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JSTRA

一般財団法人　日本船舶技術研究協会

第 10 回 ISO/TC8/SC8
（船舶及び海洋技術専門委員会／船舶設計分科委員会）
ロンドン総会出席報告書

Ⅰ　まえがき

2016 年 1 月 25 日～27 日にロンドンにおいて、第 10 回 ISO/TC8/SC8 総会及び関連するワーキンググループ（WG）が開催されました。

TC8/SC8 総会には 5 カ国（日本、中国、韓国、インドネシア及び UK）および 1 リエゾン（NACE：防食技術者協会）からの参加があり、日本からは、蓮池伸宏氏（ナカシマプロペラ株式会社）、佐藤圭氏（三菱重工業株式会社）、坂本信晶氏（国立研究開発法人海上技術安全研究所）および長谷川幸生（日本船舶技術研究協会）が参加いたしました。

今次会合では以下のスケジュールで審議が行われました（会議 AGENDA を巻末付録 1 で添付）。

開催日	AM（09:30-12:00）（議長国）	PM（13:00-17:00）（議長国）
1 月 25 日	SC8/WG10 LNG 船用傾斜計（韓国）	SC8/WG14 ﾌﾟﾛﾍﾟﾗｷｬﾋﾞﾃｰｼｮﾝ（韓国）
1 月 27 日	SC8/WG12 船舶振動（中国）＆ SC8/WG13 船舶騒音（中国）	SC8/WG15 カソード防食（NACE）
1 月 28 日	SC8 総会（韓国）	

今次会合での審議結果は次のとおりです。

【審議結果概要】

1) SC8/WG10（LNG 船用傾斜計作業委員会／コンビーナ：韓国）（検討対象規格：ISO/WD19636, LNG 船のトリム及びリストの測定に用いる傾斜計の一般要件）：　これまでの議論を通じて技術的な意見の反映は終了しているところ（日本の意見も反映済み）、今次会議では DIS（国際規格案）投票を実施するため規格としての様式（構成）のチェックを行いました。今次会議及び今後コレスポンデンスグループを通じて重複規定の削除、規定の補足などを行い、2 月末に DIS 投票用文書を取り纏めることが合意されました。（SC8 総会用 WG 報告書を巻末付録 2 で添付）

2) SC8/WG14（プロペラキャビテーション作業委員会／コンビーナ：韓国）（検討対象規格：ISO/WD20233, プロペラキャビテーション騒音評価試験法）：　これまでの審議を通じて日本が提出した、当該 ITTC 基準との整合化及び国内で用いられている Wire-mesh 法に関する規

定の追加は採用されており、今次会議では、前回会合（2015 年 7 月上海）において暫定採用となっていた、7.6 項 Other Option for Full-scale Noise Prediction について、経験式（Brown 式等）・数値流体力学（CFD）を援用した計算法の採用を求める日本意見への審議が行なわれ、認められました。また、今次会議にて韓国より新たに提案された 8 項「模型プロペラキャビテーション騒音計測結果に対する不確かさ解析」及び 9 項「模型プロペラキャビテーション騒音計測結果の報告形式」についても対応を行ない、前者については「キャビテーション騒音計測の不確かさの定量化は難しい」ことのみを規格本文中に記載し、残りの技術的な記述は全て Informative Annex で記載し、後者は削除することになり、こちらについても日本意見が全面的に採用されました。その他、今後の作業スケジュールについても日本意見に基づき、次回会議（2016 年 7 月上海）で DIS 投票用文書の最終確認を行い、8 月末に DIS 投票を行なうことが合意されました。（審議結果概要を後述）

3) SC8/WG12（船舶振動作業委員会／コンビーナ：中国）（検討対象規格：ISO/WD20154, 舶用補機の振動防止のための設計方法に関する指針）:　今次会議では WebEX（テレビ電話）で参加した USA 専門家から、ISO/TC108/SC2/WG2（船舶振動作業委員会）で作成されている関連 ISO 規格との整合を求める意見が出され、反映することになりました。日本としては情報収集を主体とした対応を行ないましたが、1 項（Scope）の記載に主機関の振動防止と誤解を生む可能性のある記載があったため、補機用機関（発電機用機関）と明確にするなど、規格作成に貢献しました。次回会議（2016 年 7 月上海）で再審議を行い、その後 CD（委員会原案）へ進めることになりました。（SC8 総会用 WG 報告書を巻末付録 3 で添付）

4) SC8/WG13（船舶騒音作業委員会／コンビーナ：中国）（検討対象規格：ISO/WD20155, 補機ポンプ配管からの船舶騒音の測定）:　水中騒音軽減のための一つの取り組みのため中国から提案されているもので、日本としては情報収集を主体とした対応を行ないました。この規格は ISO/TC43/SC3（水中の騒音分科委員会）における標準化の議論を考慮しつつ作業を進めていることが説明されましたが、船内環境を考慮しない実験室における測定方法を定めているため、船舶用 ISO 規格として取り扱うことへの疑問（陸用と何が違うのか）が払拭されず、審議は活性化しませんでした。次回会議（2016 年 7 月上海）で再審議を行い、その後 CD（委員会原案）へ進めることになりました。（SC8 総会用 WG 報告書を巻末付録 4 で添付）

