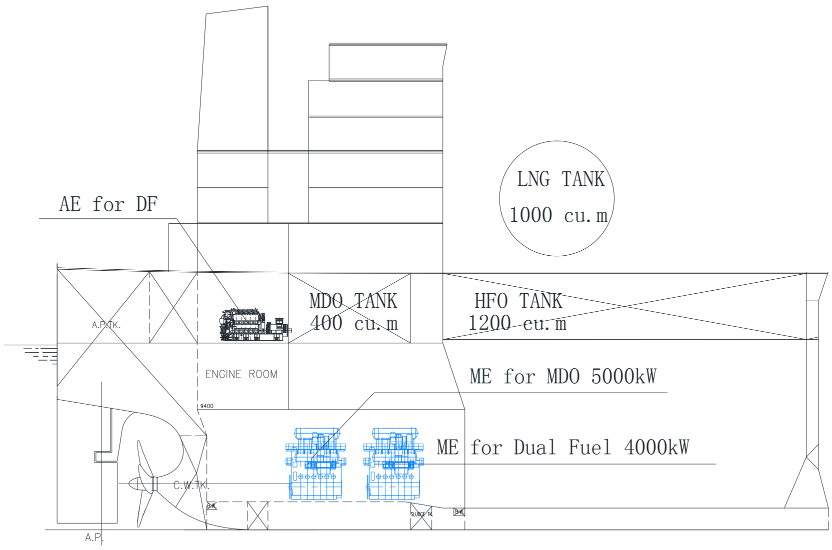
Case 3: LNG is not regarded as the "primary fuel" if dual-fuel main engine and dual-fuel auxiliary engine (LNG, pilot fuel MDO; no shaft generator) are equipped with smaller LNG tanks



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	Capacity	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	0.75 x MCR_{ME}	kW	7447.5
5	P_{AE}	0.05 x MCR_{ME}	kW	496.5
6	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
7	$C_{FAE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
8	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
9	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	3.206
10	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
11	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
12	$SFC_{ME\ LNG}$	Specific fuel consumption of ME using LNG at P_{ME}	g/kWh	136
13	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
14	$SFC_{ME\ MDO}$	Specific fuel consumption of dual fuel ME using MDO at P_{ME}	g/kWh	165
15	$SFC_{AE\ MDO}$	Specific fuel consumption of dual fuel AE using MDO at P_{AE}	g/kWh	187
16	V_{LNG}	LNG tank capacity on board	m^3	600
17	V_{HFO}	Heavy fuel oil tank capacity on board	m^3	1800
18	V_{MDO}	Marine diesel oil tank capacity on board	m^3	400
19	ρ_{LNG}	Density of LNG	kg/m^3	450
20	ρ_{HFO}	Density of heavy fuel oil	kg/m^3	991
21	ρ_{MDO}	Density of Marine diesel oil	kg/m^3	900
22	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
24	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
25	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
26	K_{LNG}	Filling rate of LNG tank	-	0.95
27	K_{HFO}	Filling rate of heavy fuel tank	-	0.98

S/N	Parameter	Formula or Source	Unit	Value
28	K_{MDO}	Filling rate of marine diesel tank	-	0.98
29	f_{DFgas}	$\frac{P_{ME}+P_{AE}}{P_{ME}+P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.1261
30	$f_{DFliquid}$	$1 - f_{DFgas}$	-	0.8739
31	EEDI	$(P_{ME} \times (\mathbf{f_{DFgas}} \times (C_{F\ Pilotfuel} \times SFC_{ME\ Pilotfuel} + C_{F\ LNG} \times SFC_{ME\ LNG}) + \mathbf{f_{DFliquid}} \times C_{FMDO} \times SFC_{ME\ MDO}) + P_{AE} \times (\mathbf{f_{DFgas}} \times (C_{FAE\ Pilotfuel} \times SFC_{AE\ Pilotfuel} + C_{F\ LNG} \times SFC_{AE\ LNG}) + \mathbf{f_{DFliquid}} \times C_{FMDO} \times SFC_{AE\ MDO})) / (V_{ref} \times Capacity)$	gCO_2/tnm	3.61

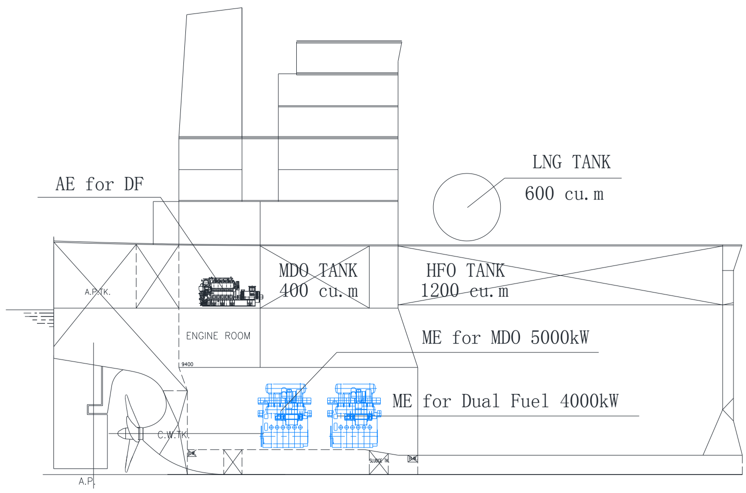
Case 4: One dual-fuel main engine (LNG, pilot fuel MDO) and one main engine (MDO) and dual-fuel auxiliary engine (LNG, pilot fuel MDO, no shaft generator) which LNG could be regarded as "primary fuel" only for the dual-fuel main engine.



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{MEMDO}	MCR rating of main engine using only MDO	kW	5000
2	MCR_{MELNG}	MCR rating of main engine using dual fuel	kW	4000
3	Capacity	Deadweight of the ship at summer load draft	DWT	81200
4	V_{ref}	Ships speed	kn	14
5	P_{MEMDO}	$0.75 \times MCR_{MEMDO}$	kW	3750
6	P_{MELNG}	$0.75 \times MCR_{MELNG}$	kW	3000
7	P_{AE}	$0.05 \times (MCR_{MEMDO} + MCR_{MELNG})$	kW	450
8	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
9	$C_{FAE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
10	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
11	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	3.206
12	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
13	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
14	$SFC_{DF\ LNG}$	Specific fuel consumption of dual fuel ME using LNG at P_{ME}	g/kWh	158
15	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
16	$SFC_{ME\ MDO}$	Specific fuel consumption of single fuel ME at P_{ME}	g/kWh	180
17	V_{LNG}	LNG tank capacity on board	m^3	1000
18	V_{HFO}	Heavy fuel oil tank capacity on board	m^3	1200

S/N	Parameter	Formula or Source	Unit	Value
19	V_{MDO}	Marine diesel oil tank capacity on board	m^3	400
20	ρ_{LNG}	Density of LNG	kg/m^3	450
21	ρ_{HFO}	Density of heavy fuel oil	kg/m^3	991
22	ρ_{MDO}	Density of Marine diesel oil	kg/m^3	900
23	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
24	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
25	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
26	K_{LNG}	Filling rate of LNG tank	-	0.95
27	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
28	K_{MDO}	Filling rate of Lmarine diesel tank	-	0.98
29	f_{DFgas}	$\frac{P_{MEMDO} + P_{MELNG} + P_{AE}}{P_{MELNG} + P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.5195
30	EEDI	$(P_{MELNG} \times (C_{F\ Pilotfuel} \times SFC_{ME\ Pilotfuel} + C_{F\ LNG} \times SFC_{DF\ LNG}) + P_{MEMDO} \times C_{F\ MDO} \times SFC_{ME\ MDO} + P_{AE} \times (C_{FAE\ Pilotfuel} \times SFC_{AE\ Pilotfuel} + C_{F\ LNG} \times SFC_{AE\ LNG})) / (v_{ref} \times Capacity)$	gCO_2/tnm	3.28

Case 5: One dual-fuel main engine (LNG, pilot fuel MDO) and one main engine (MDO) and dual-fuel auxiliary engine (LNG, pilot fuel MDO, no shaft generator) which LNG could not be regarded as "primary fuel" for the dual- fuel main engine.



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{MEMDO}	MCR rating of main engine using only MDO	kW	5000
2	MCR_{MELNG}	MCR rating of main engine using dual fuel	kW	4000
3	Capacity	Deadweight of the ship at summer load draft	DWT	81200
4	V_{ref}	Ships speed	kn	14
5	P_{MEMDO}	0.75 x MCR_{MEMDO}	kW	3750
6	P_{MELNG}	0.75 x MCR_{MELNG}	kW	3000
7	P_{AE}	0.05 x (MCR_{MEMDO} + MCR_{MELNG})	kW	450
8	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
9	$C_{FAE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
10	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
11	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	2.75
12	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
13	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7

S/N	Parameter	Formula or Source	Unit	Value
14	$SFC_{DF\ LNG}$	Specific fuel consumption of dual fuel ME using LNG at P_{ME}	g/kWh	158
15	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
16	$SFC_{DF\ MDO}$	Specific fuel consumption of dual fuel ME using MDO at P_{ME}	g/kWh	185
17	$SFC_{ME\ MDO}$	Specific fuel consumption of single fuel ME at P_{ME}	g/kWh	180
18	$SFC_{AE\ MDO}$	Specific fuel consumption of AE using MDO at P_{AE}	g/kWh	187
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29	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
30	K_{MDO}	Filling rate of marine diesel tank	-	0.98
31	f_{DFgas}	$\frac{P_{MEMDO} + P_{MELNG} + P_{AE}}{P_{MELNG} + P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.3462
32	$f_{DFliquid}$	1- f_{DFgas}	-	0.6538
33	EEDI	$(P_{MELNG}$ x $(\mathbf{f_{DFgas}}$ x $(C_{F\ Pilotfuel}$ x $SFC_{ME\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{DF\ LNG}$) + $\mathbf{f_{DFliquid}}$ x C_{FMDO} x $SFC_{DF\ MDO}$))+ P_{MEMDO} x $C_{F\ MDO}$ x $SFC_{ME\ MDO}$ + P_{AE} x ($\mathbf{f_{DFgas}}$ x ($C_{FAE\ Pilotfuel}$ x $SFC_{AE\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{AE\ LNG}$) + $\mathbf{f_{DFliquid}}$ xC_{FMDO} x $SFC_{AE\ MDO}$)) / (v_{ref} x *Capacity*)	gCO_2/tnm	3.54

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ANNEX 10

RESOLUTION MEPC.282(70)
(Adopted on 28 October 2016)

2016 GUIDELINES FOR THE DEVELOPMENT OF A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee (the Committee) conferred upon it by international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that it adopted, by resolution MEPC.203(62), Amendments to the annex of the Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (inclusion of regulations on energy efficiency for ships in MARPOL Annex VI),

NOTING that the aforementioned amendments to MARPOL Annex VI, which included a new chapter 4 on regulations on energy efficiency for ships in Annex VI, entered into force on 1 January 2013,

NOTING ALSO that regulation 22 of MARPOL Annex VI, as amended, requires each ship to keep on board a ship specific Ship Energy Efficiency Management Plan, taking into account guidelines developed by the Organization,

NOTING FURTHER that it adopted, by resolution MEPC.278(70), amendments to MARPOL Annex VI related to the data collection system for fuel oil consumption which are expected to enter into force on 1 March 2018 upon their deemed acceptance on 1 September 2017,

RECOGNIZING that the aforementioned amendments to MARPOL Annex VI require the adoption of relevant guidelines for uniform and effective implementation of the regulations and to provide sufficient lead time for industry to prepare,

HAVING CONSIDERED, at its seventieth session, draft *2016* Guidelines for the development of a Ship Energy Efficiency Management Plan *(SEEMP)*,

1 ADOPTS the *2016 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)* (the 2016 Guidelines), as set out in the annex to the present resolution;

2 INVITES Administrations to take the annexed 2016 Guidelines into account when developing and enacting national laws which give force to and implement requirements set forth in regulations 22 and 22A of MARPOL Annex VI, as amended;

3 REQUESTS the Parties to MARPOL Annex VI and other Member Governments to bring the annexed 2016 Guidelines to the attention of masters, seafarers, shipowners, ship operators and any other interested groups;

4 AGREES to keep the 2016 Guidelines under review in light of the experience gained with their implementation;

5 SUPERSEDES the *2012 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP),* adopted by resolution MEPC.213(63).

ANNEX

2016 GUIDELINES FOR THE DEVELOPMENT OF A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP)

CONTENTS

1 INTRODUCTION

1.1 The *Guidelines for the development of a Ship Energy Efficiency Management Plan* have been developed to assist with the preparation of the Ship Energy Efficiency Management Plan (SEEMP) required by regulation 22 of MARPOL Annex VI.

1.2 There are two parts to a SEEMP. Part I provides a possible approach for monitoring ship and fleet efficiency performance over time and some options to be considered when seeking to optimize the performance of the ship. Part II provides the methodologies ships of 5,000 gross tonnage and above should use to collect the data required pursuant to regulation 22A of MARPOL Annex VI and the processes that the ship should use to report the data to the ship's Administration or any organization duly authorized by it.

1.3 A sample form of the SEEMP is presented in appendices 1 and 2 for illustrative purposes. A standardized data reporting format for the data collection system is presented in appendix 3.

2 DEFINITIONS

2.1 For the purpose of these Guidelines, the definitions in MARPOL Annex VI apply.

2.2 "Ship fuel oil consumption data" means the data required to be collected on an annual basis and reported as specified in appendix IX to MARPOL Annex VI.

2.3 "Safety management system" means a structured and documented system enabling company personnel to implement effectively the company safety and environmental protection policy, as defined in paragraph 1.1 of International Safety Management Code.

PART I OF THE SEEMP: SHIP MANAGEMENT PLAN TO IMPROVE ENERGY EFFICIENCY

3 GENERAL

3.1 In global terms it should be recognized that operational efficiencies delivered by a large number of ship operators will make an invaluable contribution to reducing global carbon emissions.

3.2 The purpose of part I of the SEEMP is to establish a mechanism for a company and/or a ship to improve the energy efficiency of a ship's operation. Preferably, this aspect of the ship-specific SEEMP is linked to a broader corporate energy management policy for the company that owns, operates or controls the ship, recognizing that no two shipping companies are the same, and that ships operate under a wide range of different conditions.

3.3 Many companies will already have an environmental management system (EMS) in place under ISO 14001 which contains procedures for selecting the best measures for particular vessels and then setting objectives for the measurement of relevant parameters, along with relevant control and feedback features. Monitoring of operational environmental efficiency should therefore be treated as an integral element of broader company management systems.

3.4 In addition, many companies already develop, implement and maintain a Safety Management System. In such case, part I of the SEEMP may form part of the ship's Safety Management System.

3.5 This section provides guidance for the development of part I of the SEEMP that should be adjusted to the characteristics and needs of individual companies and ships. Part I is intended to be a management tool to assist a company in managing the ongoing environmental performance of its vessels and as such, it is recommended that a company develops procedures for implementing the plan in a manner which limits any on-board administrative burden to the minimum necessary.

3.6 Part I of the SEEMP should be developed as a ship-specific plan by the company, and should reflect efforts to improve a ship's energy efficiency through four steps: planning, implementation, monitoring, and self-evaluation and improvement. These components play a critical role in the continuous cycle to improve ship energy efficiency management. With each iteration of the cycle, some elements of part I will necessarily change while others may remain as before.

3.7 At all times safety considerations should be paramount. The trade a ship is engaged in may determine the feasibility of the efficiency measures under consideration. For example, ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers, etc.) may choose different methods of improving energy efficiency when compared to conventional cargo carriers. The nature of operations and influence of prevailing weather conditions, tides and currents combined with the necessity of maintaining safe operations may require adjustment of general procedures to maintain the efficiency of the operation, for example the ships which are dynamically positioned. The length of voyage may also be an important parameter as may trade specific safety considerations.

4 FRAMEWORK AND STRUCTURE OF PART I OF THE SEEMP

4.1 Planning

4.1.1 Planning is the most crucial stage of part I of the SEEMP, in that it primarily determines both the current status of ship energy usage and the expected improvement of ship energy efficiency. Therefore, it is encouraged to devote sufficient time to planning so that the most appropriate, effective and implementable plan can be developed.

Ship-specific measures

4.1.2 Recognizing that there are a variety of options to improve efficiency – speed optimization, weather routing and hull maintenance, for example – and that the best package of measures for a ship to improve efficiency differs to a great extent depending upon ship type, cargoes, routes and other factors, the specific measures for the ship to improve energy efficiency should be identified in the first place. These measures should be listed as a package of measures to be implemented, thus providing the overview of the actions to be taken for that ship.

4.1.3 During this process, therefore, it is important to determine and understand the ship's current status of energy usage. Part I of the SEEMP should identify energy-saving measures that have been undertaken, and should determine~~s~~ how effective these measures are in terms of improving energy efficiency. Part I also should identify what measures can be adopted to further improve the energy efficiency of the ship. It should be noted, however, that not all measures can be applied to all ships, or even to the same ship under different operating conditions and that some of them are mutually exclusive. Ideally, initial measures could yield energy (and cost) saving results that then can be reinvested into more difficult or expensive efficiency upgrades identified by part I.

4.1.4 Guidance on best practices for fuel-efficient operation of ships, set out in chapter 5, can be used to facilitate this part of the planning phase. Also, in the planning process, particular consideration should be given to minimize any on-board administrative burden.

Company-specific measures

4.1.5 The improvement of energy efficiency of ship operation does not necessarily depend on single ship management only. Rather, it may depend on many stakeholders including ship repair yards, shipowners, operators, charterers, cargo owners, ports and traffic management services. For example, "Just in time" – as explained in paragraph 5.2.4 – requires good early communication among operators, ports and traffic management service. The better coordination among such stakeholders is, the more improvement can be expected. In most cases, such coordination or total management is better made by a company rather than by a ship. In this sense, it is recommended that a company also establish an energy management plan to manage its fleet (should it not have one in place already) and make necessary coordination among stakeholders.

