標題

MEPC65 の審議結果の紹介

ClassNK
テクニカル
インフォメーション

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2013 年 5 月 13 日から 17 日にかけて開催された IMO の第 65 回海洋環境保護委員会（MEPC65）での情報及び審議結果について次の通りお知らせせいたします。

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目的のため、バラスト水管理条約が 2004 年に採択されました。
同条約は、30ヶ国以上の批准かつ批准国の合計商船船腹量が世界の商船船腹量の 35%以上となった 12ヵ月後に発効することとなっています。2013 年 6 月 20 日にドイツが批准したことより、批准国数は 37ヶ国、合計商船船腹量に対する比率は 30.32％となっており、現在未発効です。
同条約の発効と同時に、船舶は、沖合におけるバラスト水交換の実施、あるいはバラスト水処理装置を使用したバラスト水交換、のどちらかによってバラスト水の排出を管理することが求められます。その後、条約上定められたスケジュールにしたがい、将来的に全ての船舶においてバラスト水処理装置を使用したバラスト水交換が求められます。

(1) バラスト水処理装置の搭載時期の見直し

バラスト水管理条約の批准が進んでいない理由の一つとして、同条約がこのまま発効すると、発効と同時にバラスト水処理装置の搭載が必要になる船舶が多数あることが指摘されています。また前回の MEPC 会合では、処理装置の搭載が世界的に進んでいないことが認識され、条約の円滑な実施のために、処理装置を搭載する時期の見直しを検討することが合意されました。
今回の会合では、本来は条約発効までに処理装置搭載を義務付けられる既存船に対して、条約発効後の最初の国際油汚染防止証書（IOPP 証書）の更新検査まで装置搭載を猶予すること等を内容とする IMO 総会決議案が合意されました。
なお、同決議案は、本年11月に開催されるIMO総会において、採択に向けた審議が行われる予定です。
また、この総会決議案における処理装置の搭載期限の内容を、例として次ページの表に示します（2015 年 1 月 1 日以降、及び 2017 年 1 月 1 日以降に同条約が発効する場合の例）。

（次頁に続く）

[2015 年 1 月 1 日以後 2016 年 12 月 31 日までに条約が発効する場合]

起工日	バラスト水容量	処理装置の搭載期限
2009 年より前	1500m3 以上かつ 5000m3 以下	条約発効後の最初の IOPP 更新検査まで
	1500m3 未満(*)または 5000m3 より大	2016 年の引渡し基準日後の最初の IOPP 更新検査まで
2009 年以降 2012 年より前	5000m3 未満(*)	条約発効後の最初の IOPP 更新検査まで
	5000m3 以上	2016 年の引渡し基準日後の最初の IOPP 更新検査まで
2012 年以降条約の発効日より前	全船(*)	条約発効後の最初の IOPP 更新検査まで
条約の発効日以降	全船(*)	完工日まで

(*): 検査と証書の発給が要求されるのは、Floating platform、FSU 及び FPSO を除いた 400GT 以上の船舶

[2017 年 1 月 1 日以後に条約が発効する場合]

起工日	バラスト水容量	処理装置の搭載期限
条約の発効日より前	全船(*)	条約発効後の最初の IOPP 更新検査まで
条約の発効日以降		完工日まで

(*): 検査と証書の発給が要求されるのは、Floating platform、FSU 及び FPSO を除いた 400GT 以上の船舶

(2) 活性物質を用いたバラスト水処理装置の承認（添付 1 の承認状況参照）

バラスト水管理条約で規定されるバラスト水処理装置は、IMO のガイドラインに基づいて主管庁による承認（型式承認）が必要とされています。なお、同装置に有害水生生物や病原菌を殺傷・滅菌するための「活性物質」が使用される場合は、主管庁による型式承認に先立ち、IMO による活性物質単体の承認（基本承認）、及び処理装置としての総合的な承認（最終承認）が必要となります。

今回の会合において、活性物質を用いたバラスト水処理装置について、3 件の基本承認、及び 3 件の最終承認が与えられました。この結果、IMO によって最終承認が与えられた装置は、合計 31 件となりました。

現時点では、実際に船舶に搭載可能な（主管庁による型式承認が付与された）装置の数は、活性物質を用いない装置も含め、34 件となっています。

（次頁に続く）

(3) PSC（寄港国検査）におけるバラスト水サンプリング手順（添付 2._BWM.2/Circ.42 参照）
バラスト水管理条約では、PSC（寄港国検査）において、船舶が条約の要件を遵守していることを確認するため、PSC 検査官がバラスト水のサンプリングを実施し、基準への適合を確認できることとされています。
今回の会合では、PSC 検査官による上記サンプリング実施に際しての手順が試行版として承認されると共に、次の内容を含む勧告が合意されました。
(i) 同手順の試行期間は、条約発効後 2～3 年を目安とすること。
(ii) 試行期間中は、サンプリング結果のみに基づく処罰及び拘留を行わないこと。
(iii) 当該試行を通じて、PSC に適したサンプリング手法を明確化すること。

2. シップリサイクル条約関連
船舶の安全かつ環境上適正な解撤を目的として、シップリサイクル条約が 2009 年に採択されました。同条約では、船舶に対して有害物質一覧表（インベントリ）を作成・保持すること、及び条約に適合している解撤ヤードにおける船舶の解撤等が要求されています。
同条約は、15 カ国以上の批准、批准国の船腹量合計が世界船腹量の 40%以上、かつ批准国の直近 10 年における最大の年間解体船腹量の合計が批准国の合計船腹量の 3%以上となった後、24 ヶ月後に発効することとなっています。ノルウェー（商船船腹量 1.52%）が 2013 年 6 月 26 日に批准し、同条約の初めての批准国となりました。
(1) 条約の実施に必要なガイドライン等の詳細検討
今回の会合では、条約の実施に必要なガイドラインのうち、「有害物質インベントリ作成ガイドライン」（インベントリガイドライン）に定められている、インベントリに記載すべき物質に関する閾値及び適用除外の見直しについて審議が行われました。
その結果、主に次の内容の案が作成され、次回 MEPC66 における最終化に向け、継続審議されることが合意されました。
・ アスベストの閾値は、「原則として 0.1％」とする。ただし、「1％の閾値を適用する場合は、その旨を有害物質インベントリに記録すること」とする。なお、アスベストの閾値の設定については、海上安全委員会（MSC）にも助言を求める。
・ PCBs（ポリ塩化ビフェニル）及び PCNs（ポリ塩化ナフタレン）の閾値については、現行ガイドラインの「no threshold level（閾値なし）」から「50 ppm」に変更する。
・ 改正された閾値は、既存の、又は作成中のインベントリに適用する必要はないこととする。ただし、船舶の整備時などインベントリに物質が追加される場合には、当該閾値を適用すべきである。

3. 温室効果ガス（GHG）関連
温室効果ガス（GHG）の削減を国際的に定めた国連気候変動枠組み条約（UNFCCC）の京都議定書では、外航船舶をその対象外としており、IMO が国際海運からの GHG 排出の抑制対策を検討することとされています。
2011 年 7 月に開催された MEPC62 では、エネルギー効率設計指標（EEDI）及び船舶エネルギー効率管理計画（SEEMP）の船舶への据え置き等を義務化する MARPOL 条約附属書 VI の改正が採択され、本年 1 月 1 日に発効しています。

（次頁に続く）

(1) EEDI 要件の適用拡大

現行の条約では Ro-Ro 船及び LNG 船（ディーゼル推進以外）等は、EEDI 要件の規定外となっており、2014 年までに規制の枠組みを作成することが目標とされています。
今回の会合では、現行の条約で EEDI 要件の対象外となっている以下の船舶について、EEDI 規制値（リファレンスライン）、適用下限の船舶サイズ及び将来の削減率が合意され、条約改正案が承認されました。
なお、当該条約改正案は、次回 MEPC66 にて採択に向けた審議が行われる予定です。

- Ro-Ro 貨物船（自動車運搬船）、Ro-Ro 貨物船及び Ro-Ro 客船
- クルーズ客船（non-conventional propulsion）
  補足：客船のうち、電気推進等の非従来型の推進装置を有するクルーズ客船に対する EEDI 規制値及び削減値が合意された。
- LNG 船
  補足：現行条約では、ディーゼル推進の LNG 船のみが EEDI 規制の対象となっているが、二元燃料ディーゼル電気推進（DFDE）及びタービン推進を採用する LNG 船にも対象を拡大するもの。

(2) 各種ガイドラインの検討等

EEDI の計算に必要となる次のガイドライン及びガイダンスについて今回の会合で審議が行われ、以下の結果となりました。

- 荒天下での操船を確保するための最低推進出力ガイドライン(添付 3_MEPC.232(65)参照)
  EEDI の導入に伴い、極端な速力低下等を避ける目的で、「荒天下での操船を確保するための最低推進出力に関するガイドライン」が採択されました。
  なお、今回採択されたガイドラインは、EEDI 規制のフェーズ 0 の期間（2013 年 1 月から 2014 年 12 月）のみ有効な暫定ガイドラインであり、フェーズ 1（2015 年 1 月から 2019 年 12 月）以降の取り扱いについては、今後検討されることとなりました。
- 革新的省エネ技術のための EEDI 計算及び認証ガイダンス(添付 4_MEPC.1/Circ.815 参照)
  革新的省エネ技術として、次の 4 つを使用する場合の EEDI 計算及び認証に関するガイダンスが承認されました。
  (i) 船底空気潤滑システム
  (ii) 風力を利用する推進システム
  (iii) 排熱回収システム
  (iv) 太陽光発電システム

(3) 海上試運転の実施方法及び外乱補正に使用する計算方法

EEDI 規制では、EEDI 値の正確性を確保するため、海上試運転における速力等の確認及び補正が要求されています。同確認及び補正の方法に関し、ISO の手法（ISO15016:2002）と国際試験水槽会議（ITTC）が策定した手法のどちらを用いるべきか、継続的に審議が行われていました。
今回の会合では、ISO と ITTC の手法の調和作業が実施されていることを考慮し、現時点ではどちらの手法も使用できることが合意されました。

（次頁に続く）

(4) 船舶のエネルギー効率改善についての技術移転・技術協力に関する決議の検討
本年 1 月 1 日に発効した改正附属書 VI の 23 規則においては、船舶のエネルギー効率改善について、途上国に対する技術移転及び技術協力を促進することが規定されています。
今回の会合では、IMO や他の国際機関に対して途上国への技術移転及び技術協力を要請すると共に、同技術移転等を促進するための作業グループの設置等を含む決議が採択されました。

(5) 監視・報告・認証（MRV）制度
今回の会合では、船舶のエネルギー効率改善の更なる促進を目的として、また EEDI 規制と経済的手法との中間的措置として、船舶の運航データを監視し（Monitoring）、報告し（Reporting）、これを認証する（Verification）新たな枠組み（MRV 制度）が提案されました。
なお、今回は提案内容についての説明のみが行われ、次回会合以降審議されることとなりました。

(6) 経済的手法の検討
IMO においては、EEDI 規制による船舶のエネルギー効率改善を更に促進するため、燃料油課金及び排出権取引等の経済的手法（MBM: Market Based Measure）について検討が進められています。
今回の会合では、時間の制約上、審議を行わないこととなり、次回以降に審議されることとなりました。

4. NOx 3 次規制の導入時期（MARPOL 条約附属書 VI 関連）
MARPOL 条約附属書 VI には、船舶からの段階的な窒素酸化物（NOx）排出削減について規定されています。また、NOx 3 次規制については、2016 年に開始する予定とともに、同規制に対応する NOx 削減技術の開発状況等のレビューを 2013 年までに実施し、規制の開始時期を最終決定することが規定されています。
今回の会合では、「現時点の技術開発状況を考慮すると NOx 3 次規制は予定通り 2016 年に開始するべきである」との意見があったものの、開始時期を少なくとも 5 年延期すべきとする提案が多くの支持を集めました。
そのため、規制の開始時期を 5 年延期して 2021 年とする条約改正案が承認されました。
なお、同決定について、いくつかの国々*から留保の意が表明されると共に、米国から、北米及びカリブ海の NOx 放出規制海域（NOx-ECA）において現行の条約の規定通り 2016 年からの NOx 3 次規制開始を可能とするための改正提案を次回 MEPC66 に提出する用意があるとの発言がありました。
* 留保の意を表明した国：カナダ、デンマーク、フィンランド、フランス、ドイツ、イタリア、日本、ノルウェー、英国及び米国
今回承認された改正案については、MEPC66 において採択に向けた最終的な審議が行われる予定です。

（次頁に続く）

5. MARPOL 条約附属書 V（船舶からの廃物による汚染防止）の実施に関するガイドライン
   MARPOL 条約附属書 V（船舶からの廃物による汚染防止）の改正が 2013 年 1 月 1 日に発効し、同日以降船舶で発生した廃棄物の海洋への投棄は原則禁止されています。
   今回の会合では、条約及び関連ガイドラインにおいて明確になっていない、ボイラ及び排ガスエコノマイザの洗浄水の取り扱い等について審議が行われました。
   ボイラ及び排ガスエコノマイザの洗浄水に関する審議においては、同洗浄水が条約上海洋投棄が禁止されている"運航上の廃物"に該当するのか否かについて見解が分かれたため、次回会合で引き続き検討されることとなりました。
   また、海洋環境に有害な貨物残渣・貨物艙洗浄水の取り扱いについても審議が行われ、陸上の受け入れ施設が不足していることを考慮し、2015 年末までは、揚げ荷港及び次の港に陸上受け入れ施設がない場合には、貨物残渣の最小化を行う等の一定の条件を満たせば海洋への投棄を認める内容のサーキュラーを発行することが合意されました。(添付 5_MEPC.1/Circ.810 参照)

6. 強制要件の採択
   国際油汚染防止（IOPP）証書の追補に関する様式の改訂
   補足：現行の IOPP 証書の追補の記載内容から、廃油焼却炉の能力に関する記載を削除する内容であり、2014 年 10 月 1 日に発効予定です。

なお、本 MEPC65 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)

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. バラスト水処理装置の承認状況
2. PSC(寄港国検査)におけるバラスト水サンプリング手順 (BWM.2/Circ.42)
3. 荒天下での操船を確保するための最低推進出力に関するガイドライン (Resolution MEPC.232(65))
4. 革新的省エネ技術のための EEDI 計算及び認証ガイダンス (MEPC.1/Circ.815)
5. 海洋環境に有害な貨物残渣等の陸上の受け入れ施設に関するサーキュラー (MEPC.1/Circ.810)

バラスト水処理装置の承認状況

メーカー名	製品名	国名	処理方法	活性物質(G9) IMO 承認状況		型式承認(G8)
				基本承認	最終承認	承認国
Alfa-Laval AB	PureBallast	スウェーデン	フィルター＋UV（光触媒）	取得済	取得済	ﾉﾙｳｪｰ
Ocean Saver AS	OceanSaver BWTS Mark I	ノルウェー	フィルター＋キャビテーション＋脱酸素＋電気分解	取得済	取得済	ﾉﾙｳｪｰ
Ocean Saver AS	OceanSaver BWTS Mark I I	ノルウェー	フィルター＋電気分解	取得済	取得済	ﾉﾙｳｪｰ
TECHCROSS INC	Electro-Clean	韓国	電気分解	取得済	取得済	韓国
日立ﾌﾟﾗﾝﾄﾃｸﾉﾛｼﾞｰ	Clear Ballast	日本	凝集磁気分離＋フィルター	取得済	取得済	日本
三井造船	FineBallast OZ	日本	フィルター＋オゾン＋キャビテーション	取得済	取得済	日本
JFE エンジニアリング㈱	JFE Ballast Ace	日本	フィルター＋TG Ballastcleaner（次亜塩素酸ナトリウム）＋ベンチュリ	取得済	取得済	日本
RWO	CleanBallast (Ectosys)	ｽｳｪｰﾃﾞﾝ	フィルター＋電気分解	取得済	取得済	ドイツ
Resource Ballast Technologies (Pty.)Ltd	Resource Ballast Water Treatment System	南アフリカ	キャビテーション＋電気分解＋オゾン＋フィルター	取得済	取得済	南ｱﾌﾘｶ
PANASIA CO., LTD.	GloEn-Patrol	韓国	フィルター＋UV	取得済	取得済	韓国
NK CO., LTD.,	NK-O3 Blue Ballast System	韓国	オゾン	取得済	取得済	韓国
Hamworthy Greenship B.V.	Greenship's Sedinox Ballast Water Management System	オランダ	遠心分離＋電気分解	取得済	取得済	
Ecochlor Inc.	Ecochlor Ballast Water Treatment System	アメリカ	フィルター＋二酸化塩素	取得済	取得済	ドイツ