5) SC8/WG15（カソード防食作業委員会／コンビーナ：NACE）（検討対象規格：ISO/WD20313, 船舶及び海洋技術－船舶用カソード防食）:　NACE 及び欧州に於ける検査を念頭に欧州規格である CEN 規格を基礎に開発を進めることになり、今後 WG 参加各国に対して原案作成作業分担引き受けの是非が問い合わされることになりました。また、今次会議においてコンビーナは船体外板のカソード防食に留まらず、バラストタンク・ポンプなどの船内設備も含めた幅広い範囲を対象とした標準化を行なうことを強く主張しましたが、TC8/SC8 議長（韓国）は標準化の対象を安易に広げるべきではないことを指摘し、結論には至りませんでした。この議論の際、日本より ISO 規格の開発は NP（新業務項目提案）投票で各国から承認された適用範囲を逸脱できないこと、ISO/TC8 では IMO を考慮した ISO 規格作成を実施しており、IMO における基準も考慮しなければならないこと、更には ISO 規格と CEN 規格とは位置付けが異なるため、その旨は留意すべきであることを提案し、WG コンビーナが今後の ISO 規格開発に当たり考慮することになりました。（SC8 総会用 WG 報告書を巻末付録 5 で添付）

6) SC8（船舶設計分科委員会／議長・幹事：韓国）:　前述の WG 活動報告が確認されたほか、韓国から今後 NP 提案を計画している「小規模 LNG タンク用高マンガン鋼の仕様」の標準化に関するプレゼンテーションが行なわれました（巻末付録 13 で添付）。この提案は韓国国家プロジェクトに基づいており、IMO/CCC2（第 2 回貨物輸送小委員会）の INF.18 として IMO にも参考情報の提供を行なったことなどがこの ISO 規格案で定める内容の概要とともに紹介されました。なお、質疑応答の際、「小規模」の定義を確認したところ、LNG 燃料船のタンク容量では 5,000m3 程度まで、LNG 運搬船のタンク容量では 10,000m3 程度までを想定しているとの回答がありました。この標準化に関する情報は引き続きご提供させて頂く予定です。（今次 SC8 総会の出席者リストを巻末付録 6、SC8 議長報告を巻末付録 7、決議文を巻末付

録 8 で添付）

7) 次回 TC8/SC8 総会は、今回開催と同様に SC8/WGs と併催する形で 2016 年 7 月 5 日ー7 日に上海にて開催される予定です。

以下、前述のうち、このたびの ISO/TC8/SC8 総会における ISO/TC8/SC8/WG14 会議結果の詳細をご報告します。

【審議結果詳細】

SC8/WG14 プロペラキャビテーション作業委員会（韓国主導）（1/25 PM）

（参加者：韓国 4 名（SC8 議長／幹事、ISO20233 のプロジェクトリーダー他）、日本 4 名（蓮池様、佐藤様、坂本様および長谷川）、インドネシア 2 名（オブザーバー）、中国 1 名（SC8/WG12&13 議長代理）の計 11 名）

【検討対象規格】

ISO/WD 20233（プロペラキャビテーション騒音評価試験法）（今回審議用ドラフトを巻末付録 9 で添付）

【日本の対応方針】

1. 事前提出した 3 つの日本意見の採用に努める。

① 計算式関連の 7.6 項の採用

② 8 項（Uncertainty）の削除

③ 9 項（Reporting）の削除。

2. ただし、8 項及び 9 項を新たに韓国が提案しているところ、全文削除には応じない可能性がある。前述 1.の反映に最大限努力を行なうが、反映が難しい場合には、巻末付録 10 に基づく対応を行ない、日本としての懸念点の払拭に努める。

3. MARIN やドイツなどの急な出席、コメント提出などがあった場合は、これまでの国際審議で採用されている以下の事項の確保をしつつ、日本としての懸念点の是正を図る。

① Wire-mesh 法の取り入れ。

② ITTC 法との整合化

③ 計算法の言及（1 項及び 7.6 項）

4. 今回審議の結果、日本として受け入れられる内容である場合（現行案に近い内容となった場合）、3 回の国際審議を行ない、十分検討が尽くされたことを理由として、DIS（国際規格案）段階へ進めることを提案する。

5. 審議結果を明確にするため、日本意見（他国から意見提出があればその意見も含め）への採否結果を会議の席上で記載することを提案する。

6. その他、宋委員に意見を提出してきたドイツの Wittekind 氏は SC8/WG14 専門家ではなく、WG 会議への出席権及びコメント提出権を持たない。しかし、ドイツ参加者経由などでコメントを提出する可能性はあるため、その場合には、海上技術安全研究所殿に作成頂き、国内 WG 各位の意見を反映した巻末付録 10 に基づく対応を行なう。

【今次 ISO 会議の審議結果】

（今次会議用に提出された各国意見及び採否結果を巻末付録 11、SC8 総会用 WG 報告書を巻末付録 12 で添付）

1. 実船プロペラ騒音推定のその他の方法（7.6 項）

前回会合（2015 年 7 月上海）において、模型試験と同等な方法として経験式・CFD を用いる方法を採用してはどうかという意見を、日本側より提出していた。この時点では暫定的に採用する方向となっていたが、更なる審議が必要という結論であった。

経験式・CFD を援用することの有用性は主に、1) すでに設計に有効に活用されている事実があること、2) キャビテーションの発生範囲に基づく簡易推定法では推定値が推定した騒音が水槽の音響環境影響（背景雑音，反響等）を受けない、3) 従来法ではそのスケーリング法が確立されていない翼端渦キャビテーション・ハブ渦キャビテーションに由来する騒音にも対応可能という点である。経験式・CFD を用いることで、プロペラ設計の初期段階から発生し得るキャビテーション騒音の実船推定が可能となる。今次審議に当たっては、事前に経験式・CFD の使用について既存研究を調査すると共に、海上技術安全研究所殿で実施中の先導研究において、実際にその有用性を確かめた上で、審議に臨んだ。同時に規格原案中の文章中、経験式による簡易推定法については、Brown の式のみを参照する内容から、Brown の式に限定しない記述に改め、Brown の式をはじめとした複数の方法を採用できるよう、複数文献、ITTC レポート等を参照する内容に見直し、各国で鋭意進められている研究成果が得られた場合に欧州・韓国を始めとする他国にも受け入れ易い柔軟性のある表現とした。その結果、日本提案が全面的に採用となった。