Human resource development

4.1.6 For effective and steady implementation of the adopted measures, raising awareness of and providing necessary training for personnel both on shore and on board are an important element. Such human resource development is encouraged and should be considered as an important component of planning as well as a critical element of implementation.

Goal setting

4.1.7 The last part of planning is goal setting. It should be emphasized that the goal setting is voluntary, that there is no need to announce the goal or the result to the public, and that neither a company nor a ship are subject to external inspection. The purpose of goal setting is to serve as a signal which involved people should be conscious of, to create a good incentive for proper implementation, and then to increase commitment to the improvement of energy efficiency. The goal can take any form, such as the annual fuel consumption or a specific target of Energy Efficiency Operational Indicator (EEOI). Whatever the goal is, the goal should be measurable and easy to understand.

4.2 Implementation

Establishment of implementation system

4.2.1 After a ship and a company identify the measures to be implemented, it is essential to establish a system for implementation of the identified and selected measures by developing the procedures for energy management, by defining tasks and by assigning them to qualified personnel. Thus, part I of the SEEMP should describe how each measure should be implemented and who the responsible person(s) is. The implementation period (start and end dates) of each selected measure should be indicated. The development of such a system can be considered as a part of planning, and therefore may be completed at the planning stage.

Implementation and record-keeping

4.2.2 The planned measures should be carried out in accordance with the predetermined implementation system. Record-keeping for the implementation of each measure is beneficial for self-evaluation at a later stage and should be encouraged. If any identified measure cannot be implemented for any reason(s), the reason(s) should be recorded for internal use.

4.3 Monitoring

Monitoring tools

4.3.1 The energy efficiency of a ship should be monitored quantitatively. This should be done by an established method, preferably by an international standard. The EEOI developed by the Organization is one of the internationally established tools to obtain a quantitative indicator of energy efficiency of a ship and/or fleet in operation, and can be used for this purpose. Therefore, EEOI could be considered as the primary monitoring tool, although other quantitative measures also may be appropriate.

4.3.2 If used, it is recommended that the EEOI is calculated in accordance with the *Guidelines for the development of a Ship Energy Efficiency Management Plan* (MEPC.1/Circ.684) developed by the Organization, adjusted, as necessary, to a specific ship and trade.

4.3.3 In addition to the EEOI, if convenient and/or beneficial for a ship or a company, other measurement tools can be utilized. In the case where other monitoring tools are used, the concept of the tool and the method of monitoring may be determined at the planning stage.

Establishment of monitoring system

4.3.4 It should be noted that whatever measurement tools are used, continuous and consistent data collection is the foundation of monitoring. To allow for meaningful and consistent monitoring, the monitoring system, including the procedures for collecting data and the assignment of responsible personnel, should be developed. The development of such a system can be considered as a part of planning, and therefore should be completed at the planning stage.

4.3.5 It should be noted that, in order to avoid unnecessary administrative burdens on ships' staff, monitoring should be carried out as far as possible by shore staff, utilizing data obtained from existing required records such as the official and engineering log-books and oil record books, etc. Additional data could be obtained as appropriate.

Search and rescue

4.3.6 When a ship diverts from its scheduled passage to engage in search and rescue operations, it is recommended that data obtained during such operations is not used in ship energy efficiency monitoring, and that such data may be recorded separately.

4.4 Self-evaluation and improvement

4.4.1 Self-evaluation and improvement is the final phase of the management cycle. This phase should produce meaningful feedback for the coming first stage, i.e. planning stage of the next improvement cycle.

4.4.2 The purpose of self-evaluation is to evaluate the effectiveness of the planned measures and of their implementation, to deepen the understanding on the overall characteristics of the ship's operation such as what types of measures can/cannot function effectively, and how and/or why, to comprehend the trend of the efficiency improvement of that ship and to develop the improved management plan for the next cycle.

4.4.3 For this process, procedures for self-evaluation of ship energy management should be developed. Furthermore, self-evaluation should be implemented periodically by using data collected through monitoring. In addition, it is recommended to invest time in identifying the cause-and-effect of the performance during the evaluated period for improving the next stage of the management plan.

5 GUIDANCE ON BEST PRACTICES FOR FUEL-EFFICIENT OPERATION OF SHIPS

5.1 The search for efficiency across the entire transport chain takes responsibility beyond what can be delivered by the owner/operator alone. A list of all the possible stakeholders in the efficiency of a single voyage is long; obvious parties are designers, shipyards and engine manufacturers for the characteristics of the ship, and charterers, ports and vessel traffic management services, etc., for the specific voyage. All involved parties should consider the inclusion of efficiency measures in their operations both individually and collectively.

5.2 **Fuel-efficient operations**

Improved voyage planning

5.2.1 The optimum route and improved efficiency can be achieved through the careful planning and execution of voyages. Thorough voyage planning needs time, but a number of different software tools are available for planning purposes.

5.2.2 The *Guidelines for voyage planning,* adopted by resolution A.893(21), provide essential guidance for the ship's crew and voyage planners.

Weather routeing

5.2.3 Weather routeing has a high potential for efficiency savings on specific routes. It is commercially available for all types of ship and for many trade areas. Significant savings can be achieved, but conversely weather routeing may also increase fuel consumption for a given voyage.

Just in time

5.2.4 Good early communication with the next port should be an aim in order to give maximum notice of berth availability and facilitate the use of optimum speed where port operational procedures support this approach.

5.2.5 Optimized port operation could involve a change in procedures involving different handling arrangements in ports. Port authorities should be encouraged to maximize efficiency and minimize delay.

Speed optimization

5. 2.6 Speed optimization can produce significant savings. However, optimum speed means the speed at which the fuel used per tonne mile is at a minimum level for that voyage. It does not mean minimum speed; in fact, sailing at less than optimum speed will consume more fuel

rather than less. Reference should be made to the engine manufacturer's power/consumption curve and the ship's propeller curve. Possible adverse consequences of slow speed operation may include increased vibration and problems with soot deposits in combustion chambers and exhaust systems. These possible consequences should be taken into account.

5. 2.7 As part of the speed optimization process, due account may need to be taken of the need to coordinate arrival times with the availability of loading/discharge berths, etc. The number of ships engaged in a particular trade route may need to be taken into account when considering speed optimization.

5. 2.8 A gradual increase in speed when leaving a port or estuary whilst keeping the engine load within certain limits may help to reduce fuel consumption.

5. 2.9 It is recognized that under many charter parties the speed of the vessel is determined by the charterer and not the operator. Efforts should be made when agreeing charter party terms to encourage the ship to operate at optimum speed in order to maximize energy efficiency.

Optimized shaft power

5. 2.10 Operation at constant shaft RPM can be more efficient than continuously adjusting speed through engine power (see paragraph 5.7). The use of automated engine management systems to control speed rather than relying on human intervention may be beneficial.

5.3 Optimized ship handling

Optimum trim

5.3.1 Most ships are designed to carry a designated amount of cargo at a certain speed for a certain fuel consumption. This implies the specification of set trim conditions. Loaded or unloaded, trim has a significant influence on the resistance of the ship through the water and optimizing trim can deliver significant fuel savings. For any given draft there is a trim condition that gives minimum resistance. In some ships, it is possible to assess optimum trim conditions for fuel efficiency continuously throughout the voyage. Design or safety factors may preclude full use of trim optimization.

Optimum ballast

5.3.2 Ballast should be adjusted taking into consideration the requirements to meet optimum trim and steering conditions and optimum ballast conditions achieved through good cargo planning.

5.3.3 When determining the optimum ballast conditions, the limits, conditions and ballast management arrangements set out in the ship's Ballast Water Management Plan are to be observed for that ship.

5.3.4 Ballast conditions have a significant impact on steering conditions and autopilot settings and it needs to be noted that less ballast water does not necessarily mean the highest efficiency.

Optimum propeller and propeller inflow considerations

5.3.5 Selection of the propeller is normally determined at the design and construction stage of a ship's life but new developments in propeller design have made it possible for retrofitting of later designs to deliver greater fuel economy. Whilst it is certainly for consideration, the propeller is but one part of the propulsion train and a change of propeller in isolation may have no effect on efficiency and may even increase fuel consumption.

5.3.6 Improvements to the water inflow to the propeller using arrangements such as fins and/or nozzles could increase propulsive efficiency power and hence reduce fuel consumption.

Optimum use of rudder and heading control systems (autopilots)

5.3.7 There have been large improvements in automated heading and steering control systems technology. Whilst originally developed to make the bridge team more effective, modern autopilots can achieve much more. An integrated Navigation and Command System can achieve significant fuel savings by simply reducing the distance sailed "off track". The principle is simple; better course control through less frequent and smaller corrections will minimize losses due to rudder resistance. Retrofitting of a more efficient autopilot to existing ships could be considered.

5.3.8 During approaches to ports and pilot stations the autopilot cannot always be used efficiently as the rudder has to respond quickly to given commands. Furthermore at certain stages of the voyage it may have to be deactivated or very carefully adjusted, i.e. heavy weather and approaches to ports.

5.3.9 Consideration may be given to the retrofitting of improved rudder blade design (e.g. "twist-flow" rudder).

Hull maintenance

5.3.10 Docking intervals should be integrated with ship operator's ongoing assessment of ship performance. Hull resistance can be optimized by new technology-coating systems, possibly in combination with cleaning intervals. Regular in-water inspection of the condition of the hull is recommended.

5.3.11 Propeller cleaning and polishing or even appropriate coating may significantly increase fuel efficiency. The need for ships to maintain efficiency through in-water hull cleaning should be recognized and facilitated by port States.

5.3.12 Consideration may be given to the possibility of timely full removal and replacement of underwater paint systems to avoid the increased hull roughness caused by repeated spot blasting and repairs over multiple dockings.

5.3.13 Generally, the smoother the hull, the better the fuel efficiency.

Propulsion system

5.3.14 Marine diesel engines have a very high thermal efficiency (~50%). This excellent performance is only exceeded by fuel cell technology with an average thermal efficiency of 60%. This is due to the systematic minimization of heat and mechanical loss. In particular, the new breed of electronic controlled engines can provide efficiency gains. However, specific training for relevant staff may need to be considered to maximize the benefits.

Propulsion system maintenance

5.3.15 Maintenance in accordance with manufacturers' instructions in the company's planned maintenance schedule will also maintain efficiency. The use of engine condition monitoring can be a useful tool to maintain high efficiency.

5.3.16 Additional means to improve engine efficiency might include use of fuel additives; adjustment of cylinder lubrication oil consumption; valve improvements; torque analysis; and automated engine monitoring systems.

5.4 Waste heat recovery

5.4.1 Waste heat recovery is now a commercially available technology for some ships. Waste heat recovery systems use thermal heat losses from the exhaust gas for either electricity generation or additional propulsion with a shaft motor.

5.4.2 It may not be possible to retrofit such systems into existing ships. However, they may be a beneficial option for new ships. Shipbuilders should be encouraged to incorporate new technology into their designs.

5.5 Improved fleet management

5.5.1 Better utilization of fleet capacity can often be achieved by improvements in fleet planning. For example, it may be possible to avoid or reduce long ballast voyages through improved fleet planning. There is opportunity here for charterers to promote efficiency. This can be closely related to the concept of "just in time" arrivals.

5.5.2 Efficiency, reliability and maintenance-oriented data sharing within a company can be used to promote best practice among ships within a company and should be actively encouraged.

5.6 Improved cargo handling

Cargo handling is in most cases under the control of the port and optimum solutions matched to ship and port requirements should be explored.

5.7 Energy management

5.7.1 A review of electrical services on board can reveal the potential for unexpected efficiency gains. However care should be taken to avoid the creation of new safety hazards when turning off electrical services (e.g. lighting). Thermal insulation is an obvious means of saving energy. Also see comment below on shore power.

5.7.2 Optimization of reefer container stowage locations may be beneficial in reducing the effect of heat transfer from compressor units. This might be combined as appropriate with cargo tank heating, ventilation, etc. The use of water-cooled reefer plant with lower energy consumption might also be considered.

5.8 Fuel type

The use of emerging alternative fuels may be considered as a CO_2 reduction method but availability will often determine the applicability.

5.9 Other measures

5.9.1 Development of computer software for the calculation of fuel consumption, for the establishment of an emissions "footprint," to optimize operations, and the establishment of goals for improvement and tracking of progress may be considered.

5.9.2 Renewable energy sources, such as wind, solar (or photovoltaic) cell technology, have improved enormously in the recent years and should be considered for on-board application.

5.9.3 In some ports shore power may be available for some ships but this is generally aimed at improving air quality in the port area. If the shore-based power source is carbon efficient, there may be a net efficiency benefit. Ships may consider using onshore power if available.

5.9.4 Even wind assisted propulsion may be worthy of consideration.

5.9.5 Efforts could be made to source fuel of improved quality in order to minimize the amount of fuel required to provide a given power output.

5.10 Compatibility of measures

5.10.1 These Guidelines indicate a wide variety of possibilities for energy efficiency improvements for the existing fleet. While there are many options available, they are not necessarily cumulative, are often area and trade dependent and likely to require the agreement and support of a number of different stakeholders if they are to be utilized most effectively.

Age and operational service life of a ship

5.10.2 All measures identified in this document are potentially cost-effective as a result of high oil prices. Measures previously considered unaffordable or commercially unattractive may now be feasible and worthy of fresh consideration. Clearly, this equation is heavily influenced by the remaining service life of a ship and the cost of fuel.

Trade and sailing area

5.10.3 The feasibility of many of the measures described in this guidance will be dependent on the trade and sailing area of the ship. Sometimes ships will change their trade areas as a result of a change in chartering requirements but this cannot be taken as a general assumption. For example, wind-enhanced power sources might not be feasible for short sea shipping as these ships generally sail in areas with high traffic densities or in restricted waterways. Another aspect is that the world's oceans and seas each have characteristic conditions and so ships designed for specific routes and trades may not obtain the same benefit by adopting the same measures or combination of measures as other ships. It is also likely that some measures will have a greater or lesser effect in different sailing areas.

5.10.4 The trade a ship is engaged in may determine the feasibility of the efficiency measures under consideration. For example, ships that perform services at sea (pipe laying, seismic survey, OSVs, dredgers, etc.) may choose different methods of improving energy efficiency when compared to conventional cargo carriers. The length of voyage may also be an important parameter as may trade specific safety considerations. The pathway to the most efficient combination of measures will be unique to each vessel within each shipping company.

PART II OF THE SEEMP: SHIP FUEL OIL CONSUMPTION DATA COLLECTION PLAN

6 GENERAL

6.1 Regulation 22.2 of MARPOL Annex VI specifies that, "On or before 31 December 2018, in the case of a ship of 5,000 gross tonnage and above, the SEEMP shall include a description of the methodology that will be used to collect the data required by regulation 22A.1 of this Annex and the processes that will be used to report the data to the ship's Administration." Part II of the SEEMP, the Ship Fuel Oil Consumption Data Collection Plan (hereinafter referred to as "Data Collection Plan") contains such methodology and processes.

6.2 With respect to part II of the SEEMP, these Guidelines provide guidance for developing a ship-specific method to collect, aggregate, and report ship data with regard to annual fuel oil consumption, distance travelled, hours underway and other data required by regulation 22A of MARPOL Annex VI to be reported to the Administration.

6.3 Pursuant to regulation 5.4.5 of MARPOL Annex VI, the Administration should ensure that each ship's SEEMP complies with regulation 22.2 of MARPOL Annex VI prior to collecting any data.

7 GUIDANCE ON METHODOLOGY FOR COLLECTING DATA ON FUEL OIL CONSUMPTION, DISTANCE TRAVELLED AND HOURS UNDERWAY

Fuel oil[1] consumption

7.1 Fuel oil consumption should include all the fuel oil consumed on board including but not limited to the fuel oil consumed by the main engines, auxiliary engines, gas turbines, boilers and inert gas generator, for each type of fuel oil consumed, regardless of whether a ship is underway or not. Methods for collecting data on annual fuel oil consumption in metric tonnes include (in no particular order):

.1 method using bunker delivery notes (BDNs):

This method determines the annual total amount of fuel oil used based on BDNs, which are required for fuel oil for combustion purposes delivered to and used on board a ship in accordance with regulation 18 of MARPOL Annex VI; BDNs are required to be retained on board for three years after the fuel oil has been delivered. The Data Collection Plan should set out how the ship will operationalize the summation of BDN information and conduct tank readings. The main components of this approach are as follows:

.1 annual fuel oil consumption would be the total mass of fuel oil used on board the vessel as reflected in the BDNs. In this method, the BDN fuel oil quantities would be used to determine the annual total mass of fuel oil consumption, plus the amount of fuel oil left over from the last calendar year period and less the amount of fuel oil carried over to the next calendar year period;

[1] Regulation 2.9 of MARPOL Annex VI defines "fuel oil" as "fuel oil means any fuel delivered to and intended for combustion purposes for propulsion or operation on board a ship, including gas, distillate and residual fuels."