メーカー名	製品名	国名	処理方法	活性物質(G9) IMO 承認状況		型式承認(G8)
				基本承認	最終承認	承認国
Hyundai Heavy Industries Co. Ltd.	EcoBallast	韓国	フィルター＋UV	取得済	取得済	韓国
GEA Westfalia Separator Group GmbH	Ballast Master ultraV	ドイツ	フィルター ＋UV＋ 超音波	取得済	NA	ドイツ
SIEMENS	SiCURE BWMS	ドイツ	フィルター＋電気分解	取得済	取得済	
SunRui Marine Environment Engineering Company	BalClor BWMS	中国	フィルター＋電気分解	取得済	取得済	中国
DESMI Ocean Guard A/S	DESMI Ocean Guard BWMS	デンマーク	フィルター＋オゾン＋UV	取得済	取得済	デンマーク
21st Century Shipbuilding Co., Ltd.	ARA Ballast	韓国	フィルター＋プラズマ＋UV	取得済	取得済	韓国
Hyundai Heavy Industries Co. Ltd.	HiBallast	韓国	フィルター＋電気分解	取得済	取得済	韓国
Kwang San Co., Ltd.	En-Ballast	韓国	フィルター＋電気分解	取得済		
Qingdao Headway Technology Co., Ltd.	OceanGuard BWMS	中国	フィルター＋電気触媒＋超音波	取得済	取得済	中国
COSCO Shipbuilding Industrial Company	Blue Ocean Shield	中国	フィルター＋UV	取得済	N.A.	中国
Severn Trent DeNora	Severn Trent DeNora BalPure® BWMS	ドイツ	フィルター＋電気分解	取得済	取得済	ドイツ
Hamann AG*	SEDNA system	ドイツ	遠心分離器＋フィルター＋Peraclean Ocean（過酢酸/過酸化水素）	取得済	取得済	ドイツ
Samsung Heavy Industries Co., Ltd.	Purimar ™ System	韓国	フィルター＋電気分解	取得済	取得済	韓国
AQUA Eng. Co., Ltd.	AquaStar™ Ballast Water Management System	韓国	フィルター＋電気分解	取得済	取得済	韓国

メーカー名	製品名	国名	処理方法	活性物質(G9) IMO 承認状況		型式承認(G8)
				基本承認	最終承認	承認国
Kuraray Co., Ltd	MICROFADE™ Ballast Water Management System	日本	フィルター＋Kuraray AS（次亜塩素酸カルシウム）＋Kuraray NS（亜硫酸ナトリウム（中和剤））	取得済	取得済	日本
ERMA FIRST	ERMA FIRST Ballast Water Management System	ギリシャ	フィルター＋遠心分離器＋電気分解	取得済	取得済	ドイツ
Envirotech and Consultancy Pte. Ltd.	BlueSeas Ballast Water Management System	シンガポール	フィルター＋電気分解	取得済		
㈱片山化学工業研究所製	Ballast Water Management System with PERACLEAN® OCEAN (SKY-SYSTEM®)	日本	フィルター＋酢酸/過酸化水素	取得済		
JFE エンジニアリング㈱	JFE Ballast Ace (NEO-CHLOP MARINE)	日本	フィルター＋薬剤（ジクロロイソシアヌル酸ナトリウム 2 水塩）	取得済	取得済	
GEA Westfalia Separator Group GmbH	GEA Westfalia Separator BallastMaster Ballast Water Management System	ドイツ	フィルター＋次亜塩素酸ナトリウム	取得済		
Envirotech and Consultancy Pte. Ltd.	BlueWorld Ballast Water Management System	シンガポール	フィルター＋次亜塩素酸ナトリウム	取得済		
Samsung Heavy Industries Co., Ltd.	Neo-Purimar™ Ballast Water Management System	韓国	フィルター＋次亜塩素酸ナトリウム	取得済	取得済	
Environment Engineering Institute of Dalian Maritime University	DMU ·OH Ballast Water Management System	中国	フィルター＋チオ硫酸ナトリウム	取得済		
Hanla IMS Co., Ltd.	EcoGuardian™ Ballast Water Management System	韓国	フィルター＋電気分解	取得済	**取得済**	
STX Metal Co., Ltd.	Smart Ballast Ballast Water Management System	韓国	電気分解	取得済	取得済	
Korea Top Marine (KT Marine) Co., Ltd.	KTM-BWMS	韓国	Plankill pipe™(円柱ブロック)＋電気分解	取得済		
Wärtsilä Water Systems Ltd	AQUARIUS® EC ballast water management system	オランダ	フィルター＋電解滅菌	取得済	**取得済**	
HWASEUNG R&A Co. Ltd.	HS-BALLAST	韓国	電気分解	取得済		

メーカー名	製品名	国名	処理方法	活性物質(G9) IMO 承認状況		型式承認(G8)
				基本承認	最終承認	承認国
PANASIA Co., Ltd	GloEn-Saver™	韓国	フィルター＋電解滅菌	取得済		
Jiujiang Precision Measuring Technology Research Institute	OceanDoctor	中国	フィルター＋光触媒	取得済	**取得済**	
住友電気工業㈱	SEI-Ballast Water Management System	日本	フィルター＋UV	**		
Van Oord B.V.	Van Oord Ballast Water Management System	オランダ	次亜塩素酸ナトリウム(飲料水のみ)	**取得済**	**NA**	
Redox Maritime Technologies AS	REDOX AS Ballast Water Management System	ノルウェー	フィルター ＋ オゾン ＋UV	**取得済**		
SUNBO INDUSTRIES Co. Ltd., DSEC Co. Ltd. and the Korea Institute of Machinery & Material	Blue Zone™ Ballast Water Management System	韓国	オゾン	**取得済**		

（**表中の下線**は、今回承認・審議又は報告されたことを意味する。）

* Hamann AG 社のバラスト水処理装置 SEDNA system については、メーカー撤退のため実質入手不可能。

** MEPC63 にて活性物質が使用されない装置であると判断され，基本承認及び最終承認ともに不要となった。

（参考）活性物質が使用されない旗国の G8 ガイドラインに従った型式承認を取得したバラスト水処理装置

メーカー名	製品名	国名	処理方法	活性物質(G9) IMO 承認状況		型式承認(G8)
				基本承認	最終承認	承認国
OptiMarin AS	OptiMar Ballast Systems	ノルウェー	フィルター ＋UV	/	/	ﾉﾙｳｪｰ
NEI Treatment System	Venturi Oxygen Stripping	アメリカ	脱酸素 ＋ キャビテーション	/	/	ﾘﾍﾞﾘｱ
Hyde Marine Inc.	Hyde GURDIAN™	アメリカ	フィルター ＋UV	/	/	UK
Wuxi Brightskr Electronic Co., Ltd.,	BSKY™ BWMS	中国	フィルター ＋UV	/	/	中国
MAHLE Industrial Filtration	Ocean Protection System	ドイツ	フィルター ＋UV	/	/	ドイツ
Shanghai Cyeco Environmental Technology Co., Ltd.	Cyeco™ Ballast Water Management System	中国	フィルター ＋UV	/	/	中国
Knutsen Ballatvann AS	KBAL Ballast Water Management System	ノルウェー	UV	/	/	**ノルウェー**

メーカー名	製品名	国名	処理方法	活性物質(G9) IMO 承認状況		型式承認 (G8)
				基本承認	最終承認	承認国
AURAMARINE LTD.	CrystalBallast® Ballast Water Management System	ノルウェー	フィルター ＋UV			**ノルウェー**
Wärtsilä Water Systems Ltd	Wärtsilä AQUARIUS® UV ballast water management system	オランダ	フィルター＋UV			**オランダ**

（**表中の下線**は、今回報告されたことを意味する。）

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BWM.2/Circ.42
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INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER AND SEDIMENTS, 2004

Guidance on ballast water sampling and analysis for trial use in accordance with the BWM Convention and Guidelines (G2)

1 The Marine Environment Protection Committee, at its fifty-eighth session (October 2008), following the adoption of the *Guidelines for ballast water sampling (G2)* (MEPC.173(58)), instructed the Sub-Committee on Bulk Liquids and Gases (BLG) to develop, as a matter of high priority, a circular to provide sampling and analysis guidance.

2 MEPC 65 (13 to 17 May 2013) approved the *Guidance on ballast water sampling and analysis for trial use* in accordance with the BWM Convention and Guidelines (G2), as agreed by BLG 17 (4 to 8 February 2013), set out in the annex.

3 Member Governments are invited to bring this circular to the attention of all parties concerned.

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ANNEX 1

GUIDANCE ON BALLAST WATER SAMPLING AND ANALYSIS FOR TRIAL USE IN ACCORDANCE WITH THE BWM CONVENTION AND GUIDELINES (G2)

1 INTRODUCTION

The purpose of this guidance is to provide general recommendations on methodologies and approaches to sampling and analysis to test for compliance with the standards described in regulations D-1 and D-2 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention). This document is an updated version of the guidance contained in document BLG 16/WP.4, taking into account advances in research since the document was first drafted. This document should be read in conjunction with the BWM Convention, the port State control guidelines, the *Guidelines for ballast water sampling (G2)*, and the *Guidance for the assessment of compliance with the discharge standards of the BWM Convention*. Furthermore, and as instructed by MEPC 64, the sampling and analysis procedures to be used for enforcement of the BWM Convention should result in no more stringent requirements than what is required for Type Approval of ballast water management systems (BWMS).

1.2 This document is made up of two parts:

.1 a discussion of the principles of sampling, accompanied by a list of recommended methods and approaches for analysis and sampling protocols available for compliance testing to the D-1 and D-2 standards in section 5; and

.2 background information on sampling and analysis methodologies and approaches. This can be found in the annex.

1.3 Sampling and analysis for compliance testing is a complex issue. According to the *Guidelines for ballast water sampling (G2)*, testing for compliance can be performed in two steps. As a first step, prior to a detailed analysis for compliance, an indicative analysis of ballast water discharge may be undertaken to establish whether a ship is potentially in compliance with the Convention.

1.4 When testing for compliance, the sampling protocol used should result in a representative sample of the whole discharge of the ballast water from any single tank or any combination of tanks being discharged.

2 DEFINITIONS

2.1 For the purpose of this guidance, the definitions in the BWM Convention apply and:

.1 A **sample** means a relatively small quantity intended to show what the larger volume of interest is like.

.2 **Representative sampling** reflects the relative concentrations and composition of the populations (organisms and/or chemicals) in the volume of interest. Samples should be taken in accordance with the annex, part 1 and/or part 2 of the *Guidelines on ballast water sampling (G2)*.

.3 **Analysis** means the process of measuring and determining the concentrations and composition of the populations of interest (organisms and/or chemicals) within the sample.

.4 An **indicative analysis** means a compliance test that is a relatively quick indirect or direct measurement of a representative sample of the ballast water volume of interest:

.1 an indirect, indicative analysis may include measurements whose parameters do not provide a value directly comparable to the D-2 standard, including biological, chemical, or physical parameters (e.g. dissolved oxygen levels, residual chlorine levels, Adenosine triphosphate (ATP), nucleic acid, *chlorophyll a*, and that by variable fluorescence, etc. The practicalities, applicability and limitations of these methods should be understood before they are used in compliance testing;

.2 a direct measurement, which is directly comparable to the D-2 standard (i.e. the determination of the number of viable organisms per volume) may also be indicative if it has:

- a large confidence interval, or
- high-detection limits; and

.3 an indicative analysis is an analysis performed in accordance with sections 4.1 and 4.2.

.5 A **detailed analysis** means a compliance test that is likely to be more complex than indicative analysis and is a direct measurement of a representative sample used to determine the viable organism concentration of a ballast water volume of interest. The result of such measurement:

.1 should provide a direct measurement of viable organism concentration in the ballast water discharge which is directly comparable to the D-2 standard (number of viable organisms per volume);

.2 should be of sufficient quality and quantity to provide a precise measurement of organism concentration (+/- [X] organisms per volume) for the size category(ies) in the D-2 standard being tested for; and

.3 should use a measurement method with an adequate detection limit for the purpose for which it is being applied.

A detailed analysis is an analysis performed in accordance with the methods and approaches in sections 4.3 and 4.4. Detailed analysis should usually be undertaken on a sample taken in accordance with the procedures in section 4.4.

.6 **Testing for compliance** using indicative analysis and detailed analysis can employ a range of general approaches or standard methods. These approaches or methods are divided into those that sample a small proportion of the volume of interest to indicate or confirm compliance or a larger proportion of the volume of interest that can be utilized to indicate and confirm compliance. Those that provide a wide confidence interval should not be used to confirm compliance unless the result and confidence limit are demonstrably over the D-2 standard as measured directly or indirectly. Approaches/Standards are highlighted in sections 4.1, 4.2 and 4.4 for indicative analysis and sections 4.3 and 4.4 for detailed analysis.

.7 **Method** means a detailed step-by-step analysis procedure (for indicative or detailed analysis) or sampling methodology, which the laboratory or organization undertaking the work can follow, be audited against and be accredited to.

.8 **Approach** means a detailed step-by-step analysis procedure (for indicative or detailed analysis) or sampling methodology, which the laboratory or organization undertaking the work can follow. These procedures will not have been validated by an international or national standards organization.

.9 **General approach** means a conceptual description or broad methodology of sample collection or analysis.

.10 **The precision** of a measurement system is the degree to which repeated measurements under unchanged conditions show the same results.

.11 **The detection limit** is the lowest concentration level that can be determined to be statistically different from a blank sample within a stated confidence interval. Limits of detection are method and analysis specific.

.12 **Plankton** means **phytoplankton** (e.g. diatoms or dinoflagellates) **and zooplankton** (e.g. bivalve larvae or copepods) that live in the water column and are incapable of swimming against a current.

.13 **Confidence interval** means a statistical measure of the number of times out of 100 that test results can be expected to be within a specified range. For example, a confidence level of 95 per cent means that the result of an action will probably meet expectations 95 per cent of the time.

.14 **Operational indicator** means a parameter used to monitor and control the operation of the BWMS as defined during testing for Type Approval, e.g. limit values of physical or chemical parameters such as flow rates, dose, etc.

.15 **Performance Indicator** means a biological parameter (e.g. ATP, *chlorophyll a*, direct counts) used to estimate or measure the performance of the BWMS in achieving the D-2 standard.

3 PRINCIPLES FOR SAMPLING AND ANALYSIS FOR BALLAST WATER DISCHARGES

3.1 All samples and analysis carried out to determine whether a ship is in compliance with the BWM Convention should be performed under reliable and verified QA/QC procedures (note that any method, approach or sampling procedure should be rigorously validated and practicability should be assessed).

3.2 The first premise of any sampling and/or any analysis protocol is to identify the purpose of the protocol, i.e. to prove whether the discharge of a ship is meeting the D-1 standard or meeting the D-2 standard. There are many ways in which this can be done; however, they are limited by:

.1 the requirements of the methodologies available for sampling the ballast water discharge;

.2 the methods of analysis of samples being collected;

.3 the methods involved in statistically processing the results of these analyses;

.4 the specific operation of the ballast water management system (including when the treatment is applied during the ballast cycle and the type of treatment used); and

.5 the practicalities of sampling a very large volume of water and analysing it for very low concentrations of organisms.

3.3 Successful sampling and analysis is also based on identifying the viable biological population being sampled and its variability. If this population is homogenous, it is much easier to sample than one that is known to be heterogeneous. In the case of ballast water, the sample is drawn from a discharge with a population that can vary significantly. Consequently, the samples collected for indicative or detailed analysis should be representative samples.

3.4 Sampling a ballast water discharge is restricted even further when parts of the ballast water may have already been discharged. Very few inferences can be made on the quality of that ballast water already discharged based on sampling the remaining discharge as it happens. So the challenge is to determine the volume of interest and how to sample it.

3.5 The qualitative difference between indicative analysis and detailed analysis often relies on the level of statistical confidence, which, in detailed analysis may be superior.

3.6 Indicative analysis (using operational or performance indicators) can be undertaken at any time throughout the discharge. In cases where indicative analysis identifies that a system is grossly exceeding the D-2 standard, it may be sufficient to establish non-compliance, however, the practicalities, application and limitations of the methodology being used for indicative analysis need to be understood fully.

3.7 Based on the discussion in section 3.3, two different potential detailed sampling approaches can therefore be considered:

.1 sampling the entire discharge from a vessel during a port visit. During this approach:

  .1 it will be impossible, by definition, for vessels to discharge prior to sampling;

  .2 large numbers of samples are likely to be required over a long period of time;

  .3 large sample volumes may be required over a long period of time; and

  .4 sampling personnel would be required on the vessel over a significant period of time;

.2 collecting a representative sample of the ballast water being discharged during some chosen period of time, e.g. one sample or a sequence of samples. During this approach:

  .1 the sampling can be developed to fit the situation on board the vessel; and

  .2 a representative sample of the discharge can be taken, and that volume can be selected in many ways, providing the opportunity for identifying and sampling specific volumes of the discharge if appropriate, e.g. choosing a percentage of the discharge or sampling duration.