2. 模型プロペラキャビテーション騒音計測結果に対する不確かさ解析（8 項）

本件は、今回の審議前に初めて韓国から提案されたものであった。日本としては、キャビテーション騒音計測の不確かさの定量化には未だ研究要素が多く残っていることから、ISO 規格に記載するには時期尚早、従って全面的に削除すべきという意見を以て審議に臨んだ。韓国側もキャビテーション騒音計測の不確かさの定量化が難しい（例えば、背景雑音や反響に対する不確かさをどのように定量化するのかなど）ことは理解しており、審議の結果、「キャビテーション騒音計測の不確かさの定量化は難しい」ことのみを規格本文中に記載し、残りの技術的な記述は全て Informative Annex（参考附属書）に移動することとなった.

3. 模型プロペラキャビテーション騒音計測結果の報告形式（9 項）

本件も上記 “2.” 同様、今回の審議前に初めて韓国から提案されたものであった。日本としては、1) 報告形式はプロペラキャビテーション騒音評価試験法そのものには関係しないこと、2) 報告形式は試験機関毎に異なり、普遍的な報告形式を決めるには十分な議論が必要となることから、ISO 規格に記載する必要は無く、全面的に削除すべきという意見を以て審議に臨んだ。韓国側も上記日本意見に同意し、審議の結果、全面的に削除することで合意した。

4. 模型プロペラキャビテーション騒音計測の計測時間

本件は、今次会議前日にドイツより提案された。通常のキャビテーション水槽と、減圧曳航水槽とでは、プロペラの回転数が大きく異なる。キャビテーション水槽と異なり、減圧曳航水槽ではフルード数相似則を用いて試験を行う。そのためプロペラ回転数は通常の自航試験程度となり、その値はキャビテーション水槽で使用する値よりも小さい。従って、減圧曳航水槽を用いた試験時では、キャビテーション水槽試験で規定された計測時間は十分でなく、十分なサンプリング数のデータが取れないことになる。審議の結果、技術的に妥当であるドイツ提案を採用し、規格原案中に上記注意事項を記載することとなった。

5. 供試プロペラおよび船体の仕上げ精度

本件は、韓国より席上で提案された。規格原案における仕上げ精度の記述は、供試プロペラでは翼断面オフセットの記述のみ、船体では主寸法(L, B, d 等の記載は無し)のみとなっていた。しかし、上記を規定する evidence となる ITTC Recommended Procedures (7.5-01-01-01, 7.5-01-02-02)では、翼断面オフセット、主寸法以外にも要目に関して具体的な記述がある。審議の結果、規格原案を修正し ITTC Recommended Procedure に記載のとおりとすることで合意した。

6.　適用範囲（1 項）の見直し

上記 1.の**実船プロペラ騒音推定のその他の方法**（7.6 項）の審議に関連して、適用範囲（1 項）の内容を見直し、以下の記載（1 項の第一段落および第二段落）を Introduction へ移行することを合意した。

The propeller cavitation noise can be assessed by experimental and/or numerical methods in propeller design stage. The numerical method such as CFD or empirical formulae might be a good alternative to propeller cavitation noise evaluations. However, the model tests are still used widely to predict the full scale acoustic source strength of the cavitating propeller for a wide range of frequencies.

Special ships such as fishery research vessels and military vessels require propellers with less or no cavitation in their operating conditions. In this case, the noise radiated from the propeller might be less significant than the cavitating one and other mechanical noises become dominant.

7.　その他

次回会合は，2016 年 7 月 5 日ー7 日に上海にて実施予定。また日本として、次回の規格修正案を最終案（2016 年 4 月末を目途に Fix）とし、 DIS 投票段階に進めることを提案した結果、韓国コンビーナおよび審議に参加した各国の了承を得た。1 月 27 日に開催された SC8 総会において、2016 年 8 月末までに DIS 投票を実施することが決議（Resolution）された。

8.　出席者所感

今回会議に出席いただいた各位の事前の準備および会議席上での活発な説明および提案のおかげで、日本意見が全面的に反映されることになった。これまでの審議を通じて、韓国コンビーナが日本意見の妥当性を認識していることも採用に大きく貢献したものと思われる。また、国際審議においては意見だけを述べるのではなく、具体的にどのように訂正するかも合わせて提案する重要性を再認識する会議となった（相手任せでは意見が妥当であっても採用されない）。

次回会議（2016 年 7 月上海）において、DIS 投票用文書の最終確認を行なうことになっており、引き続きのフォローアップが必要である。

ISO/TC8/SC8 総会写真

MHI 佐藤様（写真後列左から 2 人目）、海技研　坂本様（同 3 人目）、ナカシマプロペラ蓮池様（同 4 人目）、長谷川（前列左から 2 人目）、Sei-chang Li SC8 議長（同三人目）

以上

ISO/TC8/SC8 ロンドン総会報告書　付録

頁番号

NOTICE OF MEETING / DRAFT AGENDA **CONVOCATION / PROJET D'ORDRE DU JOUR**	
Date	2015-12-21
Reference **ISO/TC 8/SC 8**	**N320**

Title of / Titre du TC/SC

Ships and marine technology/Ship design

Secretariat / Secrétariat KATS	MEETING / RÉUNION Meeting dates / Dates de la réunion From 2016-01-25 To 2016-01-27
Host / Invitant BSI Ms. Emelie Bratt emelie.bratt@bsigroup.com Tel. : +44 20 8996 7203 Fax : +44 20 8996 0000	Place / Lieu British Standards Institution 389 Chiswick High Road London W4 4AL United Kingdom www.bsigroup.com

P-and O-members are invited to inform the secretariat of the committee concerned, within one month of the receipt of this notice of meeting, of their intention to be represented at the meeting, the approximate number of their delegates and their need for interpretation.