.2 to determine the difference between the amount of remaining tank oil before and after the period, the tank reading should be carried out at the beginning and the end of the period;

.3 in the case of a voyage that extends across the data reporting period, the tank reading should occur by tank monitoring at the ports of departure and arrival of the voyage and by statistical methods such as rolling average using voyage days;

.4 fuel oil tank readings should be carried out by appropriate methods such as automated systems, soundings and dip tapes. The method for tank readings should be specified in the Data Collection Plan;

.5 the amount of any fuel oil offloaded should be subtracted from the fuel oil consumption of that reporting period. This amount should be based on the records of the ship's oil record book; and

.6 any supplemental data used for closing identified difference in bunker quantity should be supported with documentary evidence;

.2 method using flow meters:

This method determines the annual total amount of fuel oil consumption by measuring fuel oil flows on board by using flow meters. In case of the breakdown of flow meters, manual tank readings or other alternative methods will be conducted instead. The Data Collection Plan should set out information about the ship's flow meters and how the data will be collected and summarized, as well as how necessary tank readings should be conducted:

.1 annual fuel oil consumption may be the sum of daily fuel oil consumption data of all relevant fuel oil consuming processes on board measured by flow meters;

.2 the flow meters applied to monitoring should be located so as to measure all fuel oil consumption on board. The flow meters and their link to specific fuel oil consumers should be described in the Data Collection Plan;

.3 note that it should not be necessary to correct this fuel oil measurement method for sludge if the flow meter is installed after the daily tank as sludge will be removed from the fuel oil prior to the daily tank;

.4 the flow meters applied to monitoring fuel oil flow should be identified in the Data Collection Plan. Any consumer not monitored with a flow meter should be clearly identified, and an alternative fuel oil consumption measurement method should be included; and

.5 calibration of the flow meters should be specified. Calibration and maintenance records should be available on board;

.3 method using bunker fuel oil tank monitoring on board:

.1 to determine the annual fuel oil consumption, the amount of daily fuel oil consumption data measured by tank readings which are carried out by appropriate methods such as automated systems, soundings and dip tapes will be aggregated. The tank readings will normally occur daily when the ship is at sea and each time the ship is bunkering or de-bunkering; and

.2 the summary of monitoring data containing records of measured fuel oil consumption should be available on board.

7.2 Any corrections, e.g. density, temperature, if applied, should be documented[2].

Conversion factor C_F

7.3 If fuel oils are used that do not fall into one of the categories as described in the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.245(66)), as amended, and have no C_F-factor assigned (e.g. some "hybrid fuel oils"), the fuel oil supplier should provide a C_F-factor for the respective product supported by documentary evidence.

Distance travelled

7.4 Appendix IX of MARPOL Annex VI specifies that distance travelled should be submitted to the Administration and:

.1 distance travelled over ground in nautical miles should be recorded in the log-book in accordance with SOLAS regulation V/28.1[3];

.2 the distance travelled while the ship is underway under its own propulsion should be included into the aggregated data of distance travelled for the calendar year; and

.3 other methods to measure distance travelled accepted by the Administration may be applied. In any case, the method applied should be described in detail in the Data Collection Plan.

Hours underway

7.5 Appendix IX of MARPOL Annex VI specifies that hours underway should be submitted to the Administration. Hours underway should be an aggregated duration while the ship is underway under its own propulsion.

Data quality

7.6 The Data Collection Plan should include data quality control measures which should be incorporated into the existing shipboard safety management system. Additional measures to be considered could include:

.1 the procedure for identification of data gaps and correction thereof; and

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[2] For example, ISO 8217 provides a method for liquid fuel.

[3] Distance travelled measured using satellite data is distance travelled over the ground.

.2 the procedure to address data gaps if monitoring data is missing, for example, flow meter malfunctions.

A standardized data reporting format

7.7 Regulation 22A.3 of MARPOL Annex VI states that the data specified in appendix IX of the Annex are to be communicated electronically using a standardized form developed by the Organization. The collected data should be reported to the Administration in the standardized format shown in appendix 3.

8 DIRECT CO_2 EMISSIONS MEASUREMENT

8.1 Direct CO_2 emission measurement is not required by regulation 22A of MARPOL Annex VI.

8.2 Direct CO_2 emissions measurement, if used, should be carried out as follows:

.1 this method is based on the determination of CO_2 emission flows in exhaust gas stacks by multiplying the CO_2 concentration of the exhaust gas with the exhaust gas flow. In case of the absence or/and breakdown of direct CO_2 emissions measurement equipment, manual tank readings will be conducted instead;

.2 the direct CO_2 emissions measurement equipment applied to monitoring is located exhaustively so as to measure all CO_2 emissions in the ship. The locations of all equipment applied are described in this monitoring plan; and

.3 calibration of the CO_2 emissions measurement equipment should be specified. Calibration and maintenance records should be available on board.

APPENDIX 1

SAMPLE FORM OF SHIP MANAGEMENT PLAN TO IMPROVE ENERGY EFFICIENCY (PART I OF THE SEEMP)

Name of ship:		Gross tonnage:	
Ship type:		Capacity:	

Date of development:		Developed by:	
Implementation period:	From: Until:	Implemented by:	
Planned date of next evaluation:			

1 MEASURES

Energy efficiency measures	**Implementation** (including the starting date)	**Responsible personnel**
Weather routing	<Example> Contracted with (Service providers) to use their weather routing system and start using on trial basis as of 1 July 2012.	<Example> The master is responsible for selecting the optimum route based on the information provided by (Service providers).
Speed optimization	While the design speed (85% MCR) is 19.0 kt, the maximum speed is set at 17.0 kt as of 1 July 2012.	The master is responsible for keeping the ship's speed. The log-book entry should be checked every day.

2 MONITORING

Description of monitoring tools

3 GOAL

Measurable goals

4 EVALUATION

Procedures of evaluation

APPENDIX 2

SAMPLE FORM OF SHIP FUEL OIL CONSUMPTION DATA COLLECTION PLAN (PART II OF THE SEEMP)

1 Ship particulars

Name of ship	
IMO number	
Company	
Flag	
Ship type	
Gross tonnage	
NT	
DWT	
EEDI (if applicable)	
Ice class	

2 Record of revision of Fuel Oil Consumption Data Collection Plan

Date of revision	Revised provision

3 Ship engines and other fuel oil consumers and fuel oil types used

	Engines or other fuel oil consumers	Power	Fuel oil types
1	Type/model of main engine	(kW)	
2	Type/model of auxiliary engine	(kW)	
3	Boiler	(…)	
4	Inert gas generator	(…)	

4 Emission factor

C_F is a non-dimensional conversion factor between fuel oil consumption and CO_2 emission in the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.245(66)), as amended. The annual total amount of CO_2 is calculated by multiplying annual fuel oil consumption and C_F for the type of fuel.

Fuel oil Type	C_F (t-CO_2 / t-Fuel)
Diesel/Gas oil (e.g. ISO 8217 grades DMX through DMB)	3.206
Light fuel oil (LFO) (e.g. ISO 8217 grades RMA through RMD)	3.151
Heavy fuel oil (HFO) (e.g. ISO 8217 grades RME through RMK)	3.114
Liquefied petroleum gas (LPG) (Propane)	3.000
Liquefied petroleum gas (LPG) (Butane)	3.030
Liquefied natural gas (LNG)	2.750

Fuel oil Type	C_F (t-CO_2 / t-Fuel)
Methanol	1.375
Ethanol	1.913
Other (………)	

5 Method to measure fuel oil consumption

The applied method for measurement for this ship is given below. The description explains the procedure for measuring data and calculating annual values, measurement equipment involved, etc.

Method	Description

6 Method to measure distance travelled

Description

7 Method to measure hours underway

Description

8 Processes that will be used to report the data to the Administration

Description

9 Data quality

Description

APPENDIX 3

STANDARDIZED DATA REPORTING FORMAT FOR THE DATA COLLECTION SYSTEM

Start date (dd/mm/yyyy)		
End date (dd/mm/yyyy)		
IMO number[1]		
Ship type[2]		
Gross tonnage[3]		
NT[4]		
DWT[5]		
EEDI (if applicable)[6] (gCO_2/t.nm)		
Ice class[7] (if applicable)		
Power output (rated power) (kW)[8]	Main Propulsion Power	
	Auxiliary Engine(s)	
Distance Travelled (nm)		
Hours underway (h)		
Fuel oil consumption (t)	Diesel/Gas Oil (C_f: 3.206)	
	LFO (C_f: 3.151)	
	HFO (C_f: 3.114)	
	LPG (Propane)	
	LPG (Butane) (C_f: 3.030)	
	LNG (C_f: 2.750)	
	Methanol (C_f: 1.375)	
	Ethanol (C_f: 1.913)	
	(C_f ;.....)	
	Other(.........)	
Method used to measure fuel oil consumption[9]		

1 In accordance with the *IMO Ship Identification Number Scheme*, adopted by the Organization by resolution A.1078(28).
2 As defined in regulation 2 of MARPOL Annex VI or other (to be stated).
3 Gross tonnage should be calculated in accordance with the International Convention on Tonnage Measurement of Ships, 1969.
4 NT should be calculated in accordance with the International Convention on Tonnage Measurement of Ships, 1969. If not applicable, note "N/A".
5 DWT means the difference in tonnes between the displacement of a ship in water of relative density of 1025 kg/m^3 at the summer load draught and the lightweight of the ship. The summer load draught should be taken as the maximum summer draught as certified in the stability booklet approved by the Administration or an organization recognized by it.
6 EEDI should be calculated in accordance with the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships*, as amended, adopted by resolution MEPC 245(66). If not applicable, note "N/A".
7 Ice class should be consistent with the definition set out in the *International Code for ships operating in polar waters (Polar Code)*, adopted by resolutions MEPC.264(68) and MSC.385(94)). If not applicable, note "N/A".
8 Power output (rated power) of main and auxiliary reciprocating internal combustion engines over 130 kW (to be stated in kW). Rated power means the maximum continuous rated power as specified on the nameplate of the engine.
9 Method used to measure fuel oil consumption: 1: method using BDNs, 2: method using flow meters, 3: method using bunker fuel oil tank monitoring

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MEPC.1/Circ.864
9 December 2016

GUIDELINES FOR ONBOARD SAMPLING FOR THE VERIFICATION OF THE SULPHUR CONTENT OF THE FUEL OIL USED ON BOARD SHIPS

1 The Marine Environment Protection Committee, at its seventieth session (24 to 28 October 2016), recognizing the need to establish an agreed method for sampling to enable effective control and enforcement of liquid fuel oil being used on board ships under the provisions of MARPOL Annex VI, approved the *Guidelines for on-board sampling for the verification of the sulphur content of the fuel oil used on board ships*, as set out in the annex.

2 Member Governments are invited to bring the annexed Guidelines to the attention of Administrations, industry, relevant shipping organizations, shipping companies and other stakeholders concerned.

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ANNEX

GUIDELINES FOR ONBOARD SAMPLING FOR THE VERIFICATION OF THE SULPHUR CONTENT OF THE FUEL OIL USED ON BOARD SHIPS

1 Preface

The objective of these Guidelines is to establish an agreed method for sampling to enable effective control and enforcement of liquid fuel oil being used on board ships under the provisions of MARPOL Annex VI.

2 Sampling location

2.1 The on-board representative sample or samples should be obtained from a designated sampling point or points as agreed by the Administration taking into account the criteria given in paragraphs 2.2.1 to 2.2.5 of these Guidelines.

2.2 In the absence of the sampling point or points referred to in paragraph 2.1, the fuel sampling point to be used should fulfil all of the following conditions:

.1 be easily and safely accessible;

.2 take into account different fuel oil grades being used for the fuel oil combustion machinery item;

.3 be downstream of the in-use fuel oil service tank;

.4 be as close to the fuel oil combustion machinery as safely feasible taking into account the type of fuel oil, flow-rate, temperature, and pressure behind the selected sampling point;

.5 the sampling point should be located in a position shielded from any heated surface or electrical equipment and the shielding device or construction should be sturdy enough to endure leaks, splashes or spray under design pressure of the fuel oil supply line so as to preclude impingement of fuel oil onto such surface or equipment;

.6 be proposed by the ship's representative and accepted by the inspector; and

.7 the sampling arrangement should be provided with suitable drainage to the drain tank or other safe location.

2.3 Fuel oil samples may be taken at more than one location in the fuel oil service system to determine whether there is a possible fuel cross-contamination in the absence of fully segregated fuel service systems, or in case of multiple service tank arrangements.

3 Sample handling

The fuel oil sample should be taken when a steady flow is established in the fuel oil circulating system. The sampling connection* should be thoroughly flushed through with the fuel oil in use prior to drawing the sample. The sample or samples should be collected in a sampling container or containers and should be representative of the fuel oil being used. The sample bottles should be sealed by the inspector with a unique means of identification installed in the presence of the ship's representative. The ship should be given the option of retaining a sample. The label should include the following information:

.1 sampling point location where the sample was drawn;

.2 date and port of sampling;

.3 name and IMO number of the ship;

.4 details of seal identification; and

.5 signatures and names of the inspector and the ship's representative.

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* The sampling connection is the valve and associated pipework designated for sample collection which is connected to the fuel oil service system.

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MEPC.1/Circ.865
5 December 2016

UNIFIED INTERPRETATIONS OF THE NO_X TECHNICAL CODE 2008 RELATED TO THE APPROVAL OF SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEMS

1 The Marine Environment Protection Committee, at its seventieth session (24 to 28 October 2016), approved unified interpretations to the NO_X Technical Code 2008 related to the approval of Selective Catalytic Reduction (SCR) systems, prepared by the Sub-Committee on Pollution Prevention and Response, at its third session, as set out in the annex.

2 Member Governments are invited to use the annexed unified interpretations as guidance when applying relevant provisions of the NO_X Technical Code 2008 and to bring them to the attention of all parties concerned.

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ANNEX

UNIFIED INTERPRETATIONS OF THE NO_X TECHNICAL CODE 2008 RELATED TO THE APPROVAL OF SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEMS

Chapter 4 – Approval for serially manufactured engines: engine family and engine group concept

1 Paragraph 4.4.6.1 of the NO_X Technical Code reads as follows:

"4.4.6.1 The engine group may be defined by basic characteristics and specifications in addition to the parameters defined in 4.3.8 for an engine family."

Interpretation:

Paragraph 4.4.6.1 cross references paragraph 4.3.8 which provides guidance for selection of an engine family. For engines fitted with an SCR system to reduce NO_X emissions, it is recognized that some of the parameters provided may not be common to all engines within a group, in particular paragraphs 4.3.8.2.3 and 4.3.8.2.4 state that:

".3 individual cylinder displacement:

- to be within a total spread of 15%

.4 number of cylinders and cylinder configuration:

- applicable in certain cases only, e.g. in combination with exhaust gas cleaning devices"

For engines fitted with an SCR system to reduce NO_X emissions, the number and arrangement of cylinders may not be common to all members of the engine group. These parameters may be replaced with new parameters derived from the SCR chamber and catalyst blocks, such as the SCR space velocity (SV), catalyst block geometry and catalyst material.

2 Paragraph 4.4.6.2 of the NO_X Technical Code reads as follows:

"4.4.6.2 The following parameters and specifications shall be common to engines within an engine group:

.1 bore and stroke dimensions;

.2 method and design features of pressure charging and exhaust gas system:
- constant pressure;
- pulsating system;

.3 method of charge air cooling system:
- with/without charge air cooler;

.4 design features of the combustion chamber that affect NO_X emission;

.5 design features of the fuel injection system, plunger and injection cam that may profile basic characteristics that affect NO_X emission; and

.6 rated power at rated speed. The permitted ranges of engine power (kW/cylinder) and/or rated speed are to be declared by the manufacturer and approved by the Administration."

Interpretation:

For engines fitted with an SCR system to reduce NO_X emissions it is recognized that some of the parameters provided may not be common to all engines within a group and that new parameters derived from the SCR chamber and catalyst blocks may be used instead, such as the SCR space velocity (SV), catalyst block geometry and catalyst material.

Whilst the provisions of paragraph 4.4.6.2.1 should remain common to all engines within the group, the remaining parameters listed in paragraph 4.4.6.2 may be replaced by alternative SCR parameters, provided that the applicant is able to demonstrate that these alternative parameters are suitable for defining the engine group.

The applicant remains responsible for selecting the parent engine and demonstrating the basis of this selection to the satisfaction of the Administration.

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MEPC.1/Circ.866
30 January 2017

2014 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX (EEDI) FOR NEW SHIPS, AS AMENDED (RESOLUTION MEPC.245(66), AS AMENDED BY RESOLUTIONS MEPC.263(68) AND MEPC.281(70))

1 The Marine Environment Protection Committee, at its seventieth session (24 to 28 October 2016), adopted resolution MEPC.281(70) on *Amendments to the 2014 Guidelines on the method of calculation of the attained EEDI for new ships* (resolution MEPC.245(66), as amended by resolution MEPC.263(68)) (MEPC 70/18, paragraph 5.69).

2 A consolidated text of the Guidelines, as requested by the Committee (MEPC 70/18, paragraph 5.69), is set out in the annex.

3 Member Governments are invited to bring the annexed *2014 Guidelines on the method of calculation of the attained EEDI for new ships*, as amended by resolutions MEPC.263(68) and MEPC.281(70), to the attention of Administrations, industry, relevant shipping organizations, shipping companies and other stakeholders concerned.