3.8 The D-2 standard expresses a low concentration of organisms to identify in the analysis. The confidence in the result of any sampling and analysis depends on the error inherent in the sampling method and on the error inherent in the method used for analysing the sample. The cumulative error of both must be taken into account when evaluating the result.

3.9 The tables in sections 4.1, 4.2 and 4.3 set out the range of methodologies and approaches, currently identified for use to analyse ballast water discharges and how they relate to the specific sampling protocols in section 4.4. These methodologies and approaches are stand-alone techniques that need to be combined with specific sampling protocols. These protocols should recognize the limitations of each methodology, its inherent sampling requirements, and how it can fit into a comprehensive sampling protocol for compliance testing.

3.10 Although some methodologies and approaches used in type approval testing may also be applicable in compliance testing, the latter, especially indicative sampling, may also require other approaches.

Table 1

DEFINITION AND DIFFERENCES BETWEEN INDICATIVE AND DETAILED ANALYSIS FOR THE D-2 STANDARD

	Indicative analysis	**Detailed analysis**
Purpose	To provide a quick, rough estimate of the number of viable organisms	To provide a robust, direct measurement of the number of viable organisms
Sampling		
Volume	Small or large depending on specific analysis	Small or large depending on specific analysis
Representative sampling	Yes, representative of volume of interest	Yes, representative of volume of interest
Analysis method		
Analysis parameters	Operational (chemical, physical) and/or performance indicators (biological)	Direct counts (biological)
Time-consuming	Lower	Higher
Required skill	Lower	Higher
Accuracy of numeric organism counts	Poorer	Better
Confidence with respect to D-2	Lower	Higher

4 METHODOLOGIES FOR COMPLIANCE TESTING UNDER THE BWM CONVENTION

4.1 Table 2: Analysis methods that may provide an indication of compliance with the D-1 standard[1]

Indicator	General approach	Standard method	Notes	Level of confidence or detection limit and citation for validation studies
Salinity	Conductivity meter to monitor salinity.	No international standard for ballast water analysis at this time although standard methods for measuring salinity do exist.	External elements can affect the salinity.	To be determined.
Salinity	Refractometer to monitor salinity.	No international standard for ballast water analysis at this time although standard methods for measuring salinity do exist.	Temperature can affect the readings.	To be determined.
Types of organisms in discharge – oceanic, coastal, estuarine or fresh water	Visual identification.	No international standard for ballast water analysis at this time.	Expensive, time-consuming, needs extensively trained personnel; may produce false results if encysted organisms from previous ballasting operations hatch.	To be determined.
Turbidity	Portable turbidity sensors.	No international standard for ballast water analysis at this time.	Requires understanding of turbidity characteristics in relation to the distance from shore.	To be determined.
Dissolved Inorganic and Organic constituents (Nutrients, metals coloured dissolved organic matter (CDOM))	Portable nutrient sensors.	No international standard for ballast water analysis at this time.	Requires understanding of inorganic or organic constituent characteristics in relation to the distance from shore.	To be determined.

[1] Additional information can be found in document BLG 16/4.

4.2 Table 3: Indicative analysis methods for use when testing for potential compliance with the D-2 standard[2]

Indicator	General approach	Standard method	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 µm	Visual counts or stereo-microscopy.	No international standard for ballast water analysis at this time.	Can be expensive and time-consuming, needs moderately trained personnel. (Note that OECD Test Guideline for Testing of Chemicals 202, "*Daphnia* sp. acute immobilization test and reproduction test" could be used as basis for standard methodology.)	To be determined.
Viable organisms ≥ 50 µm	Visual inspection.	No international standard for ballast water analysis at this time.	Visual inspection is likely to only register organisms bigger than 1,000 micro-metres in minimum dimension.	To be determined.
Viable organisms ≥ 10 µm and < 50 µm	Variable fluorometry.	No international standard for ballast water analysis at this time.	Only monitors photosynthetic phytoplankton and thus may significantly underestimate other planktonic organisms in this size fraction.	To be determined.
Viable organisms ≥ 50 µm and ≥ 10 µm and < 50 µm	Photometry, nucleic acid, ATP, bulk fluorescein diacetate (FDA), *chlorophyll a.*	No international standard for ballast water analysis at this time.	Semi-quantitative results can be obtained. However, some of these organic compounds can survive for various lengths of time in aqueous solution outside the cell, potentially leading to false positives. Welschmeyer and Maurer (2012).	To be determined.

2 Additional reference can be found in document BLG 15/5/4.

Indicator	General approach	Standard method	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 μm and ≥ 10 μm and < 50 μm	Flow cytometry.	No international standard for ballast water analysis at this time.	Very expensive.	To be determined.
Enterococci	Fluorometric diagnostic kit.	No international standard for ballast water analysis at this time.	Minimum incubation time 6 h. Semi-quantitative results from portable methods (see paragraph 2.2.2 of annex 1).	To be determined.
Escherichia coli	Fluorometric diagnostic kit.	No international standard for ballast water analysis at this time.	Minimum incubation time 6 h. Semi-quantitative results from portable methods (see paragraph 2.2.2 of annex 1).	To be determined.
Vibrio cholerae (O1 and O139)	Test kits.	No international standard for ballast water analysis at this time.	Relatively rapid indicative test methods are available.	To be determined.

4.3 Table 4: Detailed Analysis Methods for use when testing for compliance with the D-2 standard

Indicator	General approach	Standard method	IMO citation	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 μm and ≥ 10 μm and < 50 μm	Visual counts or stereo-microscopy examination. May be used with vital stains in conjunction with fluorescence + movement.	No international standard for ballast water analysis at this time, but see US EPA ETV Protocol, v. 5.1	BLG 15/5/5 and BLG 15/5/6 BLG 15/INF.6	Can be expensive and time-consuming, needs trained personnel. (Note that OECD Test Guideline for Testing of Chemicals 202, "*Daphnia* sp. acute immobilization test and reproduction test" could be used as basis for standard methodology.)	To be determined.
Viable organisms ≥ 10 μm and < 50 μm	Visual counts with use of vital stains.	No international standard for ballast water analysis at this time, but see US EPA ETV Protocol, v. 5.1	BLG 15/5/10 (method) BLG 15/5/5 and BLG 15/5/6 (approach) MEPC 58 /INF.10	Requires specific knowledge to operate them. It should be noted that there may be limitations using vital stains with certain technologies.	To be determined. Steinberg et al., 2011
Viable organisms ≥ 10 μm and < 50 μm	Flow cytometers (based on *chlorophyll a* and vital stains).	No international standard for ballast water analysis at this time.	BLG 15/5/5 and BLG 15/5/6	Expensive and require specific knowledge to operate them. It should be noted that there may be limitation using vital stains with certain technologies.	To be determined.

Indicator	General approach	Standard method	IMO citation	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 μm and Viable organisms ≥ 10 μm and < 50 μm	Flow cameras (based on *chlorophyll a* and vital stains).	No international standard for ballast water analysis at this time.	BLG 15/5/5 and BLG 15/5/6	Expensive and require specific knowledge to operate them. It should be noted that there may be limitations using vital stains with certain ballast water management systems.	To be determined.
Viable organisms ≥ 50 μm and Viable organisms ≥ 10 μm and < 50 μm	Culture methods for recovery, regrowth and maturation.	No international standard for ballast water analysis at this time.	BLG 15/5/5 and BLG 15/5/6	Require specific knowledge to conduct them. Densities are expressed as Most Probable Numbers (the MPN method). Most species do not manage to grow using this method therefore cannot be used alone. 2-3 weeks incubation time needed.	To be determined.
Enterococci	Culture methods.	ISO 7899-1 or ISO 7899-2	BLG 15/5/5 and BLG 15/5/6	Requires specific knowledge to conduct them. At least 44-h incubation time. EPA Standard Method 9230	To be determined.
Escherichia coli	Culture methods.	ISO 9308-3 or ISO 9308-1	BLG 15/5/5 and BLG 15/5/6	Requires specific knowledge to conduct them. At least 24-h incubation time. EPA Standard Method 9213D	To be determined.

Indicator	General approach	Standard method	IMO citation	Notes	Level of confidence or detection limit and citation for validation studies
Vibrio cholerae (O1 and O139)	Culture and molecular biological or fluorescence methods.	ISO/TS 21872-1/13/	BLG 15/5/5 and BLG 15/5/6	Requires specific knowledge to conduct them. 24-48 h incubation time. US EPA ETV Fykse et al., 2012 (semi-quantitative pass/fail-test) Samples should only be cultured in a specialized laboratory.	To be determined.
Enterococci, *Escherichia coli, Vibrio cholerae (O1 and O139)*	Culture with fluorescense-in-situ hybridization (FISH)	No international standard for ballast water analysis at this time.		Requires specific knowledge to conduct them. Quantitative and qualitative results after 8 h. Samples should only be cultured in a specialized laboratory.	To be determined.
Viable organisms ≥ 50 µm and viable organisms ≥ 10 µm and < 50 µm	Visual counts using stereo-microscopy examination and flow cytometry.	No international Standard for ballast water analysis at this time.	BLG 17/INF.15	A Sampling Protocol that identifies whether a system is broken or not working and producing a discharge that is significantly above the D-2 standard. Designed to detect gross non-compliance with 99.9% confidence. Needs to be Validated.	To be determined.

4.4 Table 5: General approaches for sampling use when testing for compliance with the BWM Convention

General approaches for sampling	Discharge line or BW tank	Citation for validation study or use	Sample error and detection limit	Relative sample error amongst approaches
Filter skid + isokinetic sampling	Discharge line	Drake et al., 201First et al., 2012 (land-based testing); shipboard validation underway, Prototype 01, SGS	To be determined	Lower
Cylinder containing plankton net + isokinetic sampling	Discharge line	MEPC 57/INF.17	To be determined	Lower
Sampling tub containing plankton net + isokinetic sampling	Discharge line	Gollasch, 2006 and Gollasch et al., 2007 Cangelosi et al., 2011	To be determined	Lower
Continuous drip sampler + isokinetic sampling	Discharge line	Gollasch and David, 2010, 2013	To be determined	Lower
Grab sample	BW tank	David and Perkovic, 2004; David et al. 2007, BLG14/INF.6	To be determined	Higher

4.5 Table 6: Sampling and analysis methods/approaches for use when testing compliance with the BWM Convention. A checkmark indicates an appropriate combination of sampling and analysis.

Analysis type **size class or indicator microbe** **analysis method/approach**	**Filter skid** **+** **isokinetic sampling**[3]	**Plankton net** **+** **isokinetic sampling**	**Continuous drip sampler** **+** **isokinetic sampling**	**Grab sample**
Indicative Analysis ≥ 50 µm Visual inspection Stereomicroscopy counts Flow cytometry Nucleic acid ATP *Chlorophyll a,* Bulk *FDA*	✓	✓		
Indicative Analysis < 50 µm and ≥ 10 µm variable fluorometry Flow cytometry Nucleic acid ATP *Chlorophyll a,* bulkBulk *FDA*			✓	✓

[3] Methods other than using an isokinetic approach as defined in Guidelines (G2) for acquiring a representative sample may be used in certain circumstances. Such methods should be validated prior to use.

Analysis type size class or indicator microbe analysis method/approach	**Filter skid + isokinetic sampling[3]**	**Plankton net + isokinetic sampling**	**Continuous drip sampler + isokinetic sampling**	**Grab sample**
Indicative Analysis Enterococci, *E. coli* Fluorometric diagnostics			✓	✓
Indicative Analysis *Vibrio cholerae* Test kits Culture methods + microscopy			✓	✓
Detailed Analysis ≥ 50 µm Stereomicroscopy counts Flow cytometry/Flow camera	✓	✓		
Detailed Analysis < 50 µm and ≥ 10 µm Visual counts + vital stain(s) Flow cytometry/Flow camera Culture methods			✓	
Detailed Analysis Enterococci, *E. coli* Culture methods FISH with pre-cultivation			✓	
Detailed Analysis *Vibrio cholerae* Culture methods FISH with pre-cultivation			✓	

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ANNEX 2

TECHNICAL DISCUSSION FOR THE GUIDANCE TO BALLAST WATER SAMPLING AND ANALYSIS IN ACCORDANCE WITH THE BWM CONVENTION AND GUIDELINES (G2)

1 INTRODUCTION

1.1 The purpose of this annex is to provide background information on:

- the development and use of methodologies for both indicative and detailed analysis and appropriate sampling; and

- analysis of the sample at an accredited laboratory.

1.2 This annex highlights the advantages, disadvantages and limitations of many different measures. Although recommendations are given in this document on what methodologies may be used, there are distinct benefits in using certain technologies at certain times. This should not stop the use of any of the methodologies, as long as the limitations are taken into account.

1.3 Any methods for analysis used for assessing compliance with the BWM Convention should be carefully validated under a range of operating conditions.

2 INDICATIVE ANALYSIS: METHODOLOGY AND APPROACHES

2.1 The D-1 standard

2.1.1 The D-1 standard requires the vessel to exchange its ballast water 200 nm from the coastline in waters 200 m deep, or if this cannot be achieved for safety reasons, 50 nm from the coastline in waters of the same depth. Therefore, the water in exchanged ballast water should have a similar salinity to that of mid-ocean water.

2.1.2 Indicative analysis for the D-1 standard of the BWM Convention could rely on the chemical parameters (e.g. salinity) of the water in the ballast water discharge, or on an estimate of species present. However the latter might need trained personnel, If the ballast water discharge being tested has a salinity significantly less than that of 30 PSU, then it is likely that the ballast water has not been exchanged en route under the conditions required in the D-1 standard, or that the exchange has not been completed successfully.

2.1.3 Two exceptions to this are:

- when ballast water is taken up in port areas that are located in high-salinity environments, above 30 PSU. In such a case ballast water with a PSU of 30 may not originate from mid-ocean waters and therefore the ship may not be compliant with the D-1 standard; or

- when ballast water has been exchanged in designated ballast water exchange areas within 50 nm from the coastline in waters that may be of less salinity than the mid-ocean water. In this case the ballast water exchange would be compliant.

Therefore, the origin of the last ballast water exchange should be known before interpreting the results of salinity analysis.

2.1.4 Checking salinity could be backed up by further analysis of the organisms in the ballast water discharge to determine the origin of the ballast water; however, this would take time and need experienced staff. This can be done in line with the visual analysis methodologies outlined in paragraph 2.4.3 below. However, it should be noted that there are many external factors that could affect the salinity and the organisms in the ballast water, such as wet sediments in the ballast tanks, the state of the tide in the port concerned during its uptake and the fact that exchange may not remove all coastal organisms.

2.1.5 There are many ways to quickly and easily monitor the salinity of water on the market, and generic salinity measures should be used for indicative analysis.

2.2 Bacteria levels in the D-2 standard

2.2.1 Bacterial levels could be tested by a wealth of available portable methods. However, as the D-2 standard for bacteria is measured in colony forming units (CFU), the systems utilized may have to include a specific incubation time of the samples, which for commercially available systems is never shorter than four hours. Therefore, the time it takes for incubation limits the use of such systems for indicative analysis.

2.2.2 Advances in fluorometric diagnostics have resulted in a methodology that identifies the presence or absence of bacteria in a sample of the ballast water discharge. This methodology is based upon the detection of enzymes produced by the target bacteria in unconcentrated fresh water or marine samples and presently easily portable test kits for E. coli and Enterococci are available. This method can identify low levels of bacteria in water samples in less than 10 minutes, but the results are only semi-quantitative, i.e. a low level reading equates to a low level of bacteria. However, although the presence of bacteria can be shown, whether or not these organisms are living (i.e. form colonies) cannot be proven with this method at the present time. These diagnostic methods could be used in indicative analysis if very large numbers of organisms are identified.

2.3 Organisms of less than 50 micrometres and greater than or equal to 10 micrometres in minimum dimension[1] in the D-2 standard

2.3.1 Methods to measure the organisms in this category of the D-2 standard can be divided into two categories as follows:

.1 the use of biological indicators for organisms:

.1 nucleic acid;

.2 adenosine triphosphate (ATP), a coenzyme used as the main energy storage and transfer molecule in the cells of all known organisms; and

.3 indicators for the presence of organisms, such as *chlorophyll a*;

.2 the use of direct counts of living organisms (coupling a means to determine viability and manual or automatic counting of individual organisms).