Whenever possible, the names of delegates (or observers) and the name of the head of the delegation should also be sent to the secretariat of the committee concerned at least one month before the opening of the meeting.

Les membres (P) et (O) sont invités, dans un délai d'un mois à partir de la réception de la présente convocation, à faire connaître au secrétariat du comité concerné leur intention d'être représentés à la réunion, le nombre approximatif de leurs délégués et leur besoin en matière d'interprétation.

Dans la mesure du possible, une liste indiquant les noms des délégués (ou observateurs), ainsi que le nom du chef de la délégation, devrait également parvenir au secrétariat concerné un mois au moins avant l'ouverture de la réunion.

Meeting Schedule

Date	Morning session	Afternoon session
2016-01-25	WG 10(Inclinometer for LNG carriers)	WG 14(Propeller)
2016-01-26	WG 12(Ship vibration), WG 13(Ship noise)	WG 15(Cathodic protection of ships)
2016-01-27	SC 8 Plenary Meeting	

Morning session starts from 09:30, and afternoon session starts from 13:00.

Contact point : Please inform SC 8 Secretary who will participate in the ISO/TC 8/SC 8 Plenary Meeting by 2016-01-08 using Registration form attached.

ISO/TC 8/SC 8 Secretary

Mr. Byeong-cheol Choi, Tel : 82-2-2112-8064, E-mail : bcchoi@koshipa.or.kr

ISO/TC 8/SC 8 Chairman

Dr. Sei-chang Lee, Tel : 070-8103-9570, E-mail : sclee9411@gmail.com

1. Opening of the meeting (09:30)

2. Roll call of delegates

3. Adoption of the agenda : Doc. ISO/TC 8/SC 8 N320

4. Appointment of the drafting committee

5. Review of the previous Plenary Meeting Resolution

6. Report of ISO/TC 8/SC 8 Chairman and Secretary
   6.1 Report of Chairman : ISO/TC 8/SC 8 Management Report
   6.2 Report of Secretary : ISO/TC 8/SC 8 Status Report

7. Reports of Working Group Meetings
   7.1 WG 10(Inclinometer for LNG carriers) : Convenor(Mr. Dong-hyun Kim)
   7.2 WG 12(Ship vibration) : Convenor(Dr. Wenwei Wu)
   7.3 WG 13(Ship noise) : Convenor(Dr. Wenwei Wu))
   7.4 WG 14(Propeller) : Convenor(Dr. Bo-ha Lee)
   7.5 WG 15(Cathodic protection of ships) : Acting Convenor(Mr. Ken Lax)

8. Possible NWIP Presentation

9. Any other business

10. Date and place of the next meeting

11. Approval of resolutions

12. Closure of the meeting

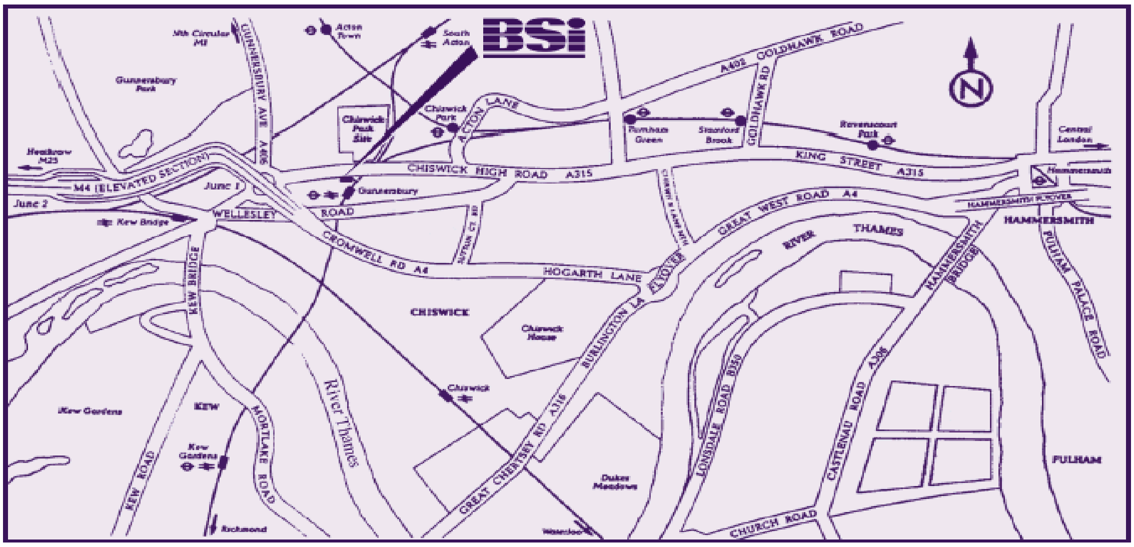
British Standards Institution

389 Chiswick High Road,
London W4 4AL
United Kingdom
Tel : +44 20 8996 7203
Ms. Emelie Bratt
E-mail : emelie.bratt@bsigroup.com
www.bsigroup.com

Location

BSI is located approximately 10 km west of the centre of London and 10 km east of London(*Heathrow*) airport. The building is located directly above *Gunnersbury* Station on the London Underground railway system (see map below).

http://www.streetmap.co.uk/streetmap.dll?grid2map?X=519750&Y=178250



Public transport

For travel around London, the Underground is recommended for most journeys. There are several ways to travel into Central London from the various airports but the following are recommended:

- from **Heathrow Airport**, take the Piccadilly Line on the Underground; change at Hammersmith and take the District line (Richmond branch) in the opposite direction (across the footbridge) to reach BSI;

- from **Gatwick Airport**, use one of the frequent train services (which include the Gatwick Express) to Victoria National Rail Station and change to the District Line on the Underground (take a Richmond train to reach BSI);
- from **London City Airport**, take the Docklands Light Railway to Bank station, which has a linking walkway to Monument Underground Station for the District Line (take a Richmond train to reach BSI);
- from **Stansted Airport**, take the Stansted Express to Liverpool Street National Rail Station and change to the Circle Line (shown in yellow) on the Underground (towards Edgware Road); to reach BSI, change to a Richmond train on the District Line at Tower Hill (or any one of the next 12 stations).