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ANNEX

2014 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX (EEDI) FOR NEW SHIPS, AS AMENDED

CONTENTS

2.11.3 f_i ; Bulk carriers and oil tankers under Common Structural Rules (CSR)

2.11.4 f_i ; Other ship types

2.12 f_c ; Cubic capacity correction factor

2.12.1 f_c ; Chemical tankers

2.12.2 f_c ; Gas carriers

2.12.3 f_{cRoPax}; Ro-ro passenger ships

2.12.4 $f_{c\ bulk\ carriers\ designed\ to\ carry\ light\ cargoes}$; Wood chip carriers

2.13 Lpp ; Length between perpendiculars

2.14 f_l ; Factor for general cargo ships equipped with cranes and other cargo-related gear

2.15 d_s ; Summer load line draught

2.16 B_s ; Breadth

2.17 ∇ ; Volumetric displacement

2.18 g ; Gravitational acceleration

APPENDIX 1 A generic and simplified power plant

APPENDIX 2 Guidelines for the development of electric power tables for EEDI (EPT-EEDI)

APPENDIX 3 A generic and simplified marine power plant for a cruise passenger ship having non-conventional propulsion

APPENDIX 4 EEDI calculation examples for use of dual fuel engines

1 Definitions

1.1 MARPOL means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997relating thereto, as amended.

1.2 For the purpose of these Guidelines, the definitions in chapter 4 of MARPOL Annex VI, as amended, apply.

2 Energy Efficiency Design Index (EEDI)

The attained new ship Energy Efficiency Design Index (EEDI) is a measure of ships' energy efficiency (g/t · nm) and calculated by the following formula:

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE} *\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME} **\right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref}}$$

* If part of the Normal Maximum Sea Load is provided by shaft generators, SFC_{ME} and C_{FME} may – for that part of the power – be used instead of SFC_{AE} and C_{FAE}

** In case of $P_{PTI(i)} > 0$, the average weighted value of ($SFC_{ME} \cdot C_{FME}$) and ($SFC_{AE} \cdot C_{FAE}$) to be used for calculation of P_{eff}

Note: This formula may not be applicable to a ship having diesel-electric propulsion, turbine propulsion or hybrid propulsion system, except for cruise passenger ships and LNG carriers.

Where:

.1 C_F is a non-dimensional conversion factor between fuel consumption measured in g and CO_2 emission also measured in g based on carbon content. The subscripts $_{ME(i)}$ and $_{AE(i)}$ refer to the main and auxiliary engine(s) respectively. C_F corresponds to the fuel used when determining SFC listed in the applicable test report included in a Technical File as defined in paragraph 1.3.15 of the NO_X Technical Code ("test report included in a NO_X technical file" hereafter). The value of C_F is as follows:

Type of fuel	Reference	Lower calorific value (kJ/kg)	Carbon content	C_F (t-CO_2/t-Fuel)
1 Diesel/Gas Oil	ISO 8217 Grades DMX through DMB	42,700	0.8744	3.206
2 Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	41,200	0.8594	3.151
3 Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	40,200	0.8493	3.114
4 Liquefied Petroleum Gas (LPG)	Propane	46,300	0.8182	3.000
	Butane	45,700	0.8264	3.030
5 Liquefied Natural Gas (LNG)		48,000	0.7500	2.750
6 Methanol		19,900	0.3750	1.375
7 Ethanol		26,800	0.5217	1.913

In case of a ship equipped with a dual-fuel main or auxiliary engine, the C_F-factor for gas fuel and the C_F-factor for fuel oil should apply and be multiplied with the specific fuel oil consumption of each fuel at the relevant EEDI load point. Meanwhile, gas fuel should be identified whether it is regarded as the "primary fuel" in accordance with the formula below:

$$f_{DFgas} = \frac{\sum_{i=1}^{ntotal} P_{total(i)}}{\sum_{i=1}^{ngasfuel} P_{gasfuel(i)}} \times \frac{V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}{\left(\sum_{i=1}^{nLiquid} V_{liquid(i)} \times \rho_{liquid(i)} \times LCV_{liquid(i)} \times K_{liquid(i)}\right) + V_{gas} \times \rho_{gas} \times LCV_{gas} \times K_{gas}}$$

$f_{DFliquid} = 1 - f_{DFgas}$

where,

f_{DFgas} is the fuel availability ratio of gas fuel corrected for the power ratio of gas engines to total engines, f_{DFgas} should not be greater than 1;

V_{gas} is the total net gas fuel capacity on board in m^3. If other arrangements, like exchangeable (specialized) LNG tank-containers and/or arrangements allowing frequent gas refuelling are used, the capacity of the whole LNG fuelling system should be used for V_{gas}. The boil-off rate (BOR) of gas cargo tanks can be calculated and included to V_{gas} if it is connected to the fuel gas supply system (FGSS);

V_{liquid} is the total net liquid fuel capacity on board in m^3 of liquid fuel tanks permanently connected to the ship's fuel system. If one fuel tank is disconnected by permanent sealing valves, V_{liquid} of the fuel tank can be ignored;

ρ_{gas} is the density of gas fuel in kg/m^3;

ρ_{liquid} is the density of each liquid fuel in kg/m^3;

LCV_{gas} is the low calorific value of gas fuel in kJ/kg;

LCV_{liquid} is the low calorific value of liquid fuel in kJ/kg;

K_{gas} is the filling rate for gas fuel tanks;

K_{liquid} is the filling rate for liquid fuel tanks;

P_{total} *is* the total installed engine power, P_{ME} *and* P_{AE} in kW;

$P_{gasfuel}$ *is* the dual fuel engine installed power, P_{ME} *and* P_{AE} in kW;

.1 If the total gas fuel capacity is at least 50% of the fuel capacity dedicated to the dual fuel engines , namely $f_{DFgas} \geq 0.5$, then gas fuel is regarded as the "Primary fuel," and $f_{DFgas} = 1$ and $f_{DFliquid} = 0$ for each dual fuel engine.

.2 If $f_{DFgas} < 0.5$, gas fuel is not regarded as the "primary fuel." The C_F and *SFC* in the EEDI calculation for each dual fuel engine (both main and auxiliary engines) should be calculated as the weighted average of C_F and *SFC* for liquid and gas mode, according to f_{DFgas}

and $f_{DFliquid}$, such as the original item of $P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}$ in the EEDI calculation is to be replaced by the formula below.

$$P_{ME(i)} \cdot (f_{DFgas(i)} \cdot (C_{FME\ pilot\ fuel(i)} \cdot SFC_{ME\ pilot\ fuel(i)} + C_{FME\ gas(i)} \cdot SFC_{ME\ gas(i)}) + f_{DFliquid(i)} \cdot C_{FME\ liquid(i)} \cdot SFC_{ME\ liquid(i)})$$

.2 V_{ref} is the ship speed, measured in nautical miles per hour (knot), on deep water in the condition corresponding to the *capacity* as defined in paragraphs 2.3.1 and 2.3.3 (in case of passenger ships and cruise passenger ships, this condition should be summer load draught as provided in paragraph 2.4) at the shaft power of the engine(s) as defined in paragraph 2.5 and assuming the weather is calm with no wind and no waves.

.3 *Capacity* is defined as follows:

.1 For bulk carriers, tankers, gas carriers, LNG carriers, ro-ro cargo ships (vehicle carriers), ro-ro cargo ships, ro-ro passenger ships, general cargo ships, refrigerated cargo carrier and combination carriers, deadweight should be used as *capacity*.

.2 For passenger ships and cruise passenger ships, gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, annex I, regulation 3, should be used as *capacity*.

.3 For containerships, 70% of the deadweight (DWT) should be used as *capacity*. EEDI values for containerships are calculated as follows:

.1 attained EEDI is calculated in accordance with the EEDI formula using 70% deadweight for *capacity*.

.2 estimated index value in the Guidelines for calculation of the reference line is calculated using 70% deadweight as:

$$Estimated\ \ Index\,Value = 3.1144 \cdot \frac{190 \cdot \sum_{i=1}^{NME} P_{MEi} + 215 \cdot P_{AE}}{70\%\mathrm{DWT} \cdot V_{ref}}$$

.3 parameters a and c for containerships in table 2 of regulation 21 of MARPOL Annex VI are determined by plotting the estimated index value against 100% deadweight i.e. a = 174.22 and c=0.201 were determined.

.4 required EEDI for a new containership is calculated using 100% deadweight as:

Required EEDI = (1-X/100) · a · 100% deadweight $^{-c}$

Where X is the reduction factor (in percentage) in accordance with table 1 in regulation 21 of MARPOL Annex VI relating to the applicable phase and size of new containership.

.4 *Deadweight* means the difference in tonnes between the displacement of a ship in water of relative density of 1,025 kg/m^3 at the summer load draught and the lightweight of the ship. The summer load draught should be taken as the maximum summer draught as certified in the stability booklet approved by the Administration or an organization recognized by it.

.5 P is the power of the main and auxiliary engines, measured in kW. The subscripts $_{ME(i)}$ and $_{AE(i)}$ refer to the main and auxiliary engine(s), respectively. The summation on i is for all engines with the number of engines ($_{nME}$) (see diagram in appendix 1).

.1 $P_{ME(i)}$ is 75% of the rated installed power (MCR[1]) for each main engine (i).

For LNG carriers having diesel electric propulsion system, $P_{ME(i)}$ should be calculated by the following formula:

$$P_{ME(i)} = 0.83 \times \frac{MPP_{Motor(i)}}{\eta_{(i)}}$$

Where:

$MPP_{Motor(i)}$ is the rated output of motor specified in the certified document.

$\eta_{(i)}$ is to be taken as the product of electrical efficiency of generator, transformer, converter, and motor, taking into consideration the weighted average as necessary.

The electrical efficiency, $\eta_{(i)}$, should be taken as 91.3% for the purpose of calculating attained EEDI. Alternatively, if the value more than 91.3% is to be applied, the $\eta_{(i)}$ should be obtained by measurement and verified by method approved by the verifier.

For LNG carriers having steam turbine propulsion systems, $P_{ME(i)}$ is 83% of the rated installed power ($MCR_{SteamTurbine}$) for each steam turbine$_{(i)}$.

The influence of additional shaft power take off or shaft power take in is defined in the following paragraphs.

.2 **Shaft generator**

In case where shaft generator(s) are installed, $P_{PTO(i)}$ is 75% of the rated electrical output power of each shaft generator. In case that shaft generator(s) are installed to steam turbine, $P_{PTO(i)}$ is 83% of the rated electrical output power and the factor of 0.75 should be replaced to 0.83.

For calculation of the effect of shaft generators two options are available:

[1] The value of MCR specified on the EIAPP certificate should be used for calculation. If the main engines are not required to have an EIAPP certificate, the MCR on the nameplate should be used.

Option 1:

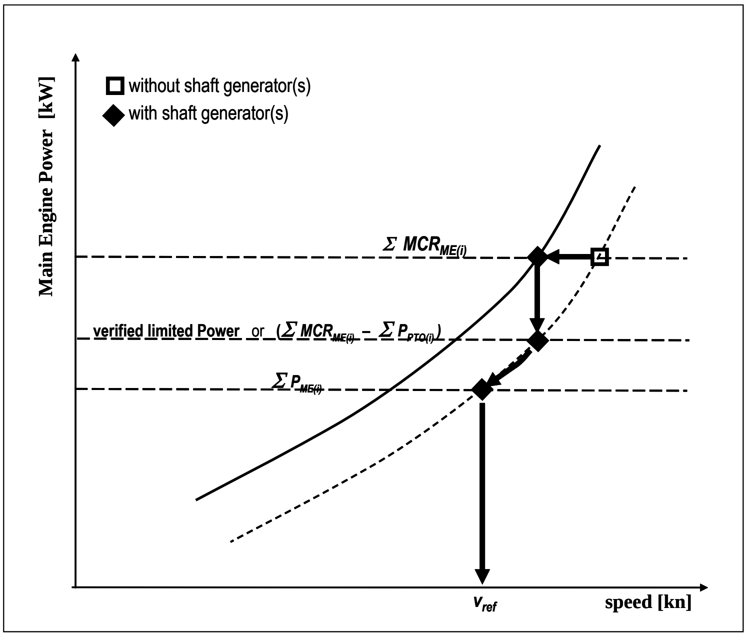
.1 The maximum allowable deduction for the calculation of $\Sigma P_{ME(i)}$ is to be no more than P_{AE} as defined in paragraph 2.5.6. For this case, $\Sigma P_{ME(i)}$ is calculated as:

$$\sum_{i=1}^{nME} P_{ME(i)} = 0.75 \times \left(\sum MCR_{ME(i)} - \sum P_{PTO(i)} \right) \quad \textit{with} \;\; 0.75 \times \sum P_{PTO(i)} \le P_{AE}$$

or

Option 2:

.2 Where an engine is installed with a higher rated power output than that which the propulsion system is limited to by verified technical means, then the value of $\Sigma P_{ME(i)}$ is 75% of that limited power for determining the reference speed, V_{ref} and for EEDI calculation. The following figure gives guidance for determination of $\Sigma P_{ME(i)}$:



.3 **Shaft motor**

In case where shaft motor(s) are installed, $P_{PTI(i)}$ is 75% of the rated power consumption of each shaft motor divided by the weighted average efficiency of the generator(s), as follows:

$$\sum P_{PTI(i)} = \frac{\sum \left(0.75 \cdot P_{SM,\max(i)} \right)}{\eta_{\overline{Gen}}}$$

Where:

$P_{SM,\max(i)}$ is the rated power consumption of each shaft motor

$\eta_{\overline{Gen}}$ is the weighted average efficiency of the generator(s)

In case that shaft motor(s) are installed to steam turbine, $P_{PTI(i)}$ is 83% of the rated power consumption and the factor of 0.75 should be replaced to 0.83.

The propulsion power at which V_{ref} is measured, is:

$$\sum P_{ME(i)} + \sum P_{PTI(i),Shaft}$$

Where:

$$\sum P_{PTI(i),Shaft} = \sum \left(0.75 \cdot P_{SM,\max(i)} \cdot \eta_{PTI(i)}\right)$$

$\eta_{PTI(i)}$ is the efficiency of each shaft motor installed

Where the total propulsion power as defined above is higher than 75% of the power the propulsion system is limited to by verified technical means, then 75% of the limited power is to be used as the total propulsion power for determining the reference speed, V_{ref} and for EEDI calculation.

In case of combined PTI/PTO, the normal operational mode at sea will determine which of these to be used in the calculation.

Note: The shaft motor's chain efficiency may be taken into consideration to account for the energy losses in the equipment from the switchboard to the shaft motor, if the chain efficiency of the shaft motor is given in a verified document.

.4 $P_{eff(i)}$ is the output of the innovative mechanical energy efficient technology for propulsion at 75% main engine power.

Mechanical recovered waste energy directly coupled to shafts need not be measured, since the effect of the technology is directly reflected in the V_{ref}.

In case of a ship equipped with a number of engines, the C_F and *SFC* should be the power weighted average of all the main engines.

In case of a ship equipped with dual-fuel engine(s), the C_F and *SFC* should be calculated in accordance with paragraphs 2.1 and 2.7.

.5 $P_{AEeff\,(i)}$ is the auxiliary power reduction due to innovative electrical energy efficient technology measured at $P_{ME(i)}$.

.6 P_{AE} is the required auxiliary engine power to supply normal maximum sea load including necessary power for propulsion machinery/systems and accommodation, e.g. main engine pumps, navigational systems and equipment and living on board, but excluding the power not for propulsion machinery/systems, e.g. thrusters, cargo pumps, cargo gear, ballast pumps, maintaining cargo, e.g. reefers and cargo hold fans, in the condition where the ship engaged in voyage at the speed (V_{ref}) under the condition as mentioned in paragraph 2.2.

.1 For ships with a total propulsion power ($\sum MCR_{ME(i)} + \frac{\sum P_{PTI(i)}}{0.75}$) of 10,000 kW or above, P_{AE} is defined as:

$$P_{AE\ (\Sigma MCR_{ME(i)} \geq 10{,}000kW)} = \left(0.025 \times \left(\sum_{i=1}^{nME} MCR_{ME(i)} + \frac{\sum_{i=1}^{nPTI} P_{PTI(i)}}{0.75} \right) \right) + 250$$

.2 For ships with a total propulsion power ($\sum MCR_{ME(i)} + \frac{\sum P_{PTI(i)}}{0.75}$) below 10,000 kW, P_{AE} is defined as:

$$P_{AE\ (\Sigma MCR_{ME(i)} < 10{,}000kW)} = \left(0.05 \times \left(\sum_{i=1}^{nME} MCR_{ME(i)} + \frac{\sum_{i=1}^{nPTI} P_{PTI(i)}}{0.75} \right) \right)$$

.3 For LNG carriers with a reliquiefaction system or compressor(s), designed to be used in normal operation and essential to maintain the LNG cargo tank pressure below the maximum allowable relief valve setting of a cargo tank in normal operation, the following terms should be added to above P_{AE} formula in accordance with 1, 2 or 3 as below:

.1 For ships having re-liquefaction system:

$$+ CargoTankCapacity_{LNG} \times BOR \times COP_{reliquefy} \times R_{reliquefy}$$

Where:

CargoTankCapacity$_{LNG}$ is the LNG Cargo Tank Capacity in m^3.

BOR is the design rate of boil-off gas of entire ship per day, which is specified in the specification of the building contract.

$COP_{reliquefy}$ is the coefficient of design power performance for reliquefying boil-off gas per unit volume, as follows:

$$COP_{reliquefy} = \frac{425\,(kg/m^3) \times 511\,(kJ/kg)}{24\,(h) \times 3600\,(\sec) \times COP_{cooling}}$$

$COP_{cooling}$ is the coefficient of design performance of reliquefaction and 0.166 should be used. Another value calculated by the manufacturer and verified by the Administration or an organization recognized by the Administration may be used.

$R_{reliquefy}$ is the ratio of boil-off gas (BOG) to be re-liquefied to entire BOG, calculated as follows.

$$R_{reliquefy} = \frac{BOG_{reliquefy}}{BOG_{total}}$$

.2 For LNG carriers with direct diesel driven propulsion system or diesel electric propulsion system, having compressor(s) which are used for supplying high-pressured gas derived from boil-off gas to the installed engines (typically intended for 2-stroke dual fuel engines):

$$+COP_{comp} \times \sum_{i=1}^{nME} SFC_{ME(i),gasmode} \times \frac{P_{ME(i)}}{1000}$$

Where:

COP_{comp} is the design power performance of compressor and 0.33 (kWh/kg) should be used. Another value calculated by the manufacturer and verified by the Administration or an organization recognized by the Administration may be used.