1 The "Minimum Dimension" means the minimum dimension of an organism based upon the dimensions of that organism's body, ignoring e.g. the size of spines, flagellae, or antenna. The minimum dimension should therefore be the smallest part of the "body", i.e. the smallest dimension between main body surfaces of an individual when looked at from all perspectives. For spherical shaped organisms, the minimum dimension should be the spherical diameter. For colony forming species, the individual should be measured as it is the smallest unit able to reproduce that needs to be tested in viability tests. This should be considered whenever size is discussed in this document.

2.3.2 The presence of nucleic acid or ATP in a sample may be taken as an indication of life, but it should be noted that this nucleic acid or ATP could come from any living organism of any size within the sample. There are no definitive methods available to correlate the amount of nucleic acid or ATP with the amount, or viability of organisms in the sample and, therefore, the presence of these chemicals are limited as an indicative analysis methodology. However, zero measurements of these chemicals may indicate that no organisms are in the sample, i.e. the treatment process was successful and in the D-2 standard is being met. Additionally, if nested filters are used to isolate specific size groups, then ATP, which degrades relatively quickly, can provide an indication of the potential presence of a large concentration of organisms in one size class. If linked to thresholds of ATP concentrations, this can be used to indicate samples which are highly likely to be above the standard.

2.3.3 The same problems occur when using other bio-chemical indicators to monitor the number of organisms in this category. As many of the organisms in this size range are likely to be phytoplankton, an obvious step would be to measure the level of *chlorophyll a*, a photosynthetic pigment which is essential for photosynthesis in the sample. Zero concentrations may indicate that there is no phytoplankton in the sample and chlorophyll *a* may also be a good indicator as to whether a BWMS using an oxidizing process was working to design dosages, as it might be expected to bleach such pigments. However, caution has to be exercised as:

.1 *chlorophyll a* can persist in seawater outside of a cell, therefore sampling should only be limited to the particulate phase. However, nucleic acid and ATP can exist in dead organisms, detrital material, senescent or dead cells, decomposing macroalgae, plant detritus from terrestrial ecosystems and other non-living particles, etc.;

.2 there may be zooplankton in the sample being analysed;

.3 no cell count can be directly measured from a *chlorophyll a* measurement, as many small cells may provide a similar signal strength to that of fewer bigger cells; and

.4 no size distinction can be made and the *chlorophyll a* could derive from phytoplankton in the larger size category of the D-2 standard.

As a consequence, direct concentration measurements of this chemical would be difficult to use in indicative analysis. A wealth of portable tools exists to document the *chlorophyll* a content in seawater.

2.3.4 One potential exception is the Pulse-Amplitude Modulated Fluorometer (PAM) which measures the *chlorophyll a* fluorescence in living cells by exciting *chlorophyll a* molecules and registering the subsequent fluorescent signal. Such a response is only available in living cells and it should be noted that this method only provides an indirect measurement of those phytoplankton that use *chlorophyll a* in the sample, in both size categories of the D-2 standard. Testing this methodology on ballast water discharges suggests that there is a correlation between the ratio of variable and maximum fluorescence and the number of phytoplankton in this size category. However, the relationship between fluorescence signals and mixed assemblages of phytoplankton from different locations needs to be validated.

2.3.5 For analysis of organisms above 10 microns in minimum dimension, a flow cytometer may also be used. A common element of these systems is that they automatically count objects, including organisms, per size class in a fluid. The more simplified systems cannot separate organisms from sediment and detritus, or living from dead organisms. More sophisticated systems can also assess organism viability for phytoplankton by using organism stains together with flow cytometry. The separation of living phytoplankton from detrital material and zooplankton is based on the presence of auto chlorophyll fluorescence of phytoplankton cells. It should be noted, however, that using *chlorophyll a* fluorescence as an indicator of living organisms may result in over counting, as the molecule can remain intact for a significant amount of time as has been proved in preparing fixed (dead) samples. The practicability to use such devices on board a ship should be carefully assessed before use. To make a stable stream to produce adequate size of water particles, the device should be set in perfectly horizontal. Also any vibration should be isolated for accurate measurement.

2.3.6 Systems using flow cytometry deliver automated results promptly and may be used to assess the number of living phytoplankton in a sample after treatment with a viability stain. However, readings provided by the flow cytometer should also be examined manually to verify the automated readings. Concerns have been raised by users that the viability of smaller algae may not always be categorized correctly in these systems, as the viability signal may be too low for detection. Other concerns include the efficiency of portable versions and the limited ability of some of them to monitor organisms greater than or equal to 50 micrometres in minimum dimension. Although these systems may become a major tool in the future, there are elements, such as the reliability of portable versions of the systems that limit their use at the present time, which is especially the case for organisms greater than or equal to 50 micrometres in minimum dimension. Also, it is not clear if the time to analyse a sample is greater than can be allotted in compliance testing. These can be overcome by taking the sample off the ship and using a fixed or mobile system near to the ship or the port.

2.3.7 Visual inspection could be another method of indicative analysis that is a quick and simple way to justify the need for detailed analysis. Taking an appropriate sample, concentrating it if necessary, and visually inspecting it against the light may show living organisms in the sample, but it should be noted that without magnification a visual inspection is likely to result in only organisms greater than or equal to 1,000 micrometres in minimum dimension being detected, unless chains or clumps are formed by colony forming organisms or the density of organisms is sufficiently large to colour the water. An assessment of the viability in such an inspection is limited to complete body movements of the organisms as organ activity and antennae or flagella movements may not be seen. As samples from BWMS that are not compliant are likely to contain organism levels that are orders of magnitude above the D-2 performance standard, visual inspections could be used in indicative analysis. However, it is assumed that only organisms bigger than 1,000 micrometres in minimum dimension may be determined in such way, therefore its use for this size category is limited.

2.3.8 Visual inspection can also be undertaken using a field stereomicroscope with a low magnification (e.g. x 10). However, this methodology may require concentration of the sample and may need analysis by a trained operator to detect viable organisms. It should be also be noted that this methodology would be more efficient and practicable for organisms greater than or equal to 50 micrometres in minimum dimension.

2.4 Organisms greater than or equal to 50 micrometres in minimum dimension in the D-2 standard

2.4.1 Many of the methodologies for monitoring organisms less than 50 micrometres and greater than or equal to 10 micrometres in minimum dimension may also be valid for monitoring organism levels in this category. However, nucleic acid and ATP methodologies encounter the same problems as outlined in paragraphs 2.3.2 and 2.3.3; and monitoring *chlorophyll a* levels, through fluorometers or the PAM methodology described above, has limited value for this size category of the D-2 standard, as the majority of organisms in this category are likely to be zooplankton.

2.4.2 Visual inspections may significantly underestimate the number of organisms in this size category due to the issues described in paragraph 2.3.8. However, the method may be robust enough to determine whether the BWMS is working at orders of magnitude above the D-2 standard based on a simple extrapolation from the sample to the D-2 standard. Detailed analysis may be needed to confirm this, especially when levels near the D-2 standard are encountered.

2.4.3 Additionally, stereomicroscopy can also be used to identify viable organisms greater than or equal to 50 micrometres in minimum dimension. The sample should be concentrated appropriately. Viability assessment should be based on movements of intact organisms. This movement may be stimulated. In addition organ activity should be observed and fully intact non-moving organisms which show organ activity should be counted as living. Stains might also be used to help in viability determination – though methods are still under development. The viable organism numbers should be recorded and the numbers extrapolated up to the total volume of water filtered.

2.4.4 If the results in paragraphs 2.4.2 and 2.4.3 show elevated levels of organisms, then this result will indicate that the D-2 standard is not being met.

2.4.5 Further research must be encouraged; innovative methods for assessing for D-2 compliance, preferably based on in situ, automatic sampling and analytical procedures, should facilitate the most uniform implementation of the BWM Convention.

2.5 Operational indicators

2.5.1 Other indirect parameters and indicators could be used to indicate whether a BWMS is meeting the D-2 standard. These include, but are not limited to, indicators from the electronic self-monitoring of the BWMS and residual chemicals (or lack of) from the BWMS, such as dissolved oxygen levels, residual chlorine, etc.

3 DETAILED ANALYSIS METHODOLOGIES AND APPROACHES

3.1 Once detailed analysis has been instigated by the port State, they should be prepared to undertake full analysis of the sample at an appropriate laboratory.

3.2 Bacteria

3.2.1 There are already international standards in place to analyse for the bacteriological indicators contained within the D-2 standard.

3.2.2 For Enterococci, ISO 7899-1 or 7899-2; or Standard Method 9230 (in the United States) should be used, and ISO 9308-3, ISO 9308-1 or Standard Method 9213D (in the United States) are appropriate for Escherichia coli. The methods used should be quantitative and based on a 95-percentile statistical evaluation. The number of laboratory samples should be sufficient to define the mean and standard deviation of Log 10 bacterial enumerations.

3.2.3 For *Vibrio cholerae* ISO/TS 21872-1/13 is appropriate. 100 ml of ballast water should be filtered and incubated according to ISO/TS 21872-1. Analysis needs to be undertaken in a specialist laboratory.

3.3 Organisms of less than 50 micrometres and greater than or equal to 10 micrometres in minimum dimension

3.3.1 Many of the analysis methods used to ascertain the numbers of organisms within this category have already been discussed in section 2. However, section 2 focuses on indicative analysis, rather than the more detailed analysis. Therefore, the following sections examine these methodologies in more detail. Some of these methodologies discussed here also relate to organisms greater than or equal to 50 micrometres in minimum dimension.

3.3.2 Simple upright and inverted microscopes are very useful for the enumeration of morphologically healthy organisms and motile organisms, as well as for measuring the size of organisms. Using this technology needs some skill and experience to evaluate the health of the individual organisms in the sample. However, this technology and experience should be available globally.

3.3.3 Fluorescence generated from photosynthetic pigments can be used for more detailed analysis of the morphological health of organisms and for the evaluation of stained organisms and a microscope with fluorescence capabilities is needed. However, this methodology only identifies phytoplankton (both living and dead) in the sample and makes no size differentiation. Zooplankton should be analysed through the methods highlighted in section 3.4.

3.3.4 Fluorescein di-acetate (FDA), chloromethylfluorescein diacetate (CMFDA) and Calcein-AM vital stains have both been used to determine viability. When non-specific esterases (enzymes found in live cells) are present, they cleave the acetate groups from the stains, and the resultant fluorescein molecules fluoresce green when illuminated with a blue light from an epi-fluorescence microscope. This method works best with live samples. Microscopes with a fluorescence capability and operators with skills and experience of analysis should be available at universities and research laboratories worldwide. However, it should be noted that these stains do not always work on all species or at all salinities and further research to validate this approach may be needed to support the use of these stains for this type of analysis.

3.3.5 Flow cytometers are advanced technologies which can be used in a laboratory to determine size, and viability of organisms in ballast water when a reliable vital stain(s) is (are) used to indicate organism viability. Cytometer detected particles, including organisms, can be processed visually or by a computer to quantify viable organisms in that sample. These systems reduce manual labour, but require specific knowledge to operate them. High particle loads in ballast water may reduce the detection limits of these methodologies and the volume of samples analysed. At the present, portable versions of these technologies have not fully been proven for use on ballast water discharges, however, samples could be taken off the ship and analysed using a fixed or mobile system near to the ship or the port.

3.3.6 Regrowth experiments, in which the visual appearance of photosynthetic organisms in a sample is followed by a specific period in order to quantify the Most Probable Number (MPN), are methods to evaluate the number of organisms in a sample. However, these are slow and are work intensive. In addition, a major drawback of this methodology may be that specific growth factors during the incubation may not be fulfilled, giving a risk of bias. Regrowth and reproduction may be seasonably variable, giving different results at different times. Further, a viable organism may be in good health and reproducing rapidly, or in poor health, not reproducing until health has improved. Finally, this is likely to be time-consuming.

3.3.7 Bulk parameter measurements, such as photosynthetic activity, are also not suitable for detailed analysis (please see paragraphs 2.3.2 and 2.3.3), but can be used as supporting data for other methods used to determine the number of viable organisms in the ballast water samples.

3.3.8 Planktonic organisms may be fragile and samples may need to be concentrated further to aid the accurate quantification of organisms. There are many methods to achieve this, however, care has to be taken to reduce physical stress as this may result in reduced viability levels. A simple, rapid, flexible and cautious method for concentrating plankton cells is the use of transparent membrane filters. If the sample analysis is performed on board the sample can be filtered directly on to this membrane, which can subsequently be placed directly under a microscope for examination. The sample volume to be analysed would need to be adjusted depending on the cell density, however, live, vital stained and fixed organisms within this size category can be evaluated on these filters. If the representative analysis is performed at a laboratory, this process for concentration should be performed at the laboratory just before starting the staining process to avoid under-estimate of viable organisms. Importantly, the loss (if any) of organisms (i.e. those cells passing through the filter and recovered in the filtrate) would need to be determined. Alternatively a filter mesh may be used to concentrate the sample and the concentrated organisms may, after filtration, be transferred into an observation chamber. Again, the loss of organisms through damage must be quantified.

3.4 Organisms greater than or equal to 50 micrometres in minimum dimension in the D-2 standard

3.4.1 Paragraphs 3.3.2 to 3.3.8 are also applicable to the analysis of organisms in this size category.

3.4.2 In addition, the following issues need to be considered when developing a methodology for analysing organism numbers in this size category:

.1 testing the sample for movement and response to different stimuli are simple techniques for the examination of viable/dead zooplankton under a stereomicroscope. The observation for organ activity, such as heartbeats, may also contribute to the viability assessment. The use of a filtering mesh (e.g. 50 microns in diagonal dimension) under the Petri dish of the stereomicroscope, or the addition of 50 micron micro beads to the sample, may help with size calculations and vital stains may also add value to these methodologies. Separate guidelines on this issue are being developed through the land-based facilities and the ETV protocol in the United States;

.2 methods using a combination of flow cytometry and microscopy have the disadvantage of high complexity, high price and small sample sizes, which means the ballast water samples would have to be concentrated further; and

.3 the storage condition and time before analysis is likely to be critical to reduce mortality in the sample.

3.4.3 It is therefore recommended that simple microscopic examination of organisms in this size category is used for compliance monitoring. The microscopic examination of organisms is a robust, simple and cheap methodology which can be completed in laboratories worldwide.

4 Sources of error

4.1 The ideal method for compliance monitoring is a procedure that:

- detects organisms in the ballast water discharge;
- has an appropriate limit of detection;
- is precise;
- is accurate;
- is economical;
- is quick;
- can be carried out with minimal technical expertise; and
- can be obtained in all parts of the world.

However, any result obtained would have to include confidence limits based on both the sampling error and analytical error.

4.2 Sources of error include, but are not limited to, errors arising within:

.1 sampling, including:

- sample loss (e.g. during filtration);
- incorrect use of equipment;
- day-to-day variations in the conditions in which the sampling is taking place; and
- the experience of the technicians;

.2 processing the sample, including:

- incorrect use of equipment;
- day-to-day variations in the conditions in which the sampling is taking place; and
- the experience [and fatigue] of the technicians;

.3 analysis of the sample:

- incorrect use of equipment;
- the experience [and fatigue] of the technicians;
- day-to-day variations in the conditions in which the sampling is taking place;
- the number of organisms counted. The distribution of organisms in a range of samples usually follows the Poisson distribution and higher numbers of samples give a lower relative variation and sample error;
- the inherent variation and errors arising from the methods used for analysis. This is especially so when the evaluation of organism numbers in a sample is based on manual counting methods due to human error. For example, although the definition of the minimum dimension of an organism in Guidelines (G2) is quite detailed, analytical results may be influenced by practical issues. These include situations when the size of an organism is determined on a two dimensional microscope, which cannot view the organism "from all perspectives"; and
- poor harmonization between laboratories and quality control within the laboratory. In the field of chemical analysis, inter-laboratory calibration occurs and is tested. Inter-laboratory calibration of biological samples is also common practice, but the difficulty in the compliance monitoring context is that the viability of the organisms needs to be documented and the viability may be impaired by the mode and duration of sample shipments to different laboratories. Therefore, laboratories should be well managed, and uncertainty limits (the analysis variation) should be calculated for each laboratory. This should be achieved in conjunction with ISO 17025, which provides a standard for the general requirements needed by laboratories to prove they are competent to carry out tests and/or calibrations, including sampling.

4.3 The variation arising from sampling should be added to that from analysis to determine the confidence limits within which the true value of the organism number lies. This has an important bearing on how the result can be used for enforcement of the BWM Convention.