If arriving by **Eurostar** at St Pancras International Station, take the Piccadilly Line on the Underground (King's Cross St. Pancras Underground Station). To reach BSI, change at Hammersmith and take the District line (Richmond branch) in the same direction (on the other side of the same platform).

For further information (in several languages), see http://www.tfl.gov.uk/

Public Transport in London

The easiest and most cost effective way to use public transport in London is to purchase an Oyster Card. This can be done either on-line or at any tube station and does not require a photo ID. An oyster card is a pay-as-you-go card that is valid on buses, tube trains, overground trains and the Docklands Light Railway (DLR). It can be topped up using a credit card at a ticket machine that can be found at any station. To encourage the use of the Oyster Card, fares are less than half the price of paying by cash. Details of Visitors Oyster cards are available at;
http://www.tfl.gov.uk/tickets/faresandtickets/visitortickets/5185.aspx
For further information on Transport for London, including maps, visit;
http://www.tfl.gov.uk

Passports and visas

All visitors to the UK require a valid passport and some may require a visa. For more information please check with your travel agent or visit http://www.ukvisas.gov.uk .
If you require a letter of invitation to obtain a visa, please contact Ms. Emelie Bratt at BSI (emelie.bratt@bsigroup.com).

Entry to the building

You will probably be asked to show a copy of the notice of meeting or agenda at the Reception desk.

Meeting facilities

Delegates will be able to access the internet via the BSI Internet Café located on the ground floor of the building. In addition, all meeting rooms have wireless internet access. Copying facilities will be available for reproduction of documents drafted during the meeting.

There is a restaurant on the first floor offering a full range of meals and snacks. BSI is located on a busy high street and there are a number of bars and restaurants within a few minutes' walk of the building.

BSI Restaurant

Visitors may use the BSI restaurant at lunchtime, but at their own expense. Meals must be paid for in UK currency (typically a two-course meal will cost £7 or £8): the restaurant does accept credit and debit cards but do not accept Euros or other foreign currency.

Electrical Appliances

The electric power supply is 220 volts AC, with a frequency of 50 hertz.
Power outlets use a plug design that is primarily used only in the UK, hence most visitors will need to purchase a plug converter at the airport.
The majority of battery chargers for mobile phones and laptops will accept a wide range of input voltages, hence a voltage converter will probably not be needed.

Currency

The unit of currency in the UK is the £ (UKP).

Hotels

The Chiswick Moran Hotel is just along the road from our offices. You should also search on www.lastminute.co.uk or www.laterooms.com or similar site as they will occasionally have sales for the nearby hotels that may work out cheaper.

When you are ready to make your booking, please contact the hotel directly and request the '**BSI Rate**' to secure the negotiated rate.

ISO/TC 8/SC 8

Ships and Marine Technology/Ship Design

Title : Ships and Marine Technology/Ship Design	Secretary : Mr. Byeong-cheol Choi
Secretariat : KATS	Email : bcchoi@koshipa.or.kr

Please complete and return this form no later than 2016-01-08
to ISO/TC 8/SC 8 Secretary, Mr. Byeong-cheol Choi.

To : Mr. Byeong-cheol Choi(bcchoi@koshipa.or.kr) Tel:+82-2-2112-8064

Registration form

10th Plenary Meeting and Working Group meetings of ISO/TC 8/SC 8

Venue : British Standards Institution
389 Chiswick High Road
London W4 4AL
United Kingdom

Morning session(M) starts from 09:30, and afternoon session(A) starts from 13:00.

Please mark **O** in Participation box.

Meeting	Date	Participation
WG 10(Inclinometer for LNG carriers)	2016-01-25(M)	
WG 14(Propeller)	2016-01-25(A)	
WG 12(Ship vibration)	2016-01-26(M)	
WG 13(Ship noise)		
WG 15(Cathodic protection of ships)	2016-01-26(A)	
ISO/TC 8/SC 8 Plenary Meeting	2016-01-27(M)	

First Name		Surname	
Representing Member Body (or Organization)		Head of delegation	
Company		Position	
City		Country	
Telephone		E-mail address	
Accompanied by (Mr./Ms./Mrs./Miss) First name & Surname			
Date of arrival		Date of departure	
Hotel name			

ISO/TC 8/SC 8/WG 10/N007

Meeting results of ISO/TC 8/SC 8/WG 10 (Inclinometer for LNG Carriers)

by

Dong-hyun Kim, Convenor

Opening

1 The 4th ISO/TC 8/SC 8/WG 10 (Inclinometer for LNG Carriers) was held on 2016-01-25 at BSI in London with the participation from China, Japan, Indonesia, Sweden and Republic of Korea.

2 The meeting was opened by SC 8/WG 10 Convenor welcoming all the participants with their active contributions to develop the international standards of the concerned Ship design.

Report of the convenor

3 The convenor shall circulate the clean working draft for review by WG members by 2016-02-15. The report of WG 10 meeting shall be submitted to SC 8 as follows:

.1 Discussion of ISO/WD 19636

- Ships and marine technology - General requirements for inclinometers used for determination of trim and list of LNG carriers has been discussed in detail at this meeting. Given the DIS target date, 2016-03-10, the convenor is encouraged to finalize the clean version of WD 19636 and to send the final draft to WG members for further comments by 2016-02-22, and submit all the necessary documentations to SC 8 secretary by 2016-02-29 for formal DIS ballot. SC 8 agrees to skip CD voting and proceed to the next DIS stage.