.3 For LNG carriers with direct diesel driven propulsion system or diesel electric propulsion system, having compressor(s) which are used for supplying low-pressured gas derived from boil-off gas to the installed engines (typically intended for 4-stroke dual fuel engines):

$$+0.02 \times \sum_{i=1}^{nME} P_{ME(i)}$$ [2]

For LNG carriers having diesel electric propulsion system, $MPP_{Motor(i)}$ should be used instead $MCR_{ME(i)}$ for P_{AE} calculation.

For LNG carriers having steam turbine propulsion system and of which electric power is primarily supplied by turbine generator closely integrated into the steam and feed water

[2] With regard to the factor of 0.02, it is assumed that the additional energy needed to compress BOG for supplying to a 4-stroke dual fuel engine is approximately equal to 2% of P_{ME}, compared to the energy needed to compress BOG for supplying to a steam turbine.

systems, P_{AE} may be treated as 0(zero) instead of taking into account electric load in calculating $SFC_{SteamTurbine}$.

.4 For ship where the P_{AE} value calculated by paragraphs 2.5.6.1 to 2.5.6.3 is significantly different from the total power used at normal seagoing, e.g. in cases of passenger ships (see NOTE under the formula of EEDI), the P_{AE} value should be estimated by the consumed electric power (excluding propulsion) in conditions when the ship is engaged in a voyage at reference speed (V_{ref}) as given in the electric power table[3], divided by the average efficiency of the generator(s) weighted by power (see appendix 2).

.6 V_{ref}, *Capacity* and *P* should be consistent with each other. As for LNG carries having diesel electric or steam turbine propulsion systems, V_{ref} is the relevant speed at 83% of MPP_{Motor} or $MCR_{SteamTubine}$ respectively.

.7 *SFC* is the certified specific fuel consumption, measured in g/kWh, of the engines or steam turbines.

.1 The subscripts $_{ME(i)}$ and $_{AE(i)}$ refer to the main and auxiliary engine(s), respectively. For engines certified to the E2 or E3 test cycles of the NO_X Technical Code 2008, the engine Specific Fuel Consumption ($SFC_{ME(i)}$) is that recorded in the test report included in a NO_X technical file for the engine(s) at 75% of MCR power of its torque rating. For engines certified to the D2 or C1 test cycles of the NO_X Technical Code 2008, the engine Specific Fuel Consumption ($SFC_{AE(i)}$) is that recorded on the test report included in a NO_X technical file at the engine(s) 50% of MCR power or torque rating. If gas fuel is used as primary fuel in accordance with paragraph 4.2.3 of the *Guidelines on survey and certification of the energy efficiency design index (EEDI)*, *SFC* in gas mode should be used. In case that installed engine(s) have no approved NO_X Technical File tested in gas mode, the *SFC* of gas mode should be submitted by the manufacturer and confirmed by the verifier.

The *SFC* should be corrected to the value corresponding to the ISO standard reference conditions using the standard lower calorific value of the fuel oil (42,700kJ/kg), referring to ISO 15550:2002 and ISO 3046-1:2002.

For ships where the P_{AE} value calculated by paragraphs 2.5.6.1 to 2.5.6.3 is significantly different from the total power used at normal seagoing, e.g. conventional passenger ships, the Specific Fuel Consumption (SFC_{AE}) of the auxiliary generators is that recorded in the test report included in a NO_X technical file for the engine(s) at 75% of MCR power of its torque rating.

[3] The electric power table should be examined and validated by the verifier. Where ambient conditions affect any electrical load in the power table, such as that for heating ventilation and air conditioning systems, the contractual ambient conditions leading to the maximum design electrical load of the installed system for the ship in general should apply.

SFC_{AE} is the power-weighted average among $SFC_{AE(i)}$ of the respective engines *i*.

For those engines which do not have a test report included in a NO_X technical file because its power is below 130 kW, the *SFC* specified by the manufacturer and endorsed by a competent authority should be used.

At the design stage, in case of unavailability of test report in the NO_X file, the *SFC* specified by the manufacturer and endorsed by a competent authority should be used.

For LNG driven engines of which *SFC* is measured in kJ/kWh should be corrected to the *SFC* value of g/kWh using the standard lower calorific value of the LNG (48,000 kJ/kg), referring to the 2006 IPCC Guidelines.

Reference lower calorific values of additional fuels are given in the table in paragraph 2.1 of these Guidelines. The reference lower calorific value corresponding to the conversion factor of the respective fuel should be used for calculation.

.2 The $SFC_{SteamTurbine}$ should be calculated by manufacturer and verified by the Administration or an organization recognized by the Administration as follows:

$$SFC_{SteamTurbine} = \frac{FuelConsumption}{\sum_{i=1}^{nME} P_{ME(i)}}$$

Where:

.1 *Fuel consumption* is fuel consumption of boiler per hour (g/h). For ships of which electric power is primarily supplied by Turbine Generator closely integrated into the steam and feed water systems, not only P_{ME} but also *electric loads* corresponding to paragraph 2.5.6 should be taken into account.

.2 The *SFC* should be corrected to the value of LNG using the standard lower calorific value of the LNG (48,000 kJ/kg) at SNAME Condition (condition standard; air temperature 24°C , inlet temperature of fan 38°C, sea water temperature 24°C).

.3 In this correction, the difference of the boiler efficiency based on lower calorific value between test fuel and LNG should be taken into account.

.8 f_j is a correction factor to account for ship specific design elements:

.1 The power correction factor, f_j, for ice-classed ships should be taken as the greater value of f_{j0} and $f_{j,min}$ as tabulated in table 1 but not greater than $f_{j,max}$ = 1.0.

For further information on approximate correspondence between ice classes, see HELCOM Recommendation 25/7[4].

Table 1: Correction factor for power f_j for ice-classed ships

Ship type	f_{j0}	$f_{j,min}$ depending on the ice class			
		IA Super	IA	IB	IC
Tanker	$\frac{0.308 L_{PP}^{1.920}}{\sum_{i=1}^{nME} P_{ME(i)}}$	$0.15 L_{PP}^{0.30}$	$0.27 L_{PP}^{0.21}$	$0.45 L_{PP}^{0.13}$	$0.70 L_{PP}^{0.06}$
Bulk carrier	$\frac{0.639 L_{PP}^{1.754}}{\sum_{i=1}^{nME} P_{ME(i)}}$	$0.47 L_{PP}^{0.09}$	$0.58 L_{PP}^{0.07}$	$0.73 L_{PP}^{0.04}$	$0.87 L_{PP}^{0.02}$
General cargo ship	$\frac{0.0227 \cdot L_{PP}^{2.483}}{\sum_{i=1}^{nME} P_{ME(i)}}$	$0.31 L_{PP}^{0.16}$	$0.43 L_{PP}^{0.12}$	$0.56 L_{PP}^{0.09}$	$0.67 L_{PP}^{0.07}$
Refrigerated cargo ships	$\frac{0.639 L_{PP}^{1.754}}{\sum_{i=1}^{nME} P_{ME(i)}}$	$0.47 L_{PP}^{0.09}$	$0.58 L_{PP}^{0.07}$	$0.73 L_{PP}^{0.04}$	$0.87 L_{PP}^{0.02}$

.2 The factor f_j, for shuttle tankers with propulsion redundancy should be f_j = 0.77. This correction factors applies to shuttle tankers with propulsion redundancy between 80,000 and 160,000 dwt. Shuttle tankers with propulsion redundancy are tankers used for loading of crude oil from offshore installations equipped with dual-engine and twin-propellers need to meet the requirements for dynamic positioning and redundancy propulsion class notation.

.3 For ro-ro cargo and ro-ro passenger ships f_{jRoRo} is calculated as follows:

$$f_{jRoRo} = \frac{1}{F_{n_L}^{\alpha} \cdot \left(\frac{L_{pp}}{B_s}\right)^{\beta} \cdot \left(\frac{B_s}{d_s}\right)^{\gamma} \cdot \left(\frac{L_{pp}}{\nabla^{1/3}}\right)^{\delta}} \quad ; \quad \text{If } f_{jRoRo} > 1 \text{ then } f_j = 1$$

where the Froude number, F_{n_L}, is defined as:

$$F_{n_L} = \frac{0.5144 \cdot V_{ref}}{\sqrt{L_{pp} \cdot g}}$$

[4] HELCOM Recommendation 25/7 may be found at http://www.helcom.fi.

and the exponents α, β, γ and δ are defined as follows:

Ship type	Exponent:			
	α	β	γ	δ
Ro-ro cargo ship	2.00	0.50	0.75	1.00
Ro-ro passenger ship	2.50	0.75	0.75	1.00

.4 The factor f_j for general cargo ships is calculated as follows:

$$f_j = \frac{0.174}{Fn_\nabla^{\ 2.3} \cdot C_b^{\ 0.3}}$$; If $f_j > 1$ then $f_j = 1$

Where

$$Fn_\nabla = \frac{0.5144 \cdot V_{ref}}{\sqrt{g \cdot \nabla^{\frac{1}{3}}}}$$; If $Fn_\nabla > 0.6$ then $Fn_\nabla = 0.6$

and

$$C_b = \frac{\nabla}{L_{pp} \cdot B_s \cdot d_s}$$

.5 For other ship types, f_j should be taken as 1.0.

.9 f_w is a non-dimensional coefficient indicating the decrease of speed in representative sea conditions of wave height, wave frequency and wind speed (e.g. Beaufort Scale 6), and is determined as follows:

.1 for the attained EEDI calculated under regulations 20 and 21 of MARPOL Annex VI, f_w is 1.00;

.2 when f_w is calculated according to the subparagraph .2.1 or .2.2 below, the value for attained EEDI calculated by the formula in paragraph 2 using the obtained f_w should be referred to as "*attained* $EEDI_{weather}$";

.1 f_w can be determined by conducting the ship specific simulation on its performance at representative sea conditions. The simulation methodology should be based on the Guidelines developed by the Organization[4] and the method and outcome for an individual ship should be verified by the Administration or an organization recognized by the Administration; and

.2 in cases where a simulation is not conducted, f_w should be taken from the "Standard f_w " table/curve. A "Standard f_w " table/curve is provided in the Guidelines[5] for each ship type defined in regulation 2 of MARPOL Annex VI, and expressed as a function of capacity (e.g. deadweight). The "Standard f_w " table/curve is based on data of actual speed reduction of as many existing ships as possible under the representative sea condition.

f_w and *attained* $EEDI_{weather}$, if calculated, with the representative sea conditions under which those values are determined, should be indicated in the EEDI Technical File to distinguish it from the attained EEDI calculated under regulations 20 and 21 of MARPOL Annex VI.

.10 $f_{eff(i)}$ is the availability factor of each innovative energy efficiency technology. $f_{eff(i)}$ for waste energy recovery system should be one (1.0)[6].

.11 f_i is the capacity factor for any technical/regulatory limitation on capacity, and should be assumed to be one (1.0) if no necessity of the factor is granted.

.1 The capacity correction factor, f_i, for ice-classed ships should be taken as the lesser value of f_{i0} and $f_{i,max}$ as tabulated in Table 2, but not less than $f_{i,min}$ = 1.0. For further information on approximate correspondence between ice classes, see HELCOM Recommendation 25/7[7].

Table 2: Capacity correction factor f_i for ice-classed ships

Ship type	f_{i0}	$f_{i,max}$ depending on the ice class			
		IA Super	IA	IB	IC
Tanker	$\frac{0.00138 \cdot L_{PP}^{3.331}}{capacity}$	$2.10L_{PP}^{-0.11}$	$1.71L_{PP}^{-0.08}$	$1.47L_{PP}^{-0.06}$	$1.27L_{PP}^{-0.04}$
Bulk carrier	$\frac{0.00403 \cdot L_{PP}^{3.123}}{capacity}$	$2.10L_{PP}^{-0.11}$	$1.80L_{PP}^{-0.09}$	$1.54L_{PP}^{-0.07}$	$1.31L_{PP}^{-0.05}$
General cargo ship	$\frac{0.0377 \cdot L_{PP}^{2.625}}{capacity}$	$2.18L_{PP}^{-0.11}$	$1.77L_{PP}^{-0.08}$	$1.51L_{PP}^{-0.06}$	$1.28L_{PP}^{-0.04}$
Containership	$\frac{0.1033 \cdot L_{PP}^{2.329}}{capacity}$	$2.10L_{PP}^{-0.11}$	$1.71L_{PP}^{-0.08}$	$1.47L_{PP}^{-0.06}$	$1.27L_{PP}^{-0.04}$
Gas carrier	$\frac{0.0474 \cdot L_{PP}^{2.590}}{capacity}$	1.25	$2.10L_{PP}^{-0.12}$	$1.60L_{PP}^{-0.08}$	$1.25L_{PP}^{-0.04}$

Note: Containership capacity is defined as 70% of the *DWT*.

[5] Refer to *Interim Guidelines for the calculation of the coefficient* f_w *for decrease in ship speed in a representative sea condition for trial use*, approved by the Organization and circulated by MEPC.1/Circ.796.

[6] EEDI calculation should be based on the normal seagoing condition outside Emission Control Area designated under regulation 13.6 of MARPOL ANNEX VI.

[7] HELCOM Recommendation 25/7 may be found at http://www.helcom.fi.

.2 $f_{i\,VSE}$[8] for ship specific voluntary structural enhancement is expressed by the following formula:

$$f_{iVSE} = \frac{DWT_{referencedesign}}{DWT_{enhanceddesign}}$$

where:

$$DWT_{referencedesign} = \Delta_{ship} - lightweight_{referencedesign}$$

$$DWT_{enhanceddesign} = \Delta_{ship} - lightweight_{enhanceddesign}$$

For this calculation the same displacement (Δ) for reference and enhanced design should be taken.

DWT before enhancements ($DWT_{reference\ design}$) is the deadweight prior to application of the structural enhancements. DWT after enhancements ($DWT_{enhanced\ design}$) is the deadweight following the application of voluntary structural enhancement. A change of material (e.g. from aluminum alloy to steel) between reference design and enhanced design should not be allowed for the $f_{i\,VSE}$ calculation. A change in grade of the same material (e.g. in steel type, grades, properties and condition) should also not be allowed.

In each case, two sets of structural plans of the ship should be submitted to the verifier for assessment. One set for the ship without voluntary structural enhancement; the other set for the same ship with voluntary structural enhancement (alternatively, one set of structural plans of the reference design with annotations of voluntary structural enhancement should also be acceptable). Both sets of structural plans should comply with the applicable regulations for the ship type and intended trade.

.3 for bulk carriers and oil tankers, built in accordance with the Common Structural Rules (CSR) of the classification societies and assigned the class notation CSR, the following capacity correction factor f_{iCSR} should apply:

$f_{iCSR} = 1 + (0.08 \cdot LWT_{CSR} / DWT_{CSR})$

Where DWT_{CSR} is the deadweight determined by paragraph 2.4 and LWT_{CSR} is the light weight of the ship.

.4 for other ship types, f_i should be taken as one (1.0).

.12 f_c is the cubic capacity correction factor and should be assumed to be one (1.0) if no necessity of the factor is granted.

.1 for chemical tankers, as defined in regulation 1.16.1 of MARPOL Annex II, the following cubic capacity correction factor f_c should apply:

[8] Structural and/or additional class notations such as, but not limited to, "strengthened for discharge with grabs" and "strengthened bottom for loading/unloading aground", which result in a loss of deadweight of the ship, are also seen as examples of "voluntary structural enhancements".

$f_c = R^{-0.7} - 0.014$, where R is less than 0.98
or
$f_c = 1.000$, where R is 0.98 and above;

where: R is the capacity ratio of the deadweight of the ship (tonnes) as determined by paragraph 2.4 divided by the total cubic capacity of the cargo tanks of the ship (m^3).

.2 for gas carriers having direct diesel driven propulsion system constructed or adapted and used for the carriage in bulk of liquefied natural gas, the following cubic capacity correction factor f_{cLNG} should apply:

$f_{cLNG} = R^{-0.56}$

where: R is the capacity ratio of the deadweight of the ship (tonnes) as determined by paragraph 2.4 divided by the total cubic capacity of the cargo tanks of the ship (m^3).

Note: This factor is applicable to LNG carriers defined as gas carriers in regulation 2.26 of MARPOL Annex VI and should not be applied to LNG carriers defined in regulation 2.38 of MARPOL Annex VI.

.3 For ro-ro passenger ships having a DWT/GT-ratio of less than 0.25, the following cubic capacity correction factor, f_{cRoPax}, should apply:

$$f_{cRoPax} = \left(\frac{(DWT/_{GT})}{0.25}\right)^{-0.8}$$

Where DWT is the Capacity and GT is the gross tonnage in accordance with the International Convention of Tonnage Measurement of Ships 1969, annex I, regulation 3.

.4 For bulk carriers having R of less than 0.55 (e.g. wood chip carriers), the following cubic capacity correction factor, $f_{c\ bulk\ carriers\ designed\ to\ carry\ light\ cargoes}$, should apply:

$f_{c\ bulk\ carriers\ designed\ to\ carry\ light\ cargoes} = R^{-0.15}$

where: R is the capacity ratio of the deadweight of the ship (tonnes) as determined by paragraph 2.4 divided by the total cubic capacity of the cargo holds of the ship (m^3).

.13 *Length between perpendiculars*, L_{pp}, means 96% of the total length on a waterline at 85% of the least moulded depth measured from the top of the keel, or the length from the foreside of the stem to the axis of the rudder stock on that waterline, if that were greater. In ships designed with a rake of keel the waterline on which this length is measured should be parallel to the designed waterline. L_{pp} should be measured in metres.

.14 f_l is the factor for general cargo ships equipped with cranes and other cargo-related gear to compensate in a loss of deadweight of the ship.