4.4 The sampling uncertainty can be obtained by setting up a null–hypothesis, that is a general or default position that is expected in the results, e.g. the average concentration of organisms is equal to the D-2 standard at a selected level of significance and then the data would be analysed using one of the following tests:

Table 1: Statistical handling of the results

Distribution of the results	Test	Notes
Normal distribution	t-test	It is unlikely this test will be used, as it is not used with "rare" populations, i.e. the expected population of organisms in treated ballast water
A distribution that is not normal	Non-parametric Wilcoxon rank test	Not normal due to the small number of samples
Poisson distribution	Chi-square test	Used when the analytical results are treated as one sample (i.e. the numbers of organisms over the entire volume are very rare [low] and combined).

Ideally, an analysis of the distribution should be performed before the data are statistically evaluated.

4.5 There has been much discussion within the IMO on whether the results of the analysis should be averaged to assess compliance or that every result should have to meet the D-2 standard. This is a unique debate at IMO due to the biological nature of the subject matter being analysed, and different States have significantly different views on this issue. Therefore, it will be very difficult to arrive at a conclusion as in the case of non-compliance the results of the analysis are likely to be used in the legal jurisdictions of each IMO Member State, and each of those States may require different evidence to support any enforcement action.

4.6 If the results of detailed analysis are to be averaged, then both the sample variation and the analysis variation need to be calculated and applied to the result. However, some analysis of the sample variation may be needed, as it may be unacceptably high. For example, for five treated ballast water samples, viable organism number results of 9,9,9,9 and 9 will provide the same average as 0,0,0,0 and 45. Both systems would pass the D-2 standard, if averaged; however, the variation is considerably bigger for the second set of results and may prove to be unacceptable because of the one large value.

4.7 If each of the results is treated as an individual value that has to meet the D-2 standard, then again the confidence limits would have to be calculated from the sampling and analytical errors. Here if all results are less than the D-2 standard, then the sampling has proved that the BWMS is meeting the standard.

4.8 The basic difference between instantaneous and average approaches is that the results of the average approach describe the variations of the concentration of organisms during the de-ballasting event, whereas the results of the instantaneous approach describes the variation based on the assumptions of the Poisson distribution. However, the average approach, based on the results of a few samples, has the disadvantage that the variation may be too high, is unacceptable and needs to be improved, which could invalidate the evaluation and lead to inconclusive results.

4.9 The instantaneous approach has the disadvantage that variations in the organism levels at different times of the discharge are not taken into account, which should not be a problem if all the samples meet the D-2 standard. If the discharge is not always under the D-2 standard, the problem can be mitigated by using a flow-integrated sample over set periods of time, which, if taken properly, represents an average of the organisms in the treated ballast water over that time when presented with variance estimates and confidence intervals. This constitutes a better representation of the ballast water quality than separate samples. In addition, a lower variation should be obtained because a larger sample is being analysed. The average approach is likely to have the same disadvantages unless the samples are very large and collected over most of the discharge.

4.10 The differences between applying an instantaneous sampling regime or an average sampling regime to the result are less extreme when taking numerous flow-integrated samples. This is because for each discharge there will be a number of results arising from samples that have been averaged over a specific time.

5 DETAILED ANALYSIS: THE SAMPLE PROTOCOL

5.1 Sample protocols for discharges of treated ballast water through a distinct discharge point fall into two categories, the first based on specified and replicated volumes and the second based on flow integration over a specified time. The first entails taking a specific number of set volumes of the ballast water discharge, whilst the second takes a continuous sample over a set time period. The flow integration sampling protocol can be achieved by either continuously sub-sampling a small amount throughout the entire duration of the discharge, therefore collecting one sample over time, or taking multiple sub-samples over a specific time scale (i.e. 5 minutes, 10 minutes or 15 minutes) repeatedly throughout the discharge, providing a result for each sub-sample.

5.2 However, for sampling protocols based on specified and replicated volumes, defining both the number of samples and their volume to ensure representativeness, takes time. As a representative sampling procedure is needed to ensure compliance with the BWM Convention, then the flow integration protocols based on set times should be implemented.

5.3 Using a sampling protocol that continuously sub-samples small amounts throughout the entire duration of the discharge, may significantly underestimate the amount of larger organisms (i.e. organisms greater than or equal to 50 micrometres in minimum dimension) in the sample due to damage to the organisms held in the cod-end of the filter. If such a system is used then a protocol for replacing the cod end needs to be developed.

5.4 The arrangements for detailed analysis should take into account the requirements of the methods and/or approaches they intend to use for detailed and/or indicative analysis. Special consideration should be given and contingencies arranged for sampling in remote ports, where it is likely to take time to mobilize samplers and sampling resources.

6 DETAILED METHODOLOGY

6.1 As described in paragraph 5.1, there are two distinct ballast water sampling protocols, one based on flow integration and one based on the use of specified and replicated volumes. As they both use filtration and concentration of the sample the following section can apply to both methods.

6.2 For in-line sampling, a sampling system should be set up which:

- collects organisms greater or equal to 50 μm;
- allows samples of the ballast water to be taken and filtered;
- enables the amount of ballast water sampled to be measured to allow for extrapolation of the results; and
- allows the filtered ballast water to be discharged safely without affecting the stability and safety of the ship, its crew and the samplers, or other discharges from the vessel such as bilge water.

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ANNEX 16

RESOLUTION MEPC.232(65)

Adopted on 17 May 2013

2013 INTERIM GUIDELINES FOR DETERMING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIPS IN ADVERSE CONDITIONS

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,

RECALLING ALSO that, at its sixty-second session, the Committee 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 amendments to MARPOL Annex VI adopted at its sixty-second session by inclusion of a new chapter 4 for regulations on energy efficiency for ships, entered into force on 1 January 2013,

NOTING ALSO that regulation 21.5 of MARPOL Annex VI, as amended, requires that the installed propulsion power shall not be less than the propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions as defined in the guidelines,

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

HAVING CONSIDERED, at its sixty-fifth session, the draft *2013 Interim Guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions*,

1. ADOPTS the *2013 Interim Guidelines for determining minimum propulsion power to maintain the manoeuvrability of ships in adverse conditions*, as set out at annex to the present resolution;

2. INVITES Administrations to take the annexed Guidelines 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 annexed Guidelines related to the Energy Efficiency Design Index (EEDI) to the attention of shipowners, ship operators, shipbuilders, ship designers and any other interested groups;

4. AGREES to keep these Guidelines under review in light of the experience gained; and

5. REVOKES the Interim Guidelines circulated by MSC-MEPC.2/Circ.11, as from this date.

ANNEX

2013 INTERIM GUIDELINES FOR DETERMINING MINIMUM PROPULSION POWER TO MAINTAIN THE MANOEUVRABILITY OF SHIP IN ADVERSE CONDITIONS

0 Purpose

The purpose of these interim guidelines is to assist Administrations and recognized organizations in verifying that ships, complying with EEDI requirements set out in regulations on Energy Efficiency for Ships, have sufficient installed propulsion power to maintain the manoeuvrability in adverse conditions, as specified in regulation 21.5 in chapter 4 of MARPOL Annex VI.

1 Definition

1.1 "Adverse conditions" mean sea conditions with the following parameters:

Significant wave height h_s, m	Peak wave period T_P, s	Mean wind speed V_w, m/s
5.5	7.0 to 15.0	19.0

JONSWAP sea spectrum with the peak parameter of 3.3 is to be considered for coastal waters.

1.2 The following adverse condition should be applied to ships defined as the following threshold value of ship size.

Ship length, m	Significant wave height h_s, m	Peak wave period T_P, s	Mean wind speed V_w, m/s
Less than 200	4.0	7.0 to 15.0	15.7
$200 \leq L_{pp} \leq 250$	Parameters linearly interpolated depending on ship's length		
More than L_{pp} = 250	Refer to paragraph 1.1		

2 Applicability*

2.1 These guidelines should be applied in the case of all new ships of types as listed in table 1 of appendix required to comply with regulations on Energy Efficiency for Ships according to regulation 21 of MARPOL Annex VI.

2.2 Notwithstanding the above, these guidelines should not be applied to the ships with un-conventional propulsion system such as pod propulsion.

2.3 These guidelines are intended for ships in unrestricted navigation; for other cases, the Administration should determine appropriate guidelines, taking the operational area and relevant restrictions into account.

* These Interim Guidelines are applied to ships required to comply with regulations on Energy Efficiency for Ships according to regulation 21 of MARPOL Annex VI during Phase 0 (i.e. for those ship types as in table 1 of appendix with the size of equal or more than 20,000 DWT).

3 Assessment procedure

3.1 The assessment can be carried out at two different levels as listed below:

.1 Minimum power lines assessment; and

.2 Simplified assessment.

3.2 The ship should be considered to have sufficient power to maintain the manoeuvrability in adverse conditions if it fulfils one of these assessment levels.

4 Assessment level 1 – minimum power lines assessment

4.1 If the ship under consideration has installed power not less than the power defined by the minimum power line for the specific ship type, the ship should be considered to have sufficient power to maintain the manoeuvrability in adverse conditions.

4.2 The minimum power lines for the different types of ships are provided in the appendix.

5 Assessment level 2 – simplified assessment

5.1 The methodology for the simplified assessment is provided in the appendix.

5.2 If the ship under consideration fulfils the requirements as defined in the simplified assessment, the ship should be considered to have sufficient power to maintain the manoeuvrability in adverse conditions.

6 Documentation

6.1 Test documentation should include at least, but not be limited to, a:

.1 description of the ship's main particulars;

.2 description of the ship's relevant manoeuvring and propulsion systems;

.3 description of the assessment level used and results; and

.4 description of the test method(s) used with references, if applicable.

* * *

Appendix

ASSESSMENT PROCEDURES TO MAINTAIN THE MANOEUVRABILITY UNDER ADVERSE CONDITIONS, APPLICABLE DURING PHASE 0 OF THE EEDI IMPLEMENTATION

1 Scope

1.1 The procedures as described below are applicable during Phase 0 of the EEDI implementation as defined in regulation 21 of MARPOL Annex VI (see also paragraph 0 – Purpose of these interim guidelines).

2 Minimum power lines

2.1 The minimum power line values of total installed MCR, in kW, for different types of ships should be calculated as follows:

Minimum Power Line Value = $a \times (DWT) + b$

Where:

DWT is the deadweight of the ship in metric tons; and
a and *b* are the parameters given in table 1 for tankers, bulk carriers and combination carriers.

Table 1: Parameters a and b for determination of the minimum power line values for the different ship types

Ship Type	a	b
Bulk Carriers	0.0687	2924.4
Tankers	0.0689	3253.0
Combination Carriers	see tankers above	

The total installed MCR of all main propulsion engines should not be less than the minimum power line value, where MCR is the value specified on the EIAPP Certificate.

3 Simplified assessment

3.1 The simplified assessment procedure is based on the principle that, if the ship has sufficient installed power to move with a certain advance speed in head waves and wind, the ship will also be able to keep course in waves and wind from any other direction. The minimum ship speed of advance in head waves and wind is thus selected depending on ship design, in such a way that the fulfilment of the ship speed of advance requirements means fulfilment of course-keeping requirements. For example, ships with larger rudder areas will be able to keep course even if the engine is less powerful; similarly, ships with a larger lateral windage area will require more power to keep course than ships with a smaller windage area.

3.2 The simplification in this procedure is that only the equation of steady motion in longitudinal direction is considered; the requirements of course-keeping in wind and waves are taken into account indirectly, by adjusting the required ship speed of advance in head wind and waves.

3.3 The assessment procedure consists of two steps:

.1 definition of the required advance speed in head wind and waves, ensuring course-keeping in all wave and wind directions; and

.2 assessment whether the installed power is sufficient to achieve the required advance speed in head wind and waves.

Definition of required ship speed of advance

3.4 The required ship advance speed through the water in head wind and waves, V_s, is set to the larger of:

.1 minimum navigational speed, V_{nav}; or

.2 minimum course-keeping speed, V_{ck}.

3.5 The minimum navigational speed, V_{nav}, facilitates leaving coastal area within a sufficient time before the storm escalates, to reduce navigational risk and risk of excessive motions in waves due to unfavourable heading with respect to wind and waves. The minimum navigational speed is set to 4.0 knots.

3.6 The minimum course-keeping speed in the simplified assessment, $V_{ck,}$ is selected to facilitate course-keeping of the ships in waves and wind from all directions. This speed is defined on the basis of the reference course-keeping speed $V_{ck,\ ref}$, related to ships with the rudder area A_R equal to 0.9 per cent of the submerged lateral area corrected for breadth effect, and an adjustment factor taking into account the actual rudder area:

$$V_{ck} = V_{ck,\ ref} - 10.0 \times (A_{R\%} - 0.9) \qquad (1)$$

where V_{ck} in knots, is the minimum course-keeping speed, $V_{ck,\ ref}$ in knots, is the reference course-keeping speed, and $A_{R\%}$ is the actual rudder area, A_R, as percentage of the submerged lateral area of the ship corrected for breadth effect, $A_{LS,\ cor}$, calculated as $A_{R\%} = A_R/A_{LS,\ cor} \cdot 100\%$. The submerged lateral area corrected for breadth effect is calculated as $A_{LS,\ cor} = L_{pp}T_m(1.0+25.0(B_{wl}/L_{pp})^2)$, where L_{pp} is the length between perpendiculars in m, B_{wl} is the water line breadth in m and T_m is the draft a midship in m. In case of high-lift rudders or other alternative steering devices, the equivalent rudder area to the conventional rudder area is to be used.

3.7 The reference course-keeping speed $V_{ck,\ ref}$ for bulk carriers, tankers and combination carriers is defined, depending on the ratio A_{FW}/A_{LW} of the frontal windage area, A_{FW}, to the lateral windage area, A_{LW}, as follows:

.1 9.0 knots for A_{FW}/A_{LW} =0.1 and below and 4.0 knots for A_{FW}/A_{LW}=0.40 and above; and

.2 linearly interpolated between 0.1 and 0.4 for intermediate values of A_{FW}/A_{LW}.

Procedure of assessment of installed power

3.8 The assessment is to be performed in maximum draught conditions at the required ship speed of advance, V_s, defined above. The principle of the assessment is that the required propeller thrust, T in N, defined from the sum of bare hull resistance in calm water

R_{cw}, resistance due to appendages R_{app}, aerodynamic resistance R_{air}, and added resistance in waves R_{aw}, can be provided by the ship's propulsion system, taking into account the thrust deduction factor t:

$$T = (R_{cw} + R_{air} + R_{aw} + R_{app})/(1-t) \tag{2}$$

3.9 The calm-water resistance for bulk carriers, tankers and combination carriers can be calculated neglecting the wave-making resistance as $R_{cw} = (1+k)C_F \frac{1}{2}\rho S V_s^2$, where k is the form factor, $C_F = \frac{0.075}{(\log_{10}\mathrm{Re}-2)^2}$ is the frictional resistance coefficient, $\mathrm{Re} = V_s L_{pp}/\nu$ is the Reynolds number, ρ is water density in kg/m^3, S is the wetted area of the bare hull in m^2, V_s is the ship advance speed in m/s, and ν is the kinematic viscosity of water in m^2/s.

3.10 The form factor k should be obtained from model tests. Where model tests are not available the empirical formula below may be used:

$$k = -0.095 + 25.6\frac{C_B}{\left(L_{pp}/B_{wl}\right)^2\sqrt{B_{wl}/T_m}} \tag{3}$$

where C_B is the block coefficient based on L_{pp}.

3.11 Aerodynamic resistance can be calculated as $R_{air} = C_{air}\frac{1}{2}\rho_a A_F V_{w,rel}^2$, where C_{air} is the aerodynamic resistance coefficient, ρ_a is the density of air in kg/m^3, A_F is the frontal windage area of the hull and superstructure in m^2, and $V_{w\,rel}$ is the relative wind speed in m/s, defined by the adverse conditions in paragraph 1.1 of the interim guidelines, V_w, added to the ship advance speed, V_s. The coefficient C_{air} can be obtained from model tests or empirical data. If none of the above is available, the value 1.0 is to be assumed.

3.12 The added resistance in waves, R_{aw}, defined by the adverse conditions and wave spectrum in paragraph 1 of the interim guidelines, is calculated as:

$$R_{aw} = 2\int_0^\infty \frac{R_{aw}(V_s,\omega)}{\zeta_a^2} S_{\zeta\zeta}(\omega)d\omega \tag{4}$$

where $R_{aw}(V_s,\omega)/\zeta_a^2$ is the quadratic transfer function of the added resistance, depending on the advance speed V_s in m/s, wave frequency ω in rad/s, the wave amplitude, ζ_a in m and the wave spectrum, $S_{\zeta\zeta}$ in m^{2}s. The quadratic transfer function of the added resistance can be obtained from the added resistance test in regular waves at the required ship advance speed V_s as per ITTC procedures 7.5-02 07-02.1 and 7.5-02 07-02.2, or from equivalent method verified by the Administration.