.2 Target date of ISO 19636

1) Target date for submission as DIS: 2016-03-10

2) Target date for submission as IS: 2017-03-10

4 WG 10 extends great appreciation to *BSI* for being a kind and helpful arrangements.

List of attendance : 09

Name	Company	Country	Email address
Dong-hyun Kim	Korea Marine Equipment Research Institute	Korea, RO (Convener WG10)	Kdh9942@komeri.re.kr
Ola Hall	Emerson	Sweden	Ola.hall@emerson.com
Kosei Hasegawa	Japan Ship Technology Research Association (JSTRA)	Japan	hasegawa@jstra.jp
Yao Shi	Standardization Administration of China (SAC)	China	345477346@qq.com
Muhdar Tasrief	Biro Klasifikasi Indonesia	Indonesia	muhdar@bki.co.id
Agus Widjaja	PT Biro Klasifikasi Indonesia	Indonesia	agus.widjaja@bki.co.id
Sei-chang Lee	SC8 Chairman	Korea, RO	sclee9411@gmail.com
Byeong-cheol Choi	SC8 Secretary (Korea Offshore and Shipbuilding Association)	Korea, RO	bcchoi@koshipa.or.kr
Cheol-soo Park	Korea Research Institute of Ships and Ocean Engineering	Korea, RO	parkcs@kriso.re.kr

Annex - Meeting result of WG12

2016-01-26

Minutes of ISO/TC8/SC8/WG12 (Ship Vibration) Meeting

by
Ms. Yao Shi, Acting Convener

Report of WG 12

January 26th, 2016

- The third WG12 meeting was held in London on January 26, 2016 mainly discussed standards of ship vibration, namely ISO/WD 20154 Guidelines on design method of vibration isolation for shipboard auxiliary machinery.

- Participants: Totally 13 representatives from China, Japan, Korea, United States (P members) and Indonesia (observers) attended the meeting (see the appendix). Dr. Wenwei WU, Mr. Skip William, Mr. Tao He and Mr. Bin Yan also attend the meeting through Webex.

- Ms. Yao Shi held the meeting on behalf of Dr. Wu Wenwei (ISO/TC8/SC8/WG12 convenor) and explained the reason for the absence of Dr. Wenwei Wu and 3 other Chinese experts due to the UK Visa problem.

- Ms. Yao Shi made a brief introduction of WG12 and the progress of work items:

  - WG12 was founded in November 2014; currently one international standard is under development ;
  - ISO/WD 20154 was officially registered in July 2014, and the NP circulation has been completed in 2014;

- Ms. Yao Shi introduced the development and way forward of ISO/WD 20154;

- Even the ISO/TC8 Resolution 269 suggest to skip CD stage, Ms. Yao Shi proposed to open the CD ballot of ISO/WD 20154 on behalf of Dr. Wenwei WU in order to collect more comments and encourage the active participation of experts.

- The convenor of ISO/TC8/SC8/WG12 will circulate the revised version of WD 20154 via Email and eCommittees by the end of April, 2016. Members of the working group are encouraged to comment on this working draft.

- The next meeting will be held in July 2016, Shanghai in conjunction with ISO/TC8/SC8 intersessional meeting.

- WG12 expressed its sincere appreciation to the host, British Standard Institute(BSI) and all members attended, for the great support of ISO/TC8/SC8/WG12 meeting in London, UK.

Appendix:

List of WG12 participants

NO	Organization	Name	E-mail address
1	SC8 Chairman(NIPA)	Sei-chang Lee	Sclee9411@gmail.com
2	SC8 Secretary (Korea Offshore and Shipbuilding Association)	Byeong-cheol Choi	bcchoi@koshipa.or.kr
3	Shipbuilding information center of china	Yao Shi	345477346@qq.com
4	Japan Ship Technology Research Association (JSTRA)	Kosei Hasegawa	hasegawa@jstra.jp
5	PT Biro Klasifikasi Indonesia	Agus Widjaja	agus.widjaja@bki.co.id
6	PT Biro Klasifikasi Indonesia	Biro Klasifikasi Indonesia	muhdar@bki.co.id
7	POSCO	Ki-Hwan Kim	kihwank@posco.com
8	Korea Research Institute of Ships and Ocean Engineering	Cheol-soo Park	parkcs@kriso.re.kr
9	Nakashima Propeller Co., Ltd	Nnobuhiro Hasuike	nobuhiro@nakashima.co.jp
10	National Maritime Research Institute	Nobuaki Sakamoto	sakamoto@nmri.co.jp
11	Mitsubishi Heavy Industries,Ltd	Kei Sato	kei_sato@mhi.co.jp

Annex - Meeting result of WG13

2016-01-26

Minutes of ISO/TC8/SC8/WG13 (Ship Noise) Meeting

by

Ms. Yao Shi, Acting Convener

Report of WG 13

January 26th, 2016

- The third WG13 meeting held in London on January 26, 2016 mainly discussed standard of ship noise, namely ISO/WD 20155 Test method of flow induced in-pipe noise source characteristic.
-
- Participants: Totally 13 representatives from China, Japan, Korea, (P members) and Indonesia (observers) attended the meeting (see the appendix). Dr. Wenwei WU, Mr. Bin Yan and Mr. Tao He also attend the meeting through Webex.

- Ms. Yao Shi held the meeting on behalf of Dr. Wenwei WU (Convneor of ISO/WD 20155) and explained the reason for the absence of Dr. Wenwei WU and 3 other Chinese experts due to the UK Visa problem.