$f_l = f_{cranes} \cdot f_{sideloader} \cdot f_{roro}$

f_{cranes}	= 1	If no cranes are present.
$f_{sideloader}$	= 1	If no side loaders are present.
f_{roro}	= 1	If no ro-ro ramp is present.

Definition of f_{cranes}:

$$f_{cranes} = 1 + \frac{\sum_{n=1}^{n} \left(0.0519 \cdot SWL_n \cdot Reach_n + 32.11\right)}{Capacity}$$

where:

SWL	=	Safe Working Load, as specified by crane manufacturer in metric tonnes
Reach	=	Reach at which the Safe Working Load can be applied in metres
N	=	Number of cranes

For other cargo gear such as side loaders and ro-ro ramps, the factor should be defined as follows:

$$f_{sideloader} = \frac{Capacity_{No\ sideloaders}}{Capacity_{sideloaders}}$$

$$f_{RoRo} = \frac{Capacity_{No\ RoRo}}{Capacity_{RoRo}}$$

The weight of the side loaders and ro-ro ramps should be based on a direct calculation, in analogy to the calculations as made for factor f_{ivse}.

.15 Summer load line draught, d_s, is the vertical distance, in metres, from the moulded baseline at mid-length to the waterline corresponding to the summer freeboard draught to be assigned to the ship.

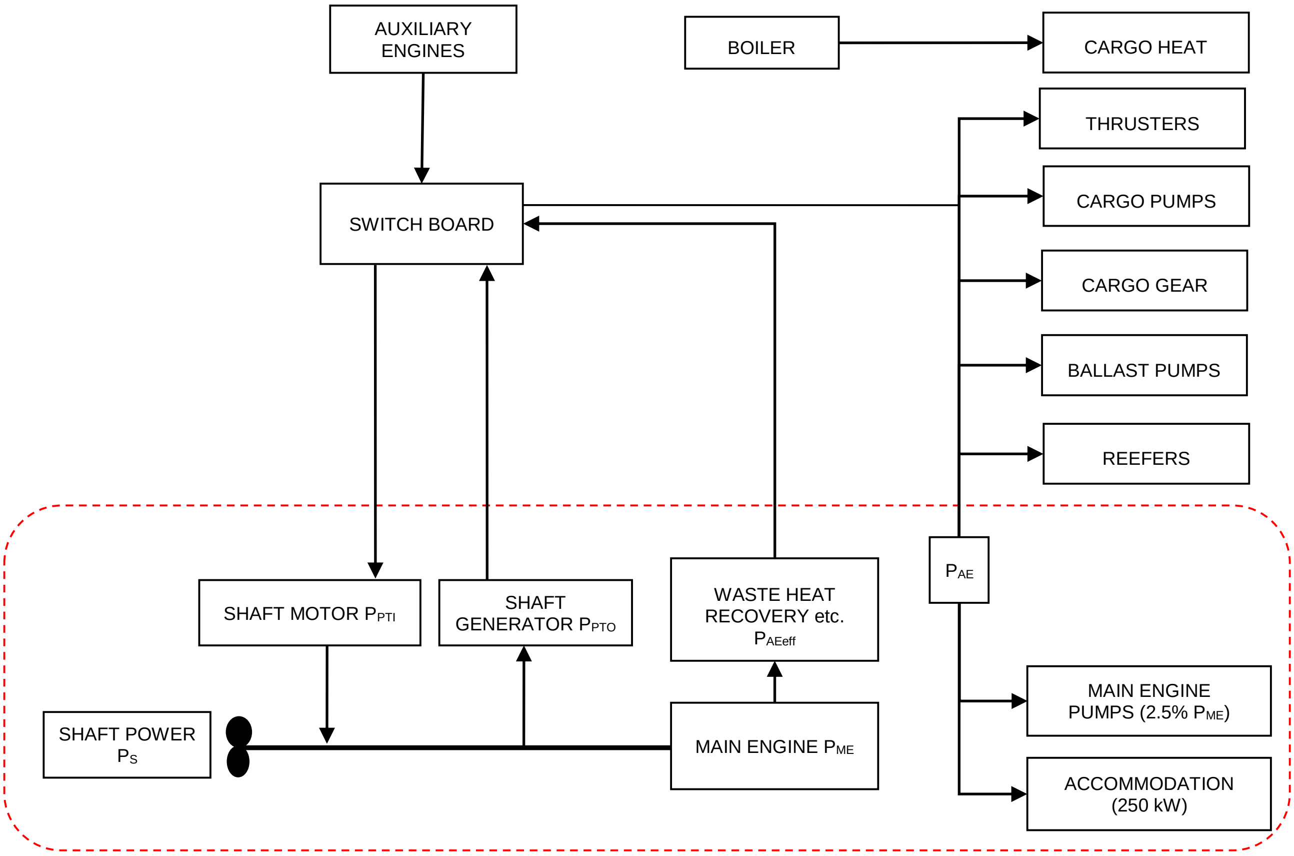
.16 Breadth, B_s, is the greatest moulded breadth of the ship, in metres, at or below the load line draught, d_s.

.17 Volumetric displacement, ∇, in cubic metres (m^3), is the volume of the moulded displacement of the ship, excluding appendages, in a ship with a metal shell, and is the volume of displacement to the outer surface of the hull in a ship with a shell of any other material, both taken at the summer load line draught, d_s, as stated in the approved stability booklet/loading manual.

.18 g is the gravitational acceleration, $9.81 m/s^2$.

APPENDIX 1

A GENERIC AND SIMPLIFIED MARINE POWER PLANT



Note 1: Mechanical recovered waste energy directly coupled to shafts need not be measured, since the effect of the technology is directly reflected in the V_{ref} .

Note 2: In case of combined PTI/PTO, the normal operational mode at sea will determine which of these to be used in the calculation.

APPENDIX 2

GUIDELINES FOR THE DEVELOPMENT OF ELECTRIC POWER TABLES FOR EEDI (EPT-EEDI)

1 Introduction

This appendix contains a guideline for the document "Electric power table for EEDI" which is similar to the actual shipyards' load balance document, utilizing well defined criteria, providing standard format, clear loads definition and grouping, standard load factors, etc. A number of new definitions (in particular the "groups") are introduced, giving an apparent greater complexity to the calculation process. However, this intermediate step to the final calculation of P_{AE} stimulates all the parties to a deep investigation through the global figure of the auxiliary load, allowing comparisons between different ships and technologies and eventually identifying potential efficiencies improvements.

2 Auxiliary load power definition

P_{AE} is to be calculated as indicated in paragraph 2.5.6 of the Guidelines, together with the following additional three conditions:

.1 non-emergency situations (e.g. "no fire", "no flood", "no blackout", "no partial blackout");

.2 evaluation time frame of 24 hours (to account loads with intermittent use); and

.3 ship fully loaded with passengers and/or cargo and crew.

3 Definition of the data to be included in the electric power table for EEDI

The electric power table for EEDI calculation should contain the following data elements, as appropriate:

.1 Load's group;
.2 Load's description;
.3 Load's identification tag;
.4 Load's electric circuit Identification;
.5 Load's mechanical rated power "*Pm*" (*kW*);
.6 Load's electric motor rated output power (*kW*);
.7 Load's electric motor efficiency "*e*" (/);
.8 Load's Rated electric power "*Pr*" (*kW*);
.9 Service factor of load "*kl*" (/);
.10 Service factor of duty "*kd*" (/);
.11 Service factor of time "*kt*" (/);
.12 Service total factor of use "*ku*" (/), where $ku=kl \cdot kd \cdot kt$;
.13 Load's necessary power "*Pload*" (*kW*), where $Pload=Pr \cdot ku$;
.14 Notes;
.15 Group's necessary power (*kW*); and
.16 Auxiliaries load's power P_{AE} (*kW*).

4 Data to be included in the electric power table for EEDI

Load groups

4.1 The loads are divided into defined groups, allowing a proper breakdown of the auxiliaries. This eases the verification process and makes it possible to identify those areas where load reductions might be possible. The groups are listed below:

.1 A – Hull, deck, navigation and safety services;
.2 B – Propulsion service auxiliaries;
.3 C – Auxiliary engine and main engine services;
.4 D – Ship's general services;
.5 E – Ventilation for engine-rooms and auxiliaries room;
.6 F – Air conditioning services;
.7 G – Galleys, refrigeration and laundries services;
.8 H – Accommodation services;
.9 I – Lighting and socket services;
.10 L – Entertainment services;
.11 N – Cargo loads; and
.12 M – Miscellaneous.

All the ship's loads should be delineated in the document, excluding only *PAeff*, the shaft motors and shaft motors chain (while the propulsion services auxiliaries are partially included below in paragraph 4.1.2 B). Some loads (i.e. thrusters, cargo pumps, cargo gear, ballast pumps, maintaining cargo, reefers and cargo hold fans) still are included in the group for sake of transparency, however their service factor is zero in order to comply with rows 4 and 5 of paragraph 2.5.6 of the Guidelines, therefore making it easier to verify that all the loads have been considered in the document and there are no loads left out of the measurement.

4.1.1 A – Hull, deck, navigation and safety services

.1 loads included in the hull services typically are: ICCP systems, mooring equipment, various doors, ballasting systems, bilge systems, stabilizing equipment, etc. Ballasting systems are indicated with service factor equal to zero to comply with row 5 of paragraph 2.5.6 of the Guidelines;

.2 loads included in the deck services typically are: deck and balcony washing systems, rescue systems, cranes, etc.;

.3 loads included in the navigation services typically are: navigation systems, navigation's external and internal communication systems, steering systems, etc.; and

.4 loads included in the safety services typically are: active and passive fire systems, emergency shutdown systems, public address systems, etc.

4.1.2 B – Propulsion service auxiliaries

This group typically includes: propulsion secondary cooling systems such as LT cooling pumps dedicated to shaft motors, LT cooling pumps dedicated to propulsion converters, propulsion UPSs, etc. Propulsion service loads do not include shaft motors (*PTI(i)*) and the auxiliaries which are part of them (shaft motor own cooling fans and pump, etc.) and the shaft motor chain losses and auxiliaries which are part of them (i.e. shaft motor converters including relevant auxiliaries such as converter own cooling fans and pumps, shaft motor transformers including relevant auxiliaries losses such as propulsion transformer own cooling fans and pumps, shaft motor harmonic filter including relevant auxiliaries losses, shaft motor excitation system including the relevant auxiliaries consumed power, etc.). Propulsion service auxiliaries include manoeuvring propulsion equipment such as manoeuvring thrusters and their auxiliaries whose service factor is to be set to zero.

4.1.3 C – Auxiliary engine and main engine services

This group includes: cooling systems, i.e. pumps and fans for cooling circuits dedicated to alternators or propulsion shaft engines (seawater, technical water dedicated pumps, etc.), lubricating and fuel systems feeding, transfer, treatment and storage, ventilation system for combustion air supply, etc.

4.1.4 D – Ship's general services

This group includes loads which provide general services which can be shared between shaft motor, auxiliary engines and main engine and accommodation support systems. Loads typically included in this group are: cooling systems, i.e. pumping seawater, technical water main circuits, compressed air systems, fresh water generators, automation systems, etc.

4.1.5 E – Ventilation for engine-rooms and auxiliaries room

This group includes all fans providing ventilation for engine-rooms and auxiliary rooms that typically are: engine-rooms cooling supply-exhaust fans, auxiliary rooms supply and exhaust fans. All the fans serving accommodation areas or supplying combustion air are not included in this group. This group does not include cargo hold fans and garage supply and exhaust fans.

4.1.6 F – Air conditioning services

All loads that make up the air conditioning service that typically are: air conditioning chillers, air conditioning cooling and heating fluids transfer and treatment, air conditioning's air handling units ventilation, air conditioning re-heating systems with associated pumping, etc. The air conditioning chillers service factor of load, service factor of time and service factor of duty are to be set as 1 (kl=*1, kt*=1 and kd=1) in order to avoid the detailed validation of the heat load dissipation document (i.e. the chiller's electric motor rated power is to be used). However, kd is to represent the use of spare chillers (e.g. four chillers are installed and one out four is spare then $kd=0$ for the spare chiller and kd=1 for the remaining three chillers), but only when the number of spare chillers is clearly demonstrated via the heat load dissipation document.

4.1.7 G – Galleys, refrigeration and laundries services

All loads related to the galleys, pantries refrigeration and laundry services that typically are: galleys various machines, cooking appliances, galleys' cleaning machines, galleys auxiliaries, refrigerated room systems including refrigeration compressors with auxiliaries, air coolers, etc.

4.1.8 H – Accommodation services

All loads related to the accommodation services of passengers and crew that typically are: crew and passengers' transportation systems, i.e. lifts, escalators, etc. environmental services, i.e. black and grey water collecting, transfer, treatment, storage, discharge, waste systems including collecting, transfer, treatment, storage, etc. accommodation fluids transfers, i.e. sanitary hot and cold water pumping, etc., treatment units, pools systems, saunas, gym equipment, etc.

4.1.9 I – Lighting and socket services

All loads related to the lighting, entertainment and socket services. As the quantity of lighting circuits and sockets within the ship may be significantly high, it is not practically feasible to list all the lighting circuits and points in the EPT for EEDI. Therefore circuits should be grouped into subgroups aimed to identify possible improvements of efficient use of power. The subgroups are:

.1 Lighting for 1) cabins, 2) corridors, 3) technical rooms/stairs, 4) public spaces/stairs, 5) engine-rooms and auxiliaries' room, 6) external areas, 7) garages and 8) cargo spaces. All should be divided by main vertical zones; and

.2 Power sockets for 1) cabins, 2) corridors, 3) technical rooms/stairs, 4) public spaces/stairs, 5) engine-rooms and auxiliaries' room, 6) garages and 7) cargo spaces. All should be divided by main vertical zones.

The calculation criteria for complex groups (e.g. cabin lighting and power sockets) subgroups are to be included via an explanatory note, indicating the load composition (e.g. lights of typical cabins, TV, hair dryer, fridge, etc., typical cabins).

4.1.10 L – Entertainment services

This group includes all loads related to entertainment services, typically: public spaces audio and video equipment, theatre stage equipment, IT systems for offices, video games, etc.

4.1.11 N – Cargo loads

This group will contain all cargo loads such as cargo pumps, cargo gear, maintaining cargo, cargo reefers loads, cargo hold fans and garage fans for sake of transparency. However, the service factor of this group is to be set to zero.

4.1.12 M – Miscellaneous

This group will contain all loads which have not been associated to the above-mentioned groups but still are contributing to the overall load calculation of the normal maximum sea load.

Loads description

4.2 This identifies the loads (for example "seawater pump").

Loads identification tag

4.3 This tag identifies the loads according to the shipyard's standards tagging system. For example, the "PTI1 fresh water pump" identification tag is "SYYIA/C" for an example ship and shipyard. This data provides a unique identifier for each load.

Loads electric circuit Identification

4.4 This is the tag of the electric circuit supplying the load. Such information allows the data validation process.

Loads mechanical rated power "Pm"

4.5 This data is to be indicated in the document only when th electric load is made by an electric motor driving a mechanical load (for example a fan, a pump, etc.). This is the rated power of the mechanical device driven by an electric motor.

Loads electric motor rated output power (kW)

4.6 The output power of the electric motor as per maker's name plate or technical specification. This data does not take part of the calculation but is useful to highlight potential over rating of the combination motor-mechanical load.

Loads electric motor efficiency "e" (/)

4.7 This data is to be entered in the document only when the electric load is made by an electric motor driving a mechanical load.

Loads rated electric power "Pr" (kW)

4.8 Typically the maximum electric power absorbed at the load electric terminals at which the load has been designed for its service, as indicated on the maker's name plate and/or maker's technical specification. When the electric load is made by an electric motor driving a mechanical load the load's rated electric power is: $Pr=Pm/e$ *(kW).*

Service factor of load "kl" (/)

4.9 Provides the reduction from the loads rated electric power to loads necessary electric power that is to be made when the load absorb less power than its rated power. For example, in case of electric motor driving a mechanical load, a fan could be designed with some power margin, leading to the fact that the fan rated mechanical power exceeds the power requested by the duct system it serves. Another example is when a pump rated power exceed the power needed for pumping in its delivery fluid circuit. Another example in case of electric self-regulating semi-conductors electric heating system is oversized and the rated power exceeds the power absorbed, according a factor *kl.*

Service factor of duty "kd" (/)

4.10 Factor of duty is to be used when a function is provided by more than one load. As all loads are to be included in the EPT for EEDI, this factor provides a correct summation of the loads. For example when two pumps serve the same circuit and they run in duty/stand-by their *Kd* factor will be ½ and ½. When three compressors serves the same circuit and one runs in duty and two in stand-by, then *kd* is 1/3, 1/3 and 1/3.

Service factor of time "kt" (/)

4.11 A factor of time based on the shipyard's evaluation about the load duty along 24 hours of ship's navigation as defined at paragraph 3. For example the Entertainment loads operate at their power for a limited period of time, 4 hours out 24 hours; as a consequence $kt=4/24$. For example, the seawater cooling pumps operate at their power all the time during the navigation at *Vref*. As a consequence $kt=1$.

Service total factor of use "ku" (/)

4.12 The total factor of use that takes into consideration all the service factors: $ku=kl \cdot kd \cdot kt$.

Loads necessary power "Pload" (kW)

4.13 The individual user contribution to the auxiliary load power is $Pload=Pr \cdot ku$.

Notes

4.14 A note, as free text, could be included in the document to provide explanations to the verifier.

Groups necessary power (kW)

4.15 The summation of the "Loads necessary power" from group A to N. This is an intermediate step which is not strictly necessary for the calculation of *PAE*. However, it is useful to allow a quantitative analysis of the *PAE*, providing a standard breakdown for analysis and potential improvements of energy saving.