3.13 The thrust deduction factor t can be obtained either from model tests or empirical formula. Default conservative estimate is t=0.7w, where w is the wake fraction. Wake fraction w can be obtained from model tests or empirical formula; default conservative estimates are given in table 2.

Table 2: Recommended values for wake fraction *w*

Block coefficient	One propeller	Two propellers
0.5	0.14	0.15
0.6	0.23	0.17
0.7	0.29	0.19
0.8 and above	0.35	0.23

3.14 The required advance coefficient of the propeller is found from the equation:

$$T = \rho u_a^2 D_P^2 K_T(J)/J^2 \quad (5)$$

where D_P is the propeller diameter, $K_T(J)$ is the open water propeller thrust coefficient, $J = u_a/nD_P$, and $u_a = V_s(1-w)$. J can be found from the curve of K_T(J)/J^2.

3.15 The required rotation rate of the propeller, *n*, in revolutions per second, is found from the relation:

$$n = u_a/(JD_P) \quad (6)$$

3.16 The required delivered power to the propeller at this rotation rate *n*, P_D in watts, is then defined from the relation:

$$P_D = 2\pi\rho n^3 D_P^5 K_Q(J) \quad (7)$$

where $K_Q(J)$ is the open water propeller torque coefficient curve. Relative rotative efficiency is assumed to be close to 1.0.

3.17 For diesel engines, the available power is limited because of the torque-speed limitation of the engine, $Q \le Q_{max}(n)$, where $Q_{max}(n)$ is the maximum torque that the engine can deliver at the given propeller rotation rate *n*. Therefore, the required minimum installed MCR is calculated taking into account:

.1 torque-speed limitation curve of the engine which is specified by the engine manufacturer; and

.2 transmission efficiency η_s which is to be assumed 0.98 for aft engine and 0.97 for midship engine, unless exact measurements are available.

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MEPC.1/Circ.815
17 June 2013

2013 GUIDANCE ON TREATMENT OF INNOVATIVE ENERGY EFFICIENCY TECHNOLOGIES FOR CALCULATION AND VERIFICATION OF THE ATTAINED EEDI

1 The Marine Environment Protection Committee, at its sixty-fifth session (13 to 17 May 2013), agreed to circulate the *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI*, as set out in the annex (MEPC 65/22, paragraph 4.134.6).

2 Member Governments are invited to bring the annexed Guidance to the attention of their Administrations, industry, relevant shipping organizations, shipping companies and other stakeholders concerned.

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ANNEX

2013 GUIDANCE ON TREATMENT OF INNOVATIVE ENERGY EFFICIENCY TECHNOLOGIES FOR CALCULATION AND VERIFICATION OF THE ATTAINED EEDI

TABLE OF CONTENTS

1 General

1.1 The purpose of this guidance is to assist manufacturers, shipbuilders, shipowners, verifiers and other interested parties related to Energy Efficiency Design Index (EEDI) of ships to treat innovative energy efficiency technologies for calculation and verification of the attained EEDI, in accordance with regulations 5, 6, 7, 8, 9 and 20 of Annex VI to MARPOL.

1.2 There are EEDI Calculation Guidelines and EEDI Survey Guidelines. This guidance does not intend to supersede those guidelines but provides the methodology of calculation, survey and certification of innovative energy efficiency technologies, which are not covered by those guidelines. In the case that there are inconsistencies between this guidance and these guidelines, those guidelines should take precedence.

1.3 This guidance might not provide sufficient measures of calculation and verification for ships with diesel-electric propulsion, turbine propulsion and hybrid propulsion system on the ground that the attained EEDI Formula shown in EEDI Calculation Guidelines may not be able to apply to such propulsion systems.

1.4 The guidance should be reviewed for the inclusion of new innovative technologies not yet covered by the guidance.

1.5 The guidance also should be reviewed, after accumulating the experiences of each innovative technology, in order to make it more robust and effective, using the feedback from actual operating data. Therefore, it is advisable that the effect of each innovative technology in actual operating conditions should be monitored and collected for future improvement of this guidance document.

2 Definitions

2.1 *EEDI Calculation Guidelines* means "2012 guidelines on the method of calculation of the attained energy efficiency design index (EEDI) for new ships (resolution MEPC.212(63))".

2.2 *EEDI Survey Guidelines* means "2012 guidelines on survey and certification of the energy efficiency design index (EEDI) (resolution MEPC.214(63))".

2.3 P_p is the propulsion power and is defined as ΣP_{ME} (In case where shaft motor(s) are installed, $\Sigma P_{ME} + \Sigma P_{PTI(i),\mathrm{shaft}}$, as shown in paragraph 2.5.3 of EEDI Calculation Guidelines).

2.4 In addition to the above, definitions of the words in this guidance are same as those of MARPOL Annex VI, EEDI Calculation Guidelines and EEDI Survey Guidelines.

3 Categorizing of Innovative Energy Efficiency Technologies

3.1 Innovative energy efficiency technologies are allocated to category (A), (B) and (C), depending on their characteristics and effects to the EEDI formula. Furthermore, innovative energy efficiency technologies of category (B) and (C) are categorized to two sub-categories (category (B-1) and (B-2), and (C-1) and (C-2), respectively).

Category (A): Technologies that shift the power curve, which results in the change of combination of P_P and V_{ref}: e.g. when V_{ref} is kept constant, P_P will be reduced and when P_P is kept constant, V_{ref} will be increased

Category (B): Technologies that reduce the propulsion power, P_P, at V_{ref}, but not generate electricity. The saved energy is counted as P_{eff}

Category (B-1): Technologies which can be used at any time during the operation and thus the availability factor (f_{eff}) should be treated as 1.00.

Category (B-2): Technologies which can be used at their full output only under limited condition. The setting of availability factor (f_{eff}) should be less than 1.00.

Category (C): Technologies that generate electricity. The saved energy is counted as P_{AEeff}

Category (C-1): Technologies which can be used at any time during the operation and thus the availability factor (f_{eff}) should be treated as 1.00.

Category (C-2): Technologies which can be used at their full output only under limited condition. The setting of availability factor (f_{eff}) should be less than 1.00.

(C) Emission reduction through the auxiliary power reduction by generating electricity for normal maximum sea load(P_{AEeff})

(B) Emission reduction through the propulsion power reduction (P_{eff})

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE}\cdot C_{FAE}\cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)}\cdot P_{AEeff(i)}\right) C_{FAE}\cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)}\cdot P_{eff(i)}\cdot C_{FME}\cdot SFC_{ME}**\right)}{f_i \cdot f_c \cdot Capacity \cdot f_w \cdot V_{ref}}$$

(A) The combination of P_P and V_{ref} as reflected in the power curve (knot-kW curve)

Innovative Energy Efficiency Technologies				
Reduction of Main Engine Power			**Reduction of Auxiliary Power**	
Category A	***Category B-1***	***Category B-2***	***Category C-1***	***Category C-2***
Cannot be separated from overall performance of the vessel	Can be treated separately from the overall performance of the vessel		Effective at all time	Depending on ambient environment
	$f_{eff}=1$	$f_{eff}<1$	$f_{eff}=1$	$f_{eff}<1$
– low friction coating – bare optimization – rudder resistance – propeller design	– hull air lubrication system (air cavity via air injection to reduce ship resistance) (can be switched off)	– wind assistance (sails, Flettner-Rotors, kites)	– waste heat recovery system (exhaust gas heat recovery and conversion to electric power)	– photovoltaic cells

4 Calculation and Verification of effects of Innovative Energy Efficiency Technologies

4.1 General

The evaluation of the benefit of any innovative technology is to be carried out in conjunction with the hull form and propulsion system with which it is intended to be used. Results of model tests or sea trials of the innovative technology in conjunction with different hull forms or propulsion systems may not be applicable.

4.2 Category (A) technology

Innovative energy efficiency technologies in category (A) affect P_P and/or V_{ref} and their effects cannot be measured in isolation. Therefore, these effects should not be calculated nor certified in isolation in this guidance but should be treated as a part of vessel in EEDI Calculation Guidelines and EEDI Survey Guidelines.

4.3 Category (B) technology

4.3.1 The effects of innovative energy technologies in category (B) are expressed as P_{eff} which would be multiplied by C_{FME} and SFC_{ME} (in the case of $P_{PTI(i)}$ >0, the average weighted value of ($SFC_{ME} \cdot C_{FME}$) and ($SFC_{AE} \cdot C_{FAE}$)) and f_{eff}, and then be deducted from the EEDI formula. In the case of category (B-1) technology, f_{eff} is 1.00.

4.3.2 Guidance on calculation and verification of effects of Category (B) innovative technologies is given in annex 1.

4.4 Category (C) technology

4.4.1 The effects of innovative energy technologies in category (C) are expressed as P_{AEeff} which would be multiplied by C_{FAE}, SFC_{AE} and f_{eff}, and then be deducted from the EEDI formula. In the case of category (C-1) technology, f_{eff} is 1.00.

4.4.2 Guidance on calculation and verification of effects of Category (C) innovative technologies is given in annex 2.

5 Average weighted value in the case of $P_{PTI(i)}$ >0

In the case of $P_{PTI(i)}$ >0, both Category (B) and Category (C) technologies might deduct the value of $P_{PTI(i)}$. In such case, following values are to be used for average weighted value in calculating $\Sigma(f_{eff(i)} \cdot P_{eff(i)} \cdot C_F \cdot SFC)$ in attained EEDI formula;

For shaft power(s):
$(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff} \cdot \eta_{GEN} \cdot \eta_{PTI(i)}) / (\Sigma P_{ME(i)} + \Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff} \cdot \eta_{GEN} \cdot \eta_{PTI(i)})$,
where, if $(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff} \cdot \eta_{GEN} \cdot \eta_{PTI(i)})$ is taken negative value, the value $(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff} \cdot \eta_{GEN} \cdot \eta_{PTI(i)})$ should be fixed to zero; and

For main engine(s):
$\Sigma P_{ME(i)} / (\Sigma P_{ME(i)} + \Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff} \cdot \eta_{GEN} \cdot \eta_{PTI(i)})$,
where, if $\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff} \cdot \eta_{GEN} \cdot \eta_{PTI(i)}$ is taken negative value, the value $(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff} \cdot \eta_{GEN} \cdot \eta_{PTI(i)})$ should be fixed to zero.

* * *

ANNEX 1[1]

GUIDANCE ON CALCULATION AND VERIFICATION OF EFFECTS OF CATEGORY (B) INNOVATIVE TECHNOLOGIES

Appendix 1

AIR LUBRICATION SYSTEM (CATEGORY (B-1))

1 Summary of innovative energy efficient technology

An air lubrication system is one of the innovative energy efficiency technologies. Ship frictional resistance can be reduced by covering the ship surface with air bubbles, which is injected from the fore part of the ship bottom by using blowers, etc.

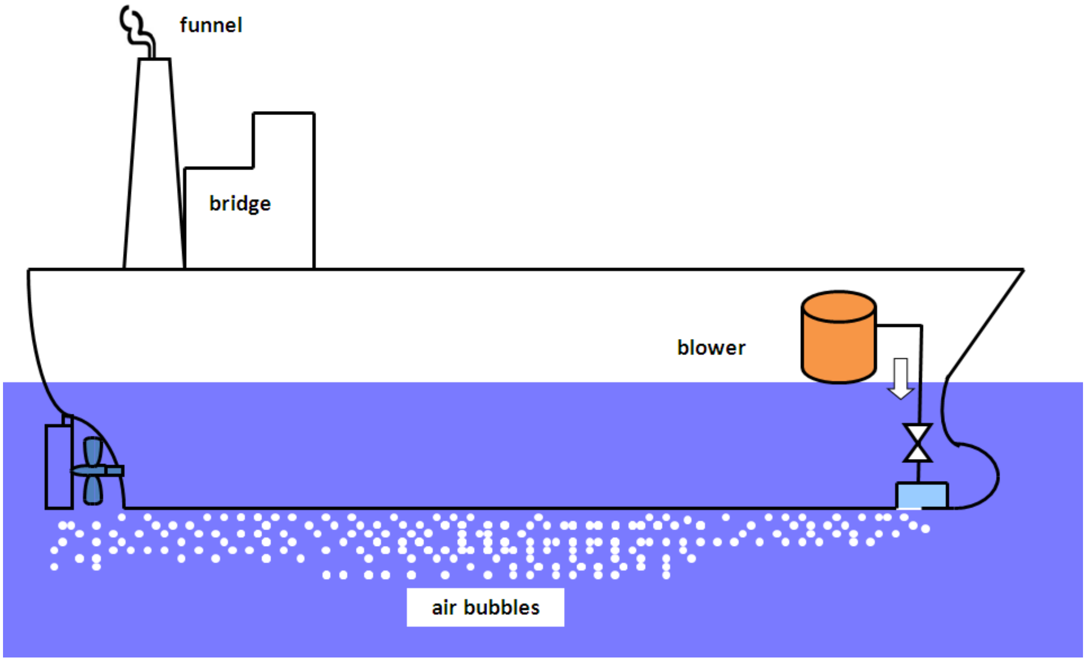

Figure 1 – Schematic illustration of an air lubrication system

2 Method of calculation

2.1 Power reduction due to air lubrication system

Power reduction factor P_{eff} due to an air lubrication system as an innovative energy efficiency technology is calculated by the following formula. The first and second terms of the right hand side represent the reduction of propulsion power by the air lubrication system and the additional power necessary for running the system, respectively. For this system, f_{eff} is 1.0 in EEDI formula.

$$P_{eff} = P_{PeffAL} - P_{AEeffAL} \frac{C_{FAE}}{C_{FME}} \frac{SFC_{AE}}{SFC_{ME}{}^{*}} \qquad (1)$$

* In the case of $P_{PTI(i)}$ >0, the average weighted value of ($SFC_{ME} \cdot C_{FME}$) and ($SFC_{AE} \cdot C_{FAE}$)

[1] All examples in appendix are used solely to illustrate the proposed methods of calculation and verification.

2.1.1 P_{eff} is the effective power reduction in kW due to the air lubrication system at the 75 per cent of the rated installed power (MCR). In case that shaft generators are installed, P_{eff} should be calculated at the 75 per cent MCR having after deducted any installed shaft generators in accordance with paragraph 2.5 of EEDI Calculation Guidelines. P_{eff} should be calculated both in the fully loaded and the sea trial conditions.

2.1.2 P_{PeffAL} is the reduction of propulsion power due to the air lubrication system in kW. P_{PeffAL} should be calculated both in the condition corresponding to the *Capacity* as defined in EEDI Calculation Guidelines (hereinafter referred to as "fully loaded condition") and the sea trial condition, taking the following items into account.

.1 area of ship surface covered with air;

.2 thickness of air layer;

.3 reduction rate of frictional resistance due to the coverage of air layer;

.4 change of propulsion efficiency due to the interaction with air bubbles (self propulsion factors and propeller open water characteristics); and

.5 change of resistance due to additional device, if equipped.

2.1.3 $P_{AEeffAL}$ is additional auxiliary power in kW necessary for running the air lubrication system in the fully loaded condition. $P_{AEeffAL}$ should be calculated as 75 per cent of the rated output of blowers based on the manufacturer's test report. For a system where the calculated value above is significantly different from the output used at normal operation in the fully loaded condition, the $P_{AEeffAL}$ value may be estimated by an alternative method. In this case, the calculation process should be submitted to a verifier.

2.2 Points to keep in mind in calculation of attained EEDI with air lubrication system

2.2.1 V_{ref} in paragraph 2.2 of EEDI Calculation Guidelines should be calculated in the condition that the air lubrication system is OFF to avoid the double count of the effect of this system.

2.2.2 In accordance with EEDI Calculation Guidelines, the EEDI value for ships for the air lubrication system ON should be calculated in the fully loaded condition.

3 Method of verification

3.1 General

Attained EEDI for a ship with an innovative energy efficient technology should be verified in accordance with EEDI Survey Guidelines. Additional information on the application of air lubrication system, which is not given in the EEDI Survey Guidelines, is contained below.