- Ms. Yao Shi made a brief introduction of WG13 and the progress of work items:

  - WG13 was founded in November 2014; currently 1 international standard is under development ;
  - ISO/WD was officially registered in July 2014, and the NP circulation has been complete in 2014;

- Ms. Yao Shi introduced the development and way forward of ISO/WD 20155;

- Even the ISO/TC8 Resolution 269 suggest to skip CD stage, Ms. Yao Shi proposed to open the CD ballot of ISO/WD 20155 on behalf of Dr. Wenwei Wu in order to collect more comments and encourage the active participation of experts.

- TC8/SC8 has officially established Category A liaison with TC43/SC3 in June 2015 and TC43/SC3 has nominated Mr. Michael Bahtiarian as their liaison officer to ISO/TC8/SC8.

- The convenor of ISO/TC8/SC8/WG13 will circulate the revised version of WD 20155 via Email and eCommittees by the end of April, 2016. Members of the working group are encouraged to comment on this working draft.

- The next meeting will be held in July 2016, Shanghai in conjunction with ISO/TC8/SC8 intersessional meeting.

- WG13 expressed its sincerely appreciation to the host, British Standard Institute(BSI) and all members attended, for the great support of ISO/TC8/SC8/WG12 meeting in London, UK.

Appendix:

List of WG13 participants

NO	Organization	Name	E-mail address
1	SC8 Chairman(NIPA)	Sei-chang Lee	Sclee9411@gmail.com
2	SC8 Secretary (Korea Offshore and Shipbuilding Association)	Byeong-cheol Choi	bcchoi@koshipa.or.kr
3	Shipbuilding information center of china	Yao Shi	345477346@qq.com
4	Japan Ship Technology Research Association (JSTRA)	Kosei Hasegawa	hasegawa@jstra.jp
5	PT Biro Klasifikasi Indonesia	Agus Widjaja	agus.widjaja@bki.co.id
6	PT Biro Klasifikasi Indonesia	Biro Klasifikasi Indonesia	muhdar@bki.co.id
7	POSCO	Ki-Hwan Kim	kihwank@posco.com
8	Korea Research Institute of Ships and Ocean Engineering	Cheol-soo Park	parkcs@kriso.re.kr
9	Nakashima Propeller Co., Ltd	Nnobuhiro Hasuike	nobuhiro@nakashima.co.jp
10	National Maritime Research Institute	Nobuaki Sakamoto	sakamoto@nmri.co.jp
11	Mitsubishi Heavy Industries,Ltd	Kei Sato	kei_sato@mhi.co.jp

10th PLENARY MEETING OF ISO/TC8/SC8

WG15 CATHODIC PROTECTION OF SHIPS

PROGRESS REPORT

Prepared by: K. C. Lax – Acting Convenor

26 January 2016

Introduction

The first meeting of this WG took place in Tokyo in February 2015. The meeting resulted in a working draft, which was issued in May 2015. The convenor (Capt. Twombly -USA) resigned in about September 2015 and a new convenor (Mr. Ellor – USA) was appointed. Mr. Ellor resigned in December 2015 and Mr. Lax (UK) was appointed as Acting Convenor.

Report of the acting convenor

A working draft for part of the proposed standard was produced in May 2015 and in June 2015 comments on the draft were made by the UK. It is understood that Japan and the UK were the only members who made any comments.

In October 2015 the convenor (Mr. Ellor) made an appeal for additional comments. It is understood that none were made.

In December 2015 a draft agenda and an outline for the proposed revised draft were issued. Comments have been received from China, but no one else. A copy of the proposed outline is attached.

There is an existing standard EN 16222:2012 that deals with the same subject. It was prepared by CEN TC 219 and is considered to be a good starting point for this document. The principle area of concern with the CEN standard is with regard to the sizing of the anode/cathode separation, which is technically wrong. One option would be to adopt this standard but modify the anode/cathode separation section. I do not know if this is administratively acceptable.

Alternatively we can write a new standard that incorporates the details in EN 16222 and improves the anode/cathode separation and seek for CEN to adopt it as a joint standard. I am a member of TC 219 Seawater group (WG 3) and my impression is that this would be acceptable to them. We could also take the opportunity to incorporate the cathodic protection of the ballast tanks.

<u>Target Dates</u>

The present target dates are:

DIS: 12 January 2016

Membership

There are 19 committee members of which 14 are potential active working group members.

Distribution by nation is:

Country	Active	Admin	Total
Belgium	2	0	2
China	3	0	3
Germany	0	1	1
Japan	3	1	4
United Kingdom	1	1	2
United States	5	2	7

Decisions required from SC 8

1. In view of the apparent lack of interest from the majority of the members should we cancel the work item?
2. If we do **not** cancel this work item then basically we have two options:
    a. Adopt EN 16222 with modified text for anode/cathode separation
    b. Prepare a new ISO draft and, ideally, seek for CEN acceptance/collaboration
3. There are major shipbuilding and seafaring nations that are conspicuous by their absence from this working group as active members, for example:
    a. South Korea
    b. Singapore
    c. Canada
    d. France
    e. Germany
    f. Finland
    g. Norway
    h. Sweden
    i. Denmark
    j. The Netherlands
4. Countries that are not actively participating should be directly approached and encouraged to participate. It is noted that Germany voted against the CEN 16222, so it is particularly important that their point of view should be presented to this WG.