Auxiliaries load's power PAE (kW)

4.16 Auxiliaries load's power *PAE* is the summation of the "Load's necessary power" of all the loads divided by the average efficiency of the generator(s) weighted by power.

$$PAE=\Sigma Pload(i) / (\text{average efficiency of the generator(s) weighted by power})$$

Layout and organization of the data indicated in the electric power table for EEDI

5 The document "Electric power table for EEDI" is to include general information (i.e. ship's name, project name, document references, etc.) and a table with:

.1 one row containing column titles;

.2 one Column for table row ID;

.3 one Column for the groups identification ("A", "B", etc.) as indicated in paragraphs 4.1.1 to 4.1.12 of this guideline;

.4 one Column for the group descriptions as indicated in paragraphs 4.1.1 to 4.1.12 of this guideline;

.5 one column each for items in paragraphs 4.2 to 4.14 of this guideline (e.g. "load tag", etc.);

.6 one row dedicated to each individual load;

.7 the summation results (i.e. summation of powers) including data from paragraphs 4.15 to 4.16 of this guideline; and

.8 explanatory notes.

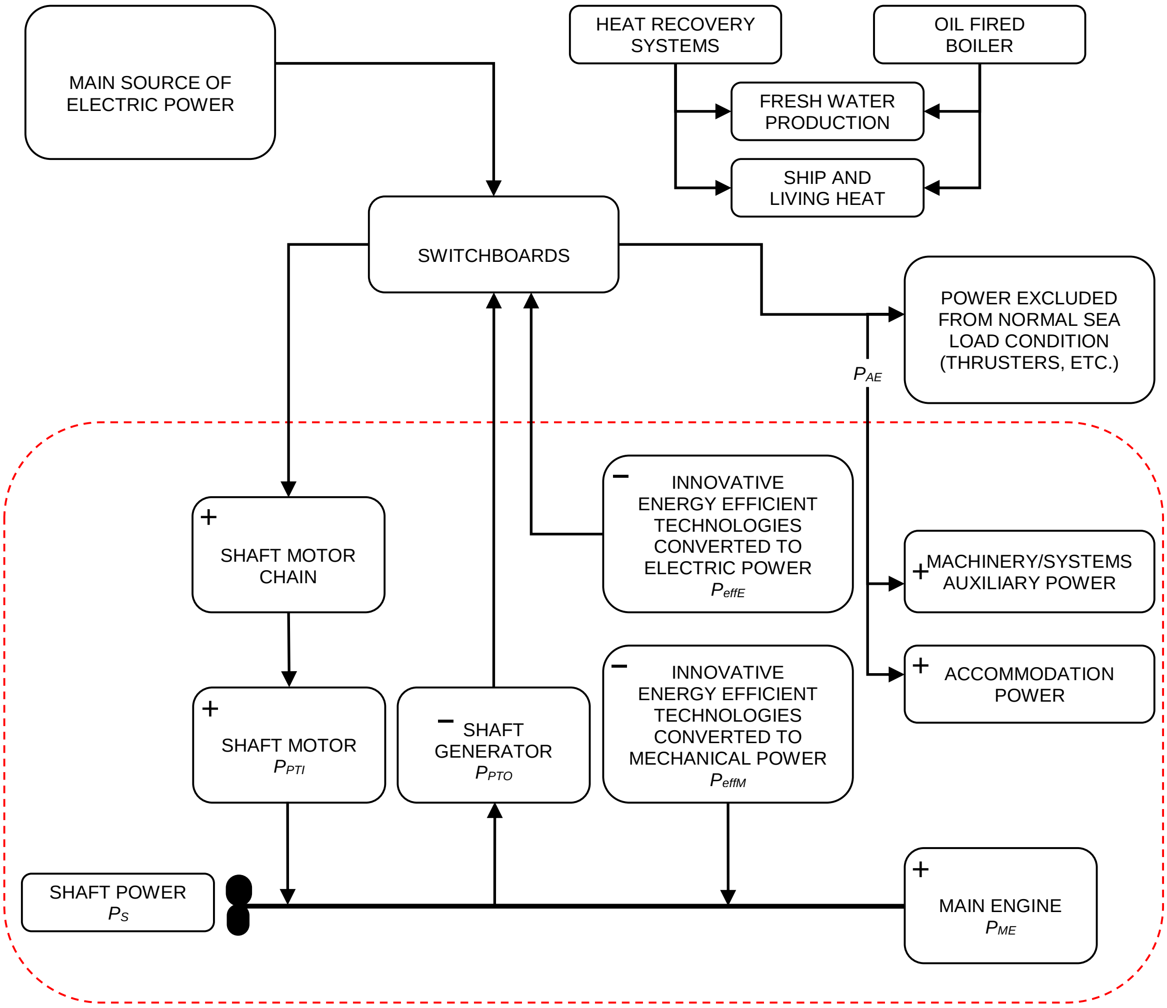
An example of an electric power table for EEDI for a cruise postal ship which transports passengers and has a car garage and reefer holds for fish trade transportation is indicated below. The data indicated and the type of ship is for reference only.

ELECTRIC POWER TABLE FOR EEDI			HULL "EXAMPLE"		PROJECT "EXAMPLE"									(NMSL=Normal Maximun Sea Load)
id	Load group	Load description	Load identification tag	Load electric circuit Identification	Load mechanical rated power "Pm" [kW]	Load electric motor rated output power [kW]	Load electric motor efficiency "e" [/]	Load Rated electric power "Pr" [kW]	service factor of load "kl" [/]	service factor of duty "kd" [/]	service factor of time "kt" [/]	service total factor of use "ku" [/]	Load necessary power "Pload" [kW]	Note
1	A	Hull cathodic protection Fwd	xxx	yyy	n.a.	n.a.	n.a.	5.2	1	1	1*	1	5.2	*in use 24hours/day
2	A	Hull cathodic protection mid	xxx	yyy	n.a.	n.a.	n.a.	7.0	1	1	1*	1	7	*in use 24hours/day
3	A	Hull cathodic protection aft	xxx	yyy	n.a.	n.a.	n.a.	4.8	1	1	1*	1	4.8	*in use 24hours/day
4	A	Ballast pump 3	xxx	yyy	30	36	0.92	32.6	0.9	0.5	1	0*	0	*not in use at **NMSL** see para 2.5.6 of Circ.681
5	A	Fwd Stb mooring winch motor n.1	xxx	yyy	90	150	0.92	97.8	0.8	1	0*	0*	0	*not in use at **NMSL** see para 2.5.6 of Circ.681
6	A	WTDs system main control panel	xxx	yyy	n.a.	n.a.	n.a.	0.5	1	1	1*	1	0.5	*in use 24hours/day
7	A	WTD 1, deck D frame 150	xxx	yyy	1.2	3	0.91	1.3	0.7	1	0.104*	0.0728	0.096	*180 secs to open/close x 100 opening a day
8	A	WTD 5, deck D frame 210	xxx	yyy	1.2	3	0.91	1.3	0.7	1	0.156*	0.1092	0.14	*180 secs to open/close x 150 opening a day
9	A	Stabilisers control unit	xxx	yyy	n.a.	n.a.	n.a.	0.7	1	1	1*	1	0.7	*in use 24hours/day
10	A	Stabilisers Hydraulic pack power pump 1	xxx	yyy	80	90	0.9	88.9	0.9	1	0*	0	0	*NMSL=> calm sea,=> stabiliser not in use
11	A	S-band Radar 1 controller	xxx	yyy	n.a.	n.a.	n.a.	0.4	1	1	1*	1	0.4	*in use 24hours/day
12	A	S-band Radar 1 motor	xxx	yyy	0.8	1	0.92	0.9	1	1	1*	1	0.9	*in use 24hours/day
13	A	Fire detection system bridge main unit	xxx	yyy	n.a.	n.a.	n.a.	1.5	1	1	1*	1	1.5	*in use 24hours/day
14	A	Fire detection system ECR unit	xxx	yyy	n.a.	n.a.	n.a.	0.9	1	1	1*	1	0.9	*in use 24hours/day
15	A	High pressure water fog contol unit	xxx	yyy	n.a.	n.a.	n.a.	1.2	1	1	1*	1	1.2	*in use 24hours/day
16	A	High pressure water fog engines rooms pump 1a	xxx	yyy	25	30	0.93	26.9	0.9	0.5	0*	0	0	*NMSL=> not emergency =>Load not in use
17	A	High pressure water fog engines rooms pump 1b	xxx	yyy	25	30	0.93	26.9	0.9	0.5	0*	0	0	* not emergency situations
18	B	PTi port fresh water pump 1	xxx	yyy	30	36	0.92	32.6	0.9	0.5*	1	0.45	14.7	* pump1,2 one is duty and one is stand-by
19	B	PTi port fresh water pump 2	xxx	yyy	30	36	0.92	32.6	0.9	0.5*	1	0.45	14.7	* pump1,2 one is duty and one is stand-by
20	B	Thrusters control system	xxx	yyy	n.a.	n.a.	n.a.	0.5	1	1	1*	1	0.5	in use 24hours/day (even if thruster motor isn't)
21	B	Bow thruster 1	xxx	yyy	3000	3000	0.96	3125.0	1	1	0*	0	0	*NMSL=>thrusters motor are not in use
22	B	PEM port cooling fan 1	xxx	yyy	20	25	0.93	21.5	0.9	1	n.a.	n.a	n.a.*	*this load is included in the propulsion chain data
23	C	HT circulation pump 1 DG 3	xxx	yyy	8	10	0.92	8.7	0.9	0.5*	1	0.45	3.9	* pump1,2 one is duty and one is stand-by
24	C	HT circulation pump 2 DG 3	xxx	yyy	8	10	0.92	8.7	0.9	0.5*	1	0.45	3.9	* pump1,2 one is duty and one is stand-by
25	C	DG3 combustion air fan	xxx	yyy	28	35	0.92	30.4	0.9	1	1*	0.9	27.4	*in use 24hours/day
26	C	DG3 exhaust gas boiler circulationg pump	xxx	yyy	6	8	0.93	6.5	0.8	1	1*	0.8	5.2	*in use 24hours/day
27	C	Alternator 3 external cooling fan	xxx	yyy	3	5	0.93	3.2	0.8	1	1*	0.8	2.75	*in use 24hours/day
28	C	fuel feed fwd booster pump a	xxx	yyy	7	9	0.92	7.6	0.9	0.5*	1	0.45	3.4	* pump1,2 one is duty and one is stand-by
29	C	fuel feed fwd booster pump b	xxx	yyy	7	9	0.92	7.6	0.9	0.5*	1	0.45	3.4	* pump1,2 one is duty and one is stand-by
30	D	Fwd main LT cooling pump 1	xxx	yyy	120	150	0.95	126.3	0.9	0.5*	1	0.45	56.8	* pump1,2 one is duty and one is stand-by
31	D	Fwd main LT cooling pump 2	xxx	yyy	120	150	0.95	126.3	0.9	0.5*	1	0.45	56.8	* pump1,2 one is duty and one is stand-by
32	E	FWD engine room supply fan 1	xxx	yyy	87.8	110	0.93	94.4	0.95	1	1*	0.95	89.7	*in use 24hours/day
33	E	FWD engine room exhaust fan 1	xxx	yyy	75	86	0.93	80.6	0.96	1	1*	0.96	77.4	*in use 24hours/day
34	E	purifier room supply fan 1	xxx	yyy	60	70	0.93	64.5	0.96	0.5	1*	0.48	31.0	*in use 24hours/day
35	E	purifier room supply fan 2	xxx	yyy	60	70	0.93	64.5	0.96	0.5	1*	0.48	31.0	*in use 24hours/day
36	F	HVAC chiller a	xxx	yyy	1450	1600	0.95	1526.3	1	2/3*	1	0.66	1007.4	*1 Chiller is spare; see heat load dissipation doc.
37	F	HVAC chiller b	xxx	yyy	1450	1600	0.95	1526.3	1	2/3*	1	0.66	1007.4	*1 Chiller is spare; see heat load dissipation doc.
38	F	HVAC chiller C	xxx	yyy	1450	1600	0.95	1526.3	1	2/3*	1	0.66	1007.4	*1 Chiller is spare; see heat load dissipation doc.
39	F	A.H.U. Ac station 5.4 supply fan	xxx	yyy	50	60	0.93	53.8	0.9	1	1*	0.9	48.4	*in use 24hours/day
40	F	A.H.U. Ac station 5.4 exhaust fan	xxx	yyy	45	55	0.93	48.4	0.9	1	1*	0.9	43.5	*in use 24hours/day
41	F	Chilled water pump a	xxx	yyy	80	90	0.93	86.0	0.88	0.5*	1	0.44	37.8	* pump1,2 one is duty and one is stand-by
42	F	Chilled water pump b	xxx	yyy	80	90	0.93	86.0	0.88	0.5*	1	0.44	37.8	* pump1,2 one is duty and one is stand-by
43	G	Italian's espresso coffee machine	xxx	yyy	n.a.	n.a.	n.a.	7.0	0.9	1	0.2*	0.18	1.3	*in use 4.8hours/day
44	G	deep freezer machine	xxx	yyy	n.a.	n.a.	n.a.	20.0	0.8	1	0.16*	0.128	3.2	*in use 4hours/day
45	G	washing machine 1	xxx	yyy	n.a.	n.a.	n.a.	8.0	0.8	1	0.33*	0.264	3.2	*in use 8hours/day
46	H	lift pax mid 4	xxx	yyy	30	40	0.93	32.3	0.5	1	0.175*	0.0875	0.9	*in use 4hours/day
47	H	vaccum collecting system 4 pump a	xxx	yyy	10	13	0.92	10.9	0.9	1	1*	0.9	8.7	*in use 24hours/day
48	H	sewage treatmet system 1 pump 1	xxx	yyy	15	17	0.93	16.1	0.9	1	1*	0.9	8.7	*in use 24hours/day
49	H	Gym running machine	xxx	yyy	n.a.	n.a.	n.a.	2.5	1	1	0.3*	0.3	0.8	*in use 7.2hours/day
50	I	Cabin's lighting MVZ3	n.a.	n.a.	n.a.	n.a.	n.a.	80*	1	1	1	1	80.0	* see explainatory note
51	I	corridors ligthing MVZ3	n.a.	n.a.	n.a.	n.a.	n.a.	10*	1	1	1	1	10.0	* see explainatory note
52	I	Cabin's sockets MVZ3	n.a.	n.a.	n.a.	n.a.	n.a.	5*	1	1	1	1	5.0	* see explainatory note
53	L	Main Theatre audio booster amplifier	xxx	yyy	n.a.	n.a.	n.a.	15.0	1	1	0.3*	0.3	4.5	*in use 7.2hours/day
54	L	Video wall atrium	xxx	yyy	n.a.	n.a.	n.a.	2.0	1	1	0.3*	0.3	0.6	*in use 7.2hours/day
55	M	Car Garage supply fan1	xxx	yyy	28	35	0.92	30.4	0.9	1	1*	0*	0	*not in use at **NMSL** see para 2.5.6 of Circ.681
56	M	Fish transportation refeer hold n.2	xxx	yyy	25	30	0.93	26.9	0.9	0.5	0*	0*	0	*not in use at **NMSL** see para 2.5.6 of Circ.681
57	N	Sliding glass roof	xxx	yyy	30	40	0.93	32.3	0.9	1	0.3*	0.27	0.2	*in use 7.2hours/day
											ΣPload(i)=		**3764**	

***PAE* =3764/(weighted average efficiency of generator(s)) [kW]** Group's necessary power (group A=22.9kW, B=29.8kW,C=49.9kW, D=113.7kW, E=229kW , F=3189kW, G=7.6kW, H=19kW, I=95kW, L=5.1kW, M=0kW, N=0.22kW)

APPENDIX 3

A GENERIC AND SIMPLIFIED MARINE POWER PLANT FOR A CRUISE PASSENGER SHIPS HAVING NON-CONVENTIONAL PROPULSION

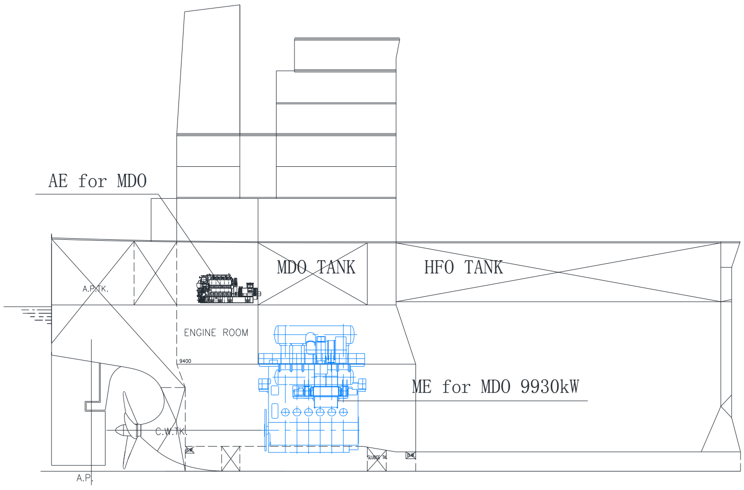


Note: Symbols for plus (+) and minus (−) indicate CO_2 contribution to EEDI formula.