3.2 Preliminary verification at the design stage

3.2.1 In addition to paragraph 4.2.2 of EEDI Survey Guidelines, the EEDI Technical File which is to be developed by a shipowner or shipbuilder should include:

.1 outline of the air lubrication system;

.2 P_{PeffAL} : the reduction of propulsion power due to the air lubrication system at the ship speed of V_{ref} both in the fully loaded and the sea trial conditions;

.3 EDR_{full} : the reduction rate of propulsion power in the fully loaded condition due to the air lubrication system. EDR_{full} is calculated by dividing $P_{MEeffAL}$ by P_{ME} in EEDI Calculation Guidelines in the fully loaded condition (See Figure 2);

.4 EDR_{trial} : the reduction rate of propulsion power in a sea trial condition due to the air lubrication system. EDR_{trial} is calculated by dividing $P_{MEeffAL}$ by P_{ME} in EEDI Calculation Guidelines in sea trial condition (see figure 2);

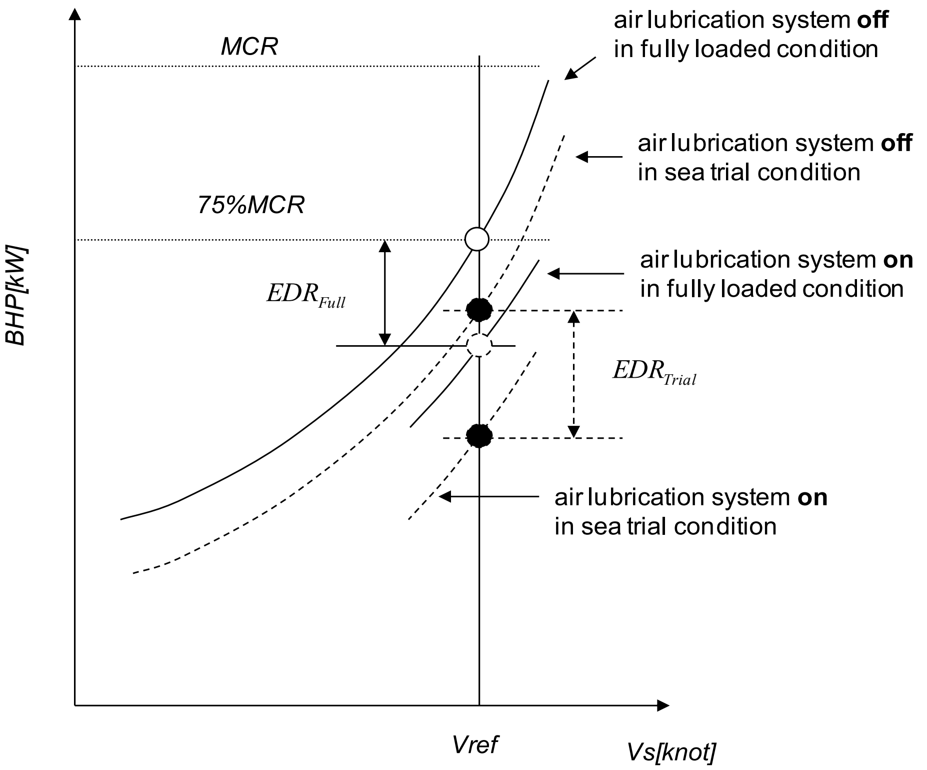

Figure 2 – Calculation of the reduction rate of propulsion power (EDR_{full} and EDR_{trial}) due to air lubrication system

.5 $P_{AEeffAL}$: additional power necessary for running the air lubrication system; and

.6 the calculated value of the EEDI for the air lubrication system ON in the fully loaded condition.

3.2.2 In addition with paragraph 4.2.7 of the EEDI Survey Guidelines, additional information that the verifier may request the shipbuilder to provide directly to it includes:

.1 the detailed calculation process of the reduction of propulsion power due to the air lubrication system : P_{PeffAL} ; and

.2 the detailed calculation process of the additional power necessary for running the air lubrication system : $P_{AEeffAL}$.

3.3 Final verification of the attained EEDI at sea trial

3.3.1 Final verification of the EEDI of ships due to the air lubrication system should be conducted at the sea trial. The procedure of final verification should be basically in accordance with paragraph 4.3 of the EEDI Survey Guidelines.

3.3.2 Prior to the sea trial, the following documents should be submitted to the verifier; a description of the test procedure that includes the measurement methods to be used at the sea trial of the ship with the air lubrication system.

3.3.3 The verifier should attend the sea trial and confirm the items described in paragraph 4.3.3 of the EEDI Survey Guidelines to be measured at the sea trial for the air lubrication system ON and OFF.

3.3.4 The main engine output at the sea trial for the air lubrication system ON and OFF should be set so that the range of the developed power curve includes the ship speed of V_{ref}.

3.3.5 The following procedure should be conducted based on the power curve developed for air lubrication system OFF.

.1 ship speed at 75 per cent MCR of main engine in the fully loaded condition, V_{ref}, should be calculated. In case that shaft generators are installed, V_{ref} should be calculated at 75 per cent MCR having after deducted any installed shaft generators in accordance with paragraph 2.5 of EEDI Calculation Guidelines.

.2 In case that V_{ref} obtained above is different from that estimated at the design stage, the reduction rate of main engine should be recalculated at new V_{ref} both in the fully loaded and the sea trial conditions.

3.3.6 The shipbuilder should develop power curves for the air lubrication system ON based on the measured ship speed and output of the main engine at the sea trial. The following calculations should be conducted.

.1 The actual reduction rate of propulsion power ADR_{trial} at the ship speed of V_{ref} at the sea trial.

.2 If the sea trial is not conducted in the fully loaded condition, the reduction rate of propulsion power in this condition should be calculated by the following formula:

$$1 - ADR_{Full} = (1 - EDR_{Full}) \times \frac{1 - ADR_{Trial}}{1 - EDR_{Trial}},$$

i.e.

$$ADR_{Full} = 1 - (1 - EDR_{Full}) \times \frac{1 - ADR_{Trial}}{1 - EDR_{Trial}} \qquad (2)$$

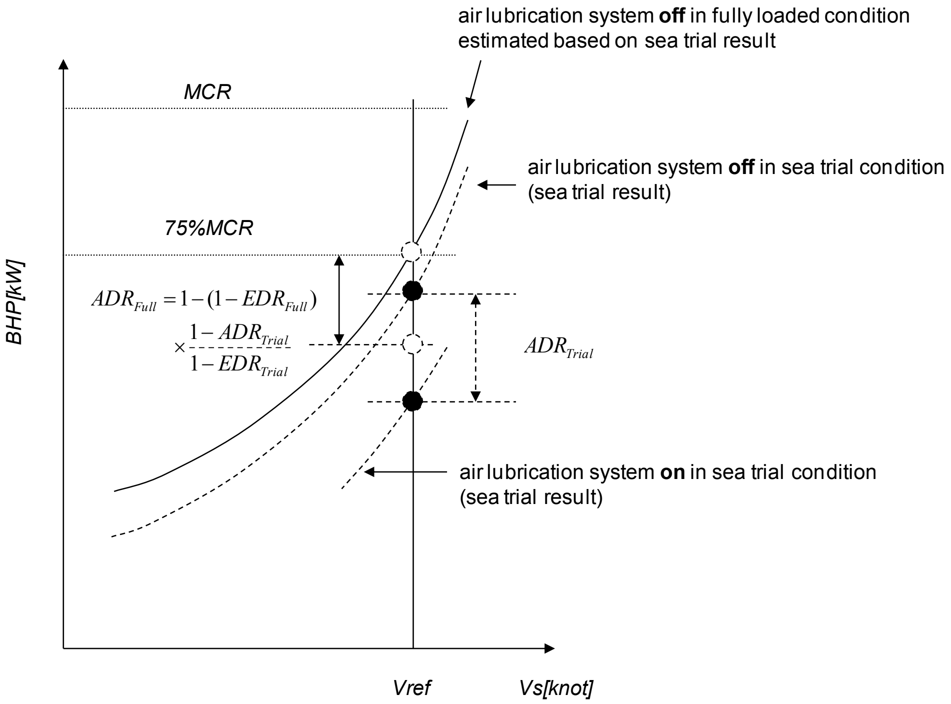

Figure 3 – Calculation of the actual reduction rate of propulsion power (ADR_{full} and ADR_{trial}) due to air lubrication system

3.3.7 The reduction of propulsion power due to the air lubrication system $P_{MEeffAL}$ in the fully loaded and the sea trial conditions should be calculated as follows:

$$P_{PeffAL\_Full} = ADR_{Full} \times P_P \tag{3}$$

$$P_{PeffAL\_Trial} = ADR_{Trial} \times P_P \tag{4}$$

3.3.8 The shipowner or the shipbuilder should revise the EEDI Technical File, as necessary, by taking the result of the sea trial into account. Such revision should include the following contents:

.1 V_{ref} , in case that it is different from that estimated at the design stage;

.2 the reduction of propulsion power P_{PeffAL} at the ship speed of V_{ref} in the fully loaded and the sea trial conditions for the air lubrication system ON.

.3 the reduction rate of propulsion power due to air lubrication system (ADR_{full} and ADR_{trial}) in the fully loaded and the sea trial conditions.

.4 the calculated value of the EEDI for the air lubrication system ON in the fully loaded condition.

Appendix 2

WIND PROPULSION SYSTEM (CATEGORY B-2)

1 Summary of innovative energy efficient technology

1.1 Wind propulsion systems belong to innovative mechanical energy efficient technologies which reduce the CO_2 emissions of ships. There are different types of wind propulsion technologies (sails, wings, kites, etc.) which generate forces dependent on wind conditions. This technical guidance defines the available effective power of wind propulsion systems as the product of the reference speed and the sum of the wind propulsion system force and the global wind probability distribution.

2 Definitions

2.1 For the purpose of these guidelines, the following definitions should apply:

.1 *Available effective power* is the multiplication of effective power P_{eff} and availability factor f_{eff} as defined in the EEDI calculation.

.2 *Wind propulsion systems* belong to innovative mechanical energy efficient technologies which reduce the CO_2 emissions of ships. These proposed guidelines apply to wind propulsion technologies that directly transfer mechanical propulsion forces to the ship's structure (sails, wings, kites, etc.).

.3 *Global wind probability matrix* contains data of the global wind power on the main global shipping routes based on a statistical survey of worldwide wind data. A detailed determination of the global wind probability matrix can be found in a separate submission (INF paper).

3 Available effective power of wind propulsion systems

3.1 The available effective power of wind propulsion systems as innovative energy efficient technology is calculated by the following formula:

$$\left(f_{eff} \cdot P_{eff}\right) = \left(\frac{0.5144 \cdot V_{ref}}{\eta_T} \sum_{i=1}^{m} \sum_{j=1}^{n} F(V_{ref})_{i,j} \cdot W_{i,j}\right) - \left(\sum_{i=1}^{m} \sum_{j=1}^{n} P(V_{ref})_{i,j} \cdot W_{i,j}\right)$$

Where:

.1 (f_{eff} * P_{eff}) is the available effective power in kW delivered by the specified wind propulsion system. f_{eff} and P_{eff} are combined in the calculation because the product of availability and power is a result of a matrix operation, addressing each wind condition with a probability and a specific wind propulsion system force.

.2 The factor 0.5144 is the conversion factor from nautical miles per hour (knots) to metres per second (m/s).

.3 V_{ref} is the ship reference speed measured in nautical miles per hour (knots), as defined in the EEDI calculation guidelines.

.4 η_T is the total efficiency of the main drive(s) at 75 per cent of the rated installed power (MCR) of the main engine(s). η_T shall be set to [0.7], if no other value is specified and verified by the verifier.

.5 $F(V_{ref})_{i,j}$ is the force matrix of the respective wind propulsion system for a given ship speed V_{ref}.

.6 $W_{i,j}$ is the global wind probability matrix (see below).

.7 $P(V_{ref})_{i,j}$ is a matrix with the same dimensions as $F(V_{ref})_{i,j}$ and $W_{i,j}$ and represents the power demand in kW for the operation of the wind propulsion system.

3.2 The first term of the formula defines the additional propulsion power to be considered for the overall EEDI calculation. The term contains the product of the ship specific speed, the force matrix and the global wind probability matrix. The second term contains the power requirement for the operation of the specific wind propulsion system which has to be subtracted from the gained wind power.

4 Wind propulsion system force matrix $F(V_{ref})_{i,j}$

4.1 Every wind propulsion system has a distinctive force characteristic dependent on ship speed, wind speed and the wind angle relative to heading. The force characteristic can be expressed in a two dimensional matrix, holding elements for any combination of wind speed and wind angle relative to heading for a given ship speed V_{ref}.

4.2 Each matrix element represents the propulsion force in kilonewton (kN) for the respective wind speed and angle. The wind angle is given in relative bearings (with 0° on the bow). Table 1 gives guidance for the determination of the wind propulsion system force matrix $\mathbf{F(V_{ref})_{i,j}}$. For the final determination of the CO_2 reduction of a system the force matrix must be approved by the verifier.

Table 1: Lay-out of a force matrix in kN for a wind propulsion system at V_{ref}

wind angle [°] / **wind speed [m/s]**	**0**	**5**	**…**	**355**
<1	$f_{1,1}$	$f_{1,2}$	…	$f_{1,72}$
<2	$f_{2,1}$	$f_{2,2}$	…	$f_{2,72}$
<3	$f_{3,1}$	$f_{3,2}$	…	$f_{3,72}$
⋮	⋮	⋮	⋱	⋮
≥25	$f_{26,1}$	$f_{26,2}$	…	$f_{26,72}$

5 The global wind probability matrix $W_{i,j}$

5.1 $\mathbf{W_{i,j}}$ represents the probability of wind conditions. Each matrix element represents the probability of wind speed and wind angle relative to the ship coordinates. The sum over all matrix elements equals 1 and is non-dimensional. Table 2 shows the layout of the global wind probability matrix. The wind probability matrix shall be gained from the wind probability on the main global shipping routes[2].

2 An example on a global wind probability matrix can be found in document MEPC 62/INF.34. This example should be subject to approval in a later session of MEPC.

Table 2: Lay-out of the global wind probability matrix

wind angle [°] / wind speed [m/s]	0	5	…	355
<1	$w_{1,1}$	$w_{1,2}$	…	$w_{1,72}$
<2	$w_{2,1}$	$w_{2,2}$	…	$w_{2,72}$
<3	$w_{3,1}$	$w_{3,2}$	…	$w_{3,72}$
⋮	⋮	⋮	⋱	⋮
≥25	$w_{26,1}$	$w_{26,2}$	…	$w_{26,72}$

6 Effective CO_2 reduction by wind propulsion systems

6.1 For the calculation of the CO_2 reduction the resulting available effective power (f_{eff} * P_{eff}) has to be multiplied with the conversion factor C_{FME} and SFC_{ME} as contained in the original EEDI formula.

7 Verification of wind propulsion systems in the EEDI certification process

7.1 General

Verification of EEDI with innovative energy efficient technologies should be conducted according to the EEDI Survey Guidelines. Additional items concerning innovative energy efficient technologies not contained in EEDI Survey Guidelines are described below.

7.2 Preliminary verification at the design stage

7.2.1 In addition to paragraph 4.2.2 **of** EEDI Survey Guidelines, the **EEDI** Technical File which is to be developed by the shipowner or shipbuilder should include:

.1 Outline of Wind propulsion systems; and

.2 Calculated value of EEDI due to the wind propulsion system.

7.2.2 In addition to paragraph 4.2.7 of the EEDI Survey Guidelines, additional information from the shipbuilder may be requested by the verifier. It includes:

.1 Detailed calculation process of the wind propulsion system force matrix $\mathbf{F(V_{ref})_{i,j}}$ and results of performance tests[3].

7.2.3 In order to prevent undesirable effects on the ship's structure or main drive, the influences of added forces on the ship should be determined during the EEDI certification process. Elements in the wind propulsion system force matrix may be limited to ship specific restrictions if necessary. The technical means to restrict the wind propulsion system's force should be verified as part of the performance test[4].

3 Performance test for the specific type of wind propulsion system are required to determine the wind propulsion system force matrix. Technical guidance for the conduction of performance tests should be subject to approval in a later session of MEPC.

4 Technical guidance for the conduction of performance tests should be subject to approval in a later session of MEPC.

7.2.4 If more than one innovative energy efficient technology is subject to approval in the EEDI certification, interactions between these technologies should be considered. The appropriate technical papers should be included in the additional information submitted to the verifier in the certification process.

7.3 Final verification of the attained EEDI at sea trial

The total net power generated by wind propulsion systems should be confirmed based on the EEDI Technical File. In addition to the confirmation, it should be confirmed prior to the final verification, whether the configuration of the wind propulsion systems on the ship is the same as applied in the pre-verification.

* * *

ANNEX 2[5]

GUIDANCE ON CALCULATION AND VERIFICATION OF EFFECTS OF CATEGORY (C) INNOVATIVE TECHNOLOGIES

Appendix 1

WASTE HEAT RECOVERY SYSTEM FOR GENERATION OF ELECTRICITY (CATEGORY (C-1))

1 Summary of innovative energy efficient technology

This Appendix provides the guidance on the treatment of high temperature waste heat recovery systems (electric generation type) as innovative energy efficiency technologies related to the reduction of the auxiliary power (concerning $P_{AEeff(i)}$). Mechanical recovered waste energy directly coupled to shafts need not be measured in this category, since the effect of the technology is directly reflected in the V_{ref}..