Resolutions from 2nd Meeting London 26 January 2016

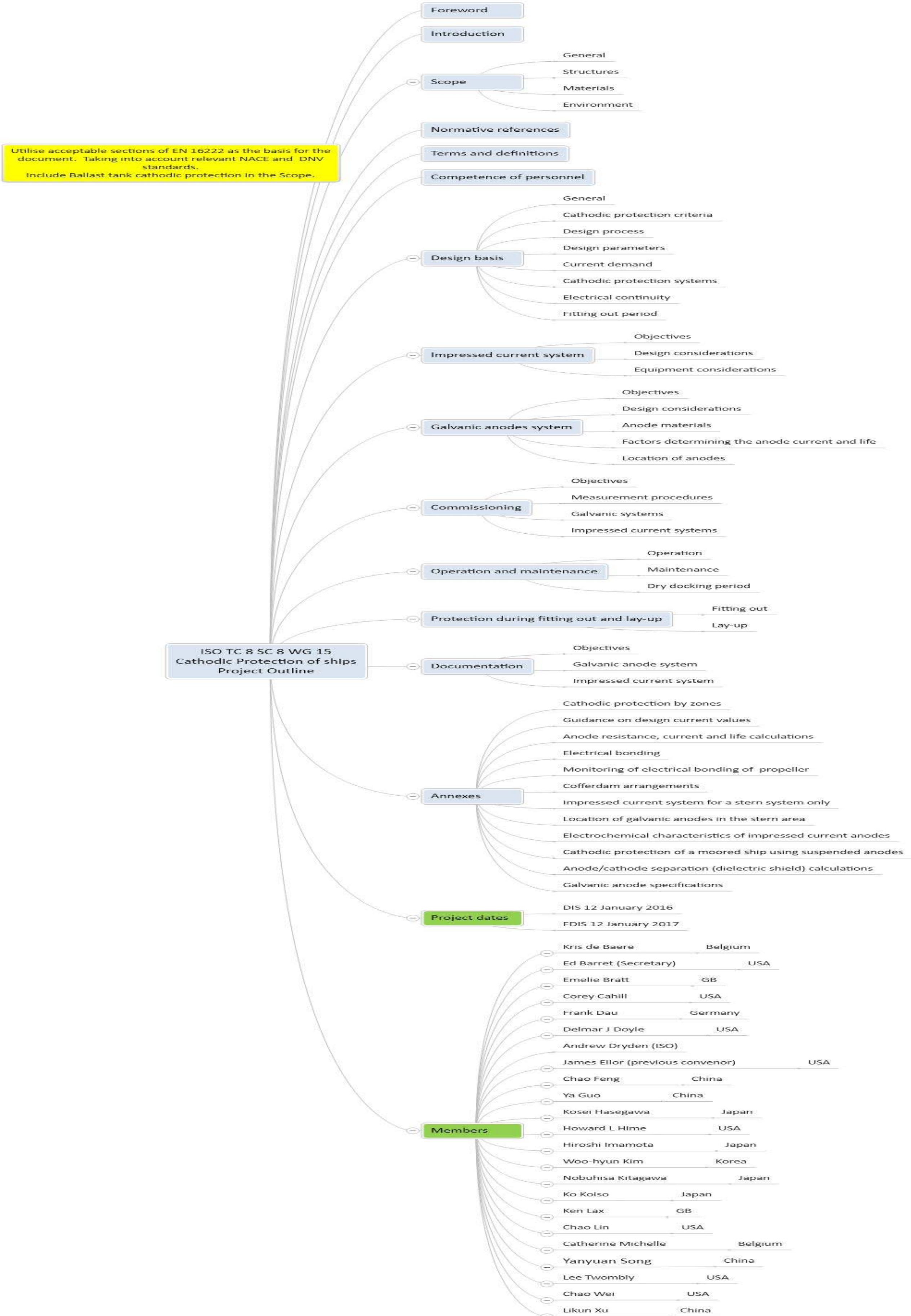
2016 – 01 A project extension will be requested from TC 8 SC 8, preferably for 1 year so that the present FDIS date will become the new DIS date

Actions from 2nd Meeting, London 26 January 2016

1. Ken Lax will contact CEN/TC 219 to see if they wish to collaborate writing the new standard

2. National delegates will check with their mirror groups who will actively participate in any future meetings.
3. Japan will confirm that they are in agreement with proposed TC 219 co-operation or advise why they oppose it.

Proposed Document Outline


ISO TC 8 SC 8 WG 15
Cathodic Protection of ships
Project Outline
Utilise acceptable sections of EN 16222 as the basis for the document. Taking into account relevant NACE and DNV standards.
Include Ballast tank cathodic protection in the Scope.
Foreword
Introduction
Scope
General
Structures
Materials
Environment
Normative references
Terms and definitions
Competence of personnel
Design basis
General
Cathodic protection criteria
Design process
Design parameters
Current demand
Cathodic protection systems
Electrical continuity
Fitting out period
Impressed current system
Objectives
Design considerations
Equipment considerations
Galvanic anodes system
Objectives
Design considerations
Anode materials
Factors determining the anode current and life
Location of anodes
Commissioning
Objectives
Measurement procedures
Galvanic systems
Impressed current systems
Operation and maintenance
Operation
Maintenance
Dry docking period
Protection during fitting out and lay-up
Fitting out
Lay-up
Documentation
Objectives
Galvanic anode system
Impressed current system
Annexes
Cathodic protection by zones
Guidance on design current values
Anode resistance, current and life calculations
Electrical bonding
Monitoring of electrical bonding of propeller
Cofferdam arrangements
Impressed current system for a stern system only
Location of galvanic anodes in the stern area
Electrochemical characteristics of impressed current anodes
Cathodic protection of a moored ship using suspended anodes
Anode/cathode separation (dielectric shield) calculations
Galvanic anode specifications
Project dates
DIS 12 January 2016
FDIS 12 January 2017
Members
Kris de Baere Belgium
Ed Barret (Secretary) USA
Emelie Bratt GB
Corey Cahill USA
Frank Dau Germany
Delmar J Doyle USA
Andrew Dryden (ISO)
James Ellor (previous convenor) USA
Chao Feng China
Ya Guo China
Kosei Hasegawa Japan