APPENDIX 4

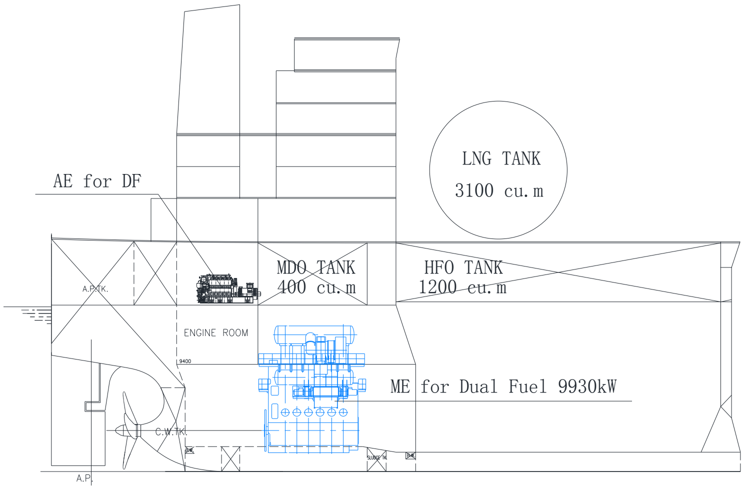
EEDI CALCULATION EXAMPLES FOR USE OF DUAL FUEL ENGINES

Case 1: Standard Kamsarmax ship, one main engine (MDO), standard auxiliary engines (MDO), no shaft generator:



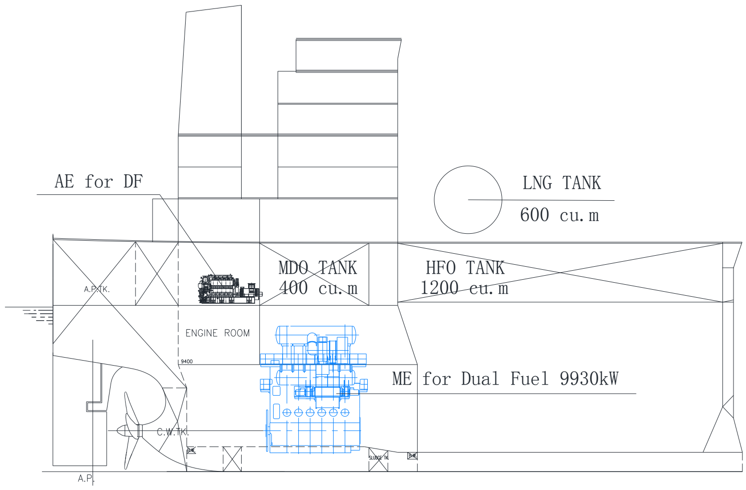
S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	Capacity	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	0.75 x MCR_{ME}	kW	7447.5
5	P_{AE}	0.05 x MCR_{ME}	kW	496.5
6	C_{FME}	C_F factor of Main engine using MDO	-	3.206
7	C_{FAE}	C_F factor of Auxiliary engine using MDO	-	3.206
8	SFC_{ME}	Specific fuel consumption of at P_{ME}	g/kWh	165
9	SFC_{AE}	Specific fuel consumption of at P_{AE}	g/kWh	210
10	EEDI	$((P_{ME} \times C_{F\,ME} \times SFC_{ME})+(P_{AE} \times C_{FAE} \times SFC_{AE})) / (V_{ref} \times Capacity)$	gCO_2/tnm	3.76

Case 2: LNG is regarded as the "primary fuel" if dual-fuel main engine and dual-fuel auxiliary engine (LNG, pilot fuel MDO; no shaft generator) are equipped with bigger LNG tanks:



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	Capacity	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	0.75 x MCR_{ME}	kW	7447.5
5	P_{AE}	0.05 x MCR_{ME}	kW	496.5
6	$CF_{Pilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
7	$CF_{AE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
8	CF_{LNG}	C_F factor of dual fuel engine using LNG	-	2.75
9	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
10	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
11	$SFC_{ME\ LNG}$	Specific fuel consumption of ME using LNG at P_{ME}	g/kWh	136
12	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
13	V_{LNG}	LNG tank capacity on board	m^3	3100
14	V_{HFO}	Heavy fuel oil tank capacity on board	m^3	1200
15	V_{MDO}	Marine diesel oil tank capacity on board	m^3	400
16	ρ_{LNG}	Density of LNG	kg/m^3	450
17	ρ_{HFO}	Density of heavy fuel oil	kg/m^3	991
18	ρ_{MDO}	Density of Marine diesel oil	kg/m^3	900
19	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
20	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
21	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
22	K_{LNG}	Filling rate of LNG tank	-	0.95
23	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
24	K_{MDO}	Filling rate of marine diesel tank	-	0.98
25	f_{DFgas}	$\frac{P_{ME}+P_{AE}}{P_{ME}+P_{AE}} \times \frac{V_{LNG}\times\rho_{LNG}\times LCV_{LNG}\times K_{LNG}}{V_{HFO}\times\rho_{HFO}\times LCV_{HFO}\times K_{HFO}+V_{MDO}\times\rho_{MDO}\times LCV_{MDO}\times K_{MDO}+V_{LNG}\times\rho_{LNG}\times LCV_{LNG}\times K_{LNG}}$	-	0.5068
26	EEDI	$(P_{ME} \times (C_{F\ Pilotfuel} \times SFC_{ME\ Pilotfuel} + C_{F\ LNG} \times SFC_{ME\ LNG}) + P_{AE} \times (C_{F\ Pilotfuel} \times SFC_{AE\ Pilotfuel} + C_{F\ LNG} \times SFC_{AE\ LNG})) / (V_{ref} \times Capacity)$	gCO_2/tnm	2.78

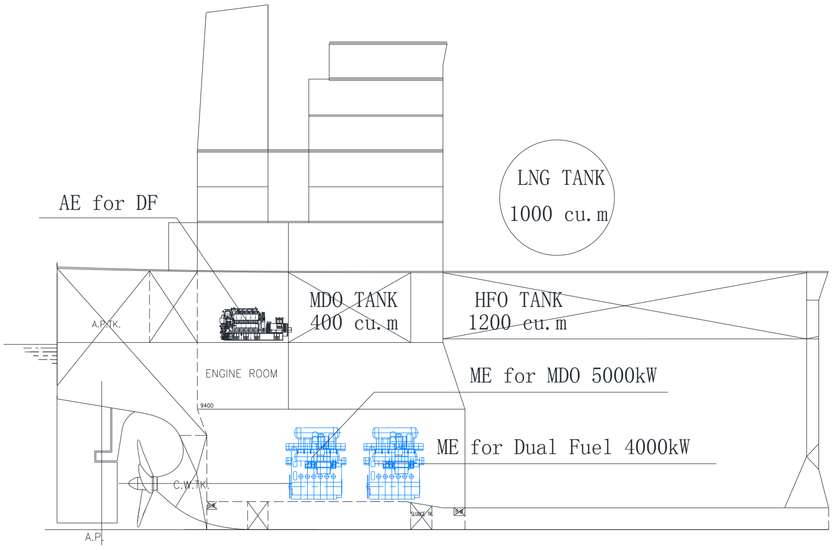
Case 3: LNG is not regarded as the "primary fuel" if dual-fuel main engine and dual-fuel auxiliary engine (LNG, pilot fuel MDO; no shaft generator) are equipped with smaller LNG tanks:



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{ME}	MCR rating of main engine	kW	9930
2	Capacity	Deadweight of the ship at summer load draft	DWT	81200
3	V_{ref}	Ships speed as defined in EEDI regulation	kn	14
4	P_{ME}	0.75 x MCR_{ME}	kW	7447.5
5	P_{AE}	0.05 x MCR_{ME}	kW	496.5
6	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
7	$C_{FAE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
8	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
9	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	3.206
10	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
11	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
12	$SFC_{ME\ LNG}$	Specific fuel consumption of ME using LNG at P_{ME}	g/kWh	136
13	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
14	$SFC_{ME\ MDO}$	Specific fuel consumption of dual fuel ME using MDO at P_{ME}	g/kWh	165
15	$SFC_{AE\ MDO}$	Specific fuel consumption of dual fuel AE using MDO at P_{AE}	g/kWh	187
16	V_{LNG}	LNG tank capacity on board	m^3	600
17	V_{HFO}	Heavy fuel oil tank capacity on board	m^3	1800
18	V_{MDO}	Marine diesel oil tank capacity on board	m^3	400
19	ρ_{LNG}	Density of LNG	kg/m^3	450
20	ρ_{HFO}	Density of heavy fuel oil	kg/m^3	991
21	ρ_{MDO}	Density of Marine diesel oil	kg/m^3	900
22	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
24	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
25	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
26	K_{LNG}	Filling rate of LNG tank	-	0.95
27	K_{HFO}	Filling rate of heavy fuel tank	-	0.98

S/N	Parameter	Formula or Source	Unit	Value
28	K_{MDO}	Filling rate of marine diesel tank	-	0.98
29	f_{DFgas}	$\frac{P_{ME}+P_{AE}}{P_{ME}+P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.1261
30	$f_{DFliquid}$	1- f_{DFgas}	-	0.8739
31	EEDI	$(P_{ME}$ x (f_{DFgas} x ($C_{F\ Pilotfuel}$ x $SFC_{ME\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{ME\ LNG}$) + $f_{DFliquid}$ x C_{FMDO} x $SFC_{ME\ MDO}$) + P_{AE} x (f_{DFgas} x ($C_{FAE\ Pilotfuel}$ x $SFC_{AE\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{AE\ LNG}$)+ $f_{DFliquid}$ x C_{FMDO} x $SFC_{AE\ MDO}$)) / (V_{ref} x $Capacity$)	gCO_2/tnm	3.61

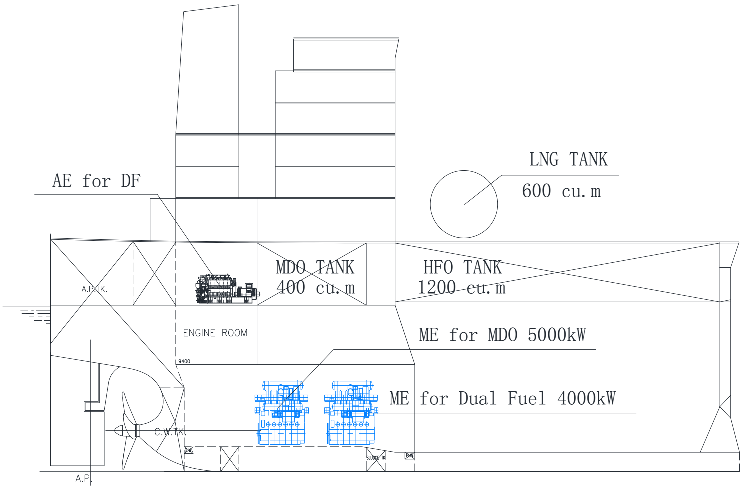
Case 4: One dual-fuel main engine (LNG, pilot fuel MDO) and one main engine (MDO) and dual-fuel auxiliary engine (LNG, pilot fuel MDO, no shaft generator) which LNG could be regarded as "primary fuel" only for the dual-fuel main engine:



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{MEMDO}	MCR rating of main engine using only MDO	kW	5000
2	MCR_{MELNG}	MCR rating of main engine using dual fuel	kW	4000
3	Capacity	Deadweight of the ship at summer load draft	DWT	81200
4	V_{ref}	Ships speed	kn	14
5	P_{MEMDO}	0.75 x MCR_{MEMDO}	kW	3750
6	P_{MELNG}	0.75 x MCR_{MELNG}	kW	3000
7	P_{AE}	0.05 x (MCR_{MEMDO} + MCR_{MELNG})	kW	450
8	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
9	$C_{FAE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
10	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
11	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	3.206
12	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6
13	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
14	$SFC_{DF\ LNG}$	Specific fuel consumption of dual fuel ME using LNG at P_{ME}	g/kWh	158
15	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
16	$SFC_{ME\ MDO}$	Specific fuel consumption of single fuel ME at P_{ME}	g/kWh	180
17	V_{LNG}	LNG tank capacity on board	m^3	1000
18	V_{HFO}	Heavy fuel oil tank capacity on board	m^3	1200

S/N	Parameter	Formula or Source	Unit	Value
19	V_{MDO}	Marine diesel oil tank capacity on board	m^3	400
20	ρ_{LNG}	Density of LNG	kg/m^3	450
21	ρ_{HFO}	Density of heavy fuel oil	kg/m^3	991
22	ρ_{MDO}	Density of Marine diesel oil	kg/m^3	900
23	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
24	LCV_{HFO}	Low calorific value of heavy fuel oil	kJ/kg	40200
25	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
26	K_{LNG}	Filling rate of LNG tank	-	0.95
27	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
28	K_{MDO}	Filling rate of Lmarine diesel tank	-	0.98
29	f_{DFgas}	$\frac{P_{MEMDO}+P_{MELNG}+P_{AE}}{P_{MELNG}+P_{AE}} \times \frac{V_{LNG}\times\rho_{LNG}\times LCV_{LNG}\times K_{LNG}}{V_{HFO}\times\rho_{HFO}\times LCV_{HFO}\times K_{HFO}+V_{MDO}\times\rho_{MDO}\times LCV_{MDO}\times K_{MDO}+V_{LNG}\times\rho_{LNG}\times LCV_{LNG}\times K_{LNG}}$	-	0.5195
30	EEDI	$(P_{MELNG}$ x $(C_{F\ Pilotfuel}$ x $SFC_{ME\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{DF\ LNG}$) + P_{MEMDO} x $C_{F\ MDO}$ x $SFC_{ME\ MDO}$ + P_{AE} x $(C_{FAE\ Pilotfuel}$ x $SFC_{AE\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{AE\ LNG}$)) / (V_{ref} x *Capacity*)	gCO_2/tnm	3.28

Case 5: One dual-fuel main engine (LNG, pilot fuel MDO) and one main engine (MDO) and dual-fuel auxiliary engine (LNG, pilot fuel MDO, no shaft generator) which LNG could not be regarded as "primary fuel" for the dual- fuel main engine:



S/N	Parameter	Formula or Source	Unit	Value
1	MCR_{MEMDO}	MCR rating of main engine using only MDO	kW	5000
2	MCR_{MELNG}	MCR rating of main engine using dual fuel	kW	4000
3	Capacity	Deadweight of the ship at summer load draft	DWT	81200
4	V_{ref}	Ships speed	kn	14
5	P_{MEMDO}	0.75 x MCR_{MEMDO}	kW	3750
6	P_{MELNG}	0.75 x MCR_{MELNG}	kW	3000
7	P_{AE}	0.05 x (MCR_{MEMDO} + MCR_{MELNG})	kW	450
8	$C_{FPilotfuel}$	C_F factor of pilot fuel for dual fuel ME using MDO	-	3.206
9	$C_{FAE\ Plilotfuel}$	C_F factor of pilot fuel for Auxiliary engine using MDO	-	3.206
10	C_{FLNG}	C_F factor of dual fuel engine using LNG	-	2.75
11	C_{FMDO}	C_F factor of dual fuel ME/AE engine using MDO	-	2.75
12	$SFC_{MEPilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel ME at P_{ME}	g/kWh	6

S/N	Parameter	Formula or Source	Unit	Value
13	$SFC_{AE\ Pilotfuel}$	Specific fuel consumption of pilot fuel for dual fuel AE at P_{AE}	g/kWh	7
14	$SFC_{DF\ LNG}$	Specific fuel consumption of dual fuel ME using LNG at P_{ME}	g/kWh	158
15	$SFC_{AE\ LNG}$	Specific fuel consumption of AE using LNG at P_{AE}	g/kWh	160
16	$SFC_{DF\ MDO}$	Specific fuel consumption of dual fuel ME using MDO at P_{ME}	g/kWh	185
17	$SFC_{ME\ MDO}$	Specific fuel consumption of single fuel ME at P_{ME}	g/kWh	180
18	$SFC_{AE\ MDO}$	Specific fuel consumption of AE using MDO at P_{AE}	g/kWh	187
19	V_{LNG}	LNG tank capacity on board	m^3	600
20	V_{HFO}	Heavy fuel oil tank capacity on board	m^3	1200
21	V_{MDO}	Marine diesel oil tank capacity on board	m^3	400
22	ρ_{LNG}	Density of LNG	kg/m^3	450
23	ρ_{HFO}	Density of heavy fuel oil	kg/m^3	991
24	ρ_{MDO}	Density of Marine diesel oil	kg/m^3	900
25	LCV_{LNG}	Low calorific value of LNG	kJ/kg	48000
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27	LCV_{MDO}	Low calorific value of marine diesel oil	kJ/kg	42700
28	K_{LNG}	Filling rate of LNG tank	-	0.95
29	K_{HFO}	Filling rate of heavy fuel tank	-	0.98
30	K_{MDO}	Filling rate of marine diesel tank	-	0.98
31	f_{DFgas}	$\frac{P_{MEMDO} + P_{MELNG} + P_{AE}}{P_{MELNG} + P_{AE}} \times \frac{V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}{V_{HFO} \times \rho_{HFO} \times LCV_{HFO} \times K_{HFO} + V_{MDO} \times \rho_{MDO} \times LCV_{MDO} \times K_{MDO} + V_{LNG} \times \rho_{LNG} \times LCV_{LNG} \times K_{LNG}}$	-	0.3462
32	$f_{DFliquid}$	1- f_{DFgas}	-	0.6538
33	EEDI	(P_{MELNG} x (f_{DFgas} x ($C_{F\ Pilotfuel}$ x $SFC_{ME\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{DF\ LNG}$) + $f_{DFliquid}$ x C_{FMDO} x $SFC_{DF\ MDO}$))+ P_{MEMDO} x $C_{F\ MDO}$ x $SFC_{ME\ MDO}$ + P_{AE} x (f_{DFgas} x ($C_{FAE\ Pilotfuel}$ x $SFC_{AE\ Pilotfuel}$ + $C_{F\ LNG}$ x $SFC_{AE\ LNG}$) + $f_{DFliquid}$ x C_{FMDO} x $SFC_{AE\ MDO}$)) / (V_{ref} x *Capacity*)	gCO_2/tnm	3.54