Waste heat energy technologies increase the efficiency utilization of the energy generated from fuel combustion in the engine through recovery of the thermal energy of exhaust gas, cooling water, etc., thereby generating electricity.

There are the following two methods of generating electricity by the waste heat energy technologies (electric generation type).

(A) Method to recover thermal energy by a heat exchanger and to drive the thermal engine which drives an electric generator.

(B) Method to drive directly an electric generator using power turbine, etc. Furthermore, there is a waste heat recovery system which combines both of the above methods.

[5] All examples in appendix are used solely to illustrate the proposed methods of calculation and verification.

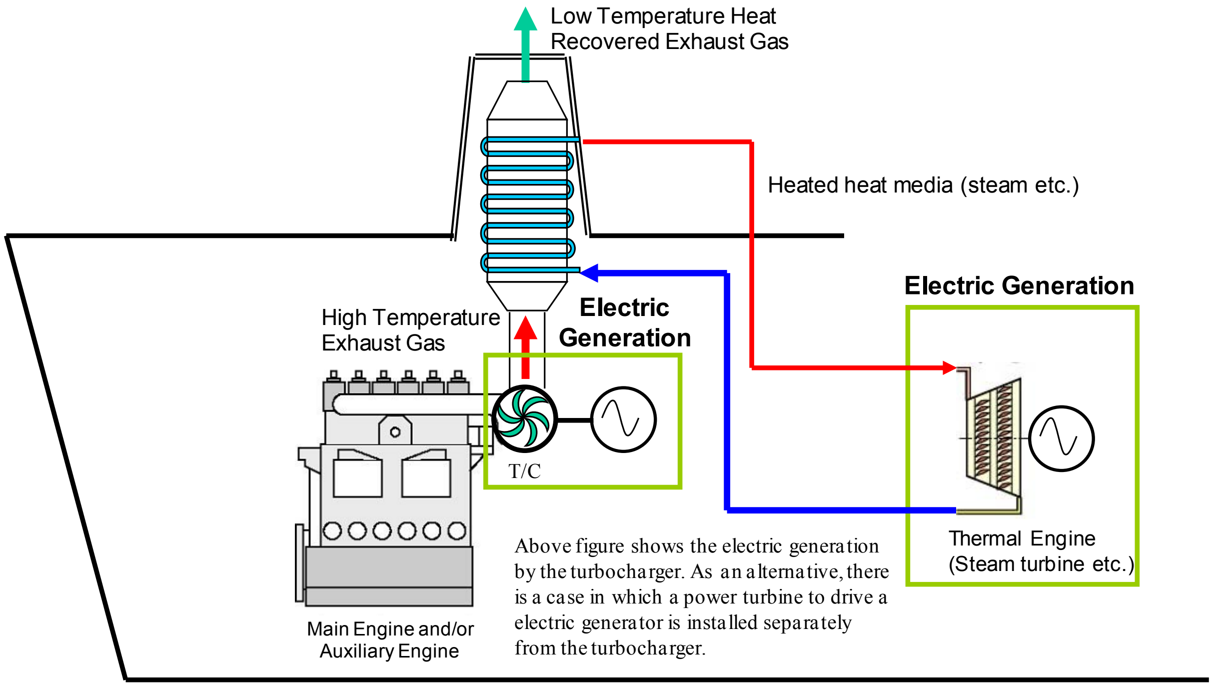

Figure 1 – Schematic illustration of Exhaust Heat Recovery

2 Method of calculation

2.1 Power reduction due to waste heating recovery system

The reduction of power by the waste heat recovery system is calculated by the following equation. For this system, f_{eff} is 1.00 in EEDI formula.

$$P_{AEeff} = P'_{AEeff} - P_{AEeff_{loss}} \tag{1}$$

In the above equation, P'_{AEeff} is power produced by the waste heat recovery system. P_{AEeff_Loss} is the necessary power to drive the waste heat recovery system.

2.1.1 P_{AEeff} is the reduction of the ship's total auxiliary power (kW) by the waste heat recovery system under the ship performance condition applied for EEDI calculation. The power generated by the system under this condition and fed into the main switch board is to be taken into account, regardless of its application on board the vessel (except for power consumed by machinery as described in paragraph 2.1.4).

2.1.2 P'_{AEeff} is defined by the following equation.

$$P'_{AEeff} = \frac{W_e}{\eta_g}, \tag{2}$$

where:

W_e : Calculated production of electricity by the waste heat recovery system
η_g : Weighted average generator efficiency

2.1.3 P_{AEeff} is determined by the following factors:

.1 temperature and mass flow of exhaust gas of the engines, etc.;

.2 constitution of the waste heat recovery system; and

.3 efficiency and performances of the components of the waste heat recovery system.

2.1.4 P_{AEeff_Loss} is the power (kW) for the pump, etc., necessary to drive the waste heat recovery system.

3 Method of verification

3.1 General

Verification of EEDI with innovative energy efficient technologies should be conducted according to the EEDI Survey Guidelines. Additional items concerning innovative energy efficient technologies not contained in EEDI Survey Guidelines are described below.

3.2 Preliminary verification at the design stage

3.2.1 In addition to paragraph 4.2.2 of EEDI Survey Guidelines, the EEDI Technical File which is to be developed by the shipowner or shipbuilder should include:

.1 diagrams, such as a plant diagram, a process flow diagram, or a piping and instrumentation diagram outlining the waste heat recovery system, and its related information such as specifications of the system components;

.2 deduction of the saved energy from the auxiliary engine power by the waste heat recovery system; and

.3 calculation result of EEDI.

3.2.2 In addition to paragraph 4.2.7 of the EEDI Survey Guidelines, additional information that the verifier may request the shipbuilder to provide directly to it includes:

.1 exhaust gas data for the main engine at 75 per cent MCR (and/or the auxiliary engine at the measurement condition of SFC) at different ambient air inlet temperatures, e.g. 5°C, 25°C and 35°C; which consist of:

.1.1 exhaust gas mass flow for turbo charger (kg/h);

.1.2 exhaust gas temperatures after turbo charger (C°);

.1.3 exhaust gas bypass mass flow available for power turbine, if any (kg/h);

.1.4 exhaust gas temperature for bypass flow (C°); and

.1.5 exhaust gas pressure for bypass flow (bar).

.2 in the case of system using heat exchanger, expected output steam flows and steam temperatures for the exchanger, based on the exhaust gas data from the main engine;

.3 estimation process of the heat energy recovered by the waste heat recovery system; and

.4 further details of the calculation method of P_{AEeff} defined in paragraph 2.1 of this appendix.

3.3 Final verification of the attained EEDI at sea trial

3.3.1 Deduction of the saved energy from the auxiliary engine power by the waste heat recovery system should be verified by the results of shop tests of the waste heat recovery system's principal components and, where possible, at sea trials.

3.3.2 In the case of systems for which shop tests are difficult to be conducted, e.g. in case of the exhaust gas economizer, the performance of the waste heat recovery system should be verified by measuring the amount of the generated steam, its temperature, etc. at the sea trial. In that case, the measured vapour amount, temperature, etc. should be corrected to the value under the exhaust gas condition when they were designed, and at the measurement conditions of *SFC* of the main/auxiliary engine(s). The exhaust gas condition should be corrected based on the atmospheric temperature in the engine-room (Measurement condition of *SFC* of main/auxiliary engine(s); i.e. 25°C), etc.

Appendix 2

PHOTOVOLTAIC POWER GENERATION SYSTEM (CATEGORY (C-2))

1 Summary of innovative energy efficient technology

Photovoltaic (PV) power generation system set on a ship will provide part of the electric power either for propelling the ship or for use inboard. PV power generation system consists of PV modules and other electric equipment. Figure 1 shows a schematic diagram of PV power generation system. The PV module consists of combining solar cells and there are some types of solar cell such as "Crystalline silicon terrestrial photovoltaic" and "Thin-film terrestrial photovoltaic", etc.

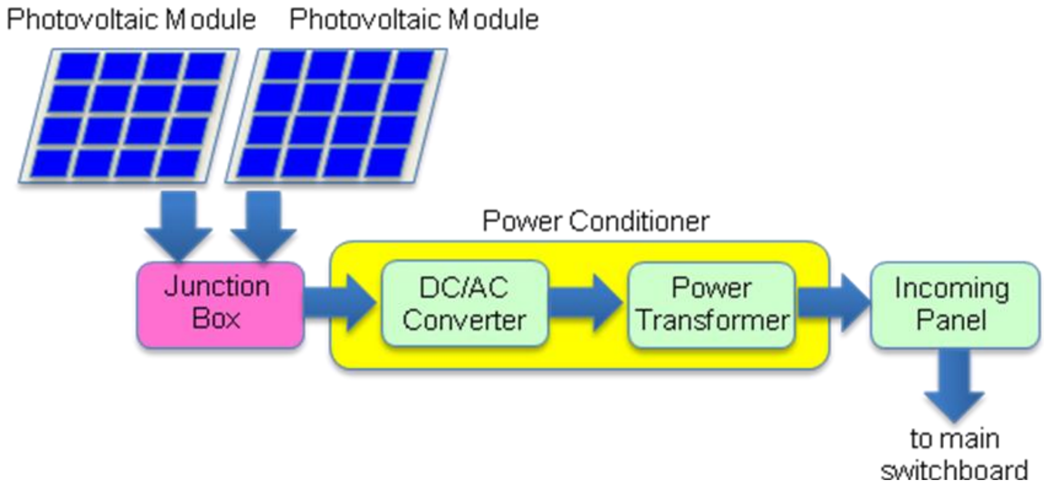

Figure 1 – Schematic diagram of photovoltaic power generation system

2 Method of calculation

2.1 Electric power due to photovoltaic power generation system

The auxiliary power reduction due to the PV power generation system can be calculated as follows:

$$f_{eff} \cdot P_{AEeff} = \{f_{rad} \times (1 + L_{temp} / 100)\} \times \{P_{max} \times (1 - L_{others} / 100) \times N / \eta_{GEN}\} \quad (1)$$

2.1.1 $f_{eff} \cdot P_{AEeff}$ is the total net electric power (kW) generated by the PV power generation system.

2.1.2 Effective coefficient f_{eff} is the ratio of average PV power generation in main global shipping routes to the nominal PV power generation specified by the manufacturer. Effective coefficient can be calculated by the following formula using the solar irradiance and air temperature of main global shipping routes:

$$f_{eff} = f_{rad} \times (1 + L_{temp} / 100) \quad (2)$$

2.1.3 f_{rad} is the ratio of the average solar irradiance on main global shipping route to the nominal solar irradiance specified by the manufacturer. Nominal maximum generating power P_{max} is measured under the Standard Test Condition (STC) of IEC standard[6]. STC specified by manufacturer is that: Air Mass (AM) 1.5, the module's temperature is 25°C, and the solar irradiance is 1000 W/m^2. The average solar irradiance on main global shipping route is 200 W/m^2. Therefore, f_{rad} is calculated by the following formula:

$$f_{rad} = 200\ \mathrm{W/m^2} \div 1000\ \mathrm{W/m^2} = 0.2 \qquad (3)$$

2.1.4 L_{temp} is the correction factor, which is usually in minus, and derived from the temperature of PV modules, and the value is expressed in per cent. The average temperature of the modules is deemed 40°C, based on the average air temperature on main global shipping routes. Therefore, L_{temp} is derived from the temperature coefficient f_{temp} (percent/K) specified by the manufacturer (See IEC standard[6]) as follows:

$$L_{temp} = f_{temp} \times (40°\mathrm{C} - 25°\mathrm{C}) \qquad (4)$$

2.1.5 P_{AEeff} is the generated PV power divided by the weighted average efficiency of the generator(s) under the condition specified by the manufacturer and expressed as follows:

$$P_{AEeff} = P_{max} \times (1 - L_{others}/100) \times N / \eta_{GEN}, \qquad (5)$$

where η_{GEN} is the weighted average efficiency of the generator(s).

2.1.6 P_{max} is the nominal maximum generated PV power generation of a module expressed in kilowatt, specified based on IEC Standards[6].

2.1.7 L_{others} is the summation of other losses expressed by percent and includes the losses in a power conditioner, at contact, by electrical resistance, etc. Based on experiences, it is estimated that L_{others} is 10 per cent (the loss in the power conditioner: 5 per cent and the sum of other losses: 5%). However, for the loss in the power conditioner, it is practical to apply the value specified based on IEC Standards[7].

2.1.8 *N* is the numbers of modules used in a PV power generation system.

3 Method of verification

3.1 General

Verification of EEDI with innovative energy efficient technologies is conducted according to EEDI Survey Guidelines**.** This section provides additional requirements related to innovative technologies.

3.2 Preliminary verification at the design stage

3.2.1 In addition to paragraph 4.2.2 of EEDI Survey guidelines, the EEDI Technical File which is to be developed by the shipowner or shipbuilder should include:

6 Refer to IEC 61215 "Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval" for Crystalline silicon terrestrial PV modules, and to IEC 61646 "Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval" for Thin-film terrestrial PV modules.

7 IEC 61683 "Photovoltaic systems – Power conditioners – Procedure for measuring efficiency".

.1 outline of the PV power generation system;

.2 power generated by the PV power generation system; and

.3 calculated value of EEDI due to the PV power generation system.

3.2.2 In addition to paragraph 4.2.7 of the EEDI survey guidelines, additional information that the verifier may request the shipbuilder to provide directly to it includes:

.1 detailed calculation process of the auxiliary power reduction by the PV power generation system; and

.2 detailed calculation process of the total net electric power $(f_{eff} \cdot P_{AEeff})$ specified in paragraph 2 in this guidance.

3.3 Final verification of the attained EEDI at sea trial

The total net electric power generated by PV power generation system should be confirmed based on the EEDI Technical File. In addition to the confirmation, it should be confirmed whether the configuration of the PV power generation systems on ship is as applied, prior to the final verification.

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MEPC.1/Circ.810
27 June 2013

IMPLEMENTATION OF MARPOL ANNEX V

Adequate port reception facilities for cargoes declared as harmful to the marine environment under MARPOL Annex V

1 The Marine Environment Protection Committee (the Committee), at its sixty-fourth session (1 to 5 October 2012), noting the short time between publishing criteria for solid bulk cargoes considered harmful to the marine environment (HME) under the revised MARPOL Annex V and the entry into force of the Annex (on 1 January 2013), and recognizing the difficulties this would cause for shippers to classify cargoes, agreed to issue circular MEPC.1/Circ.791 on Provisional classification of solid bulk cargoes under the revised MARPOL Annex V between 1 January 2013 and 31 December 2014.

2 At its sixty-fifth session (13 to 17 May 2013), the Committee acknowledged that, as a result of the difficulties experienced by shippers, consequential problems are being experienced by shipowners and operators in obtaining HME declarations and, when cargoes have been classified as HME, finding adequate reception facilities at receiving terminals.

3 In light of the above, the Committee agreed that, until 31 December 2015, cargo hold washwater from holds previously containing solid bulk cargoes classified as HME may be discharged outside special areas, providing:

.1 based upon the information received from the relevant port authorities, the master determines that there are no adequate reception facilities either at the receiving terminal or at the next port of call;

.2 the ship is en route and as far as practicable from the nearest land, but not less than 12 nautical miles;

.3 before washing, solid bulk cargo residue is removed (and bagged for discharge ashore) as far as practicable and holds are swept;

.4 filters are used in the bilge wells to collect any remaining solid particles and minimize solid residue discharge; and

.5 the discharge is recorded in the Garbage Record Book and the flag State is notified utilizing the Revised Consolidated Format for Reporting Alleged Inadequacies of Port Reception Facilities (MEPC.1/Circ.469/Rev.2).

4 In addition, the Committee urged Parties to MARPOL Annex V to:

.1 ensure the provision of adequate facilities at ports and terminals for the reception of solid bulk cargo residues including those contained in washwater;

.2 ensure shippers within their jurisdiction provide complete and accurate cargo declarations in accordance with MARPOL Annex V (and circular MEPC.1/Circ.791) and section 4 of the IMSBC Code; and

.3 notify the Organization for transmission to the Parties concerned of all cases where the facilities are alleged to be inadequate.

5 Further, ports and terminals receiving cargoes classified as HME are urged to provide adequate port reception facilities, including for residues contained in washwater. In the absence of such facilities, to minimize residues discharged under paragraph 3, terminals should facilitate the discharge of all solid bulk cargo residues ashore, including hold sweepings.

6 Member Governments are invited to bring the content of this circular to the attention of those interested, including port State control authorities, coastguard and maritime surveillance services, as appropriate.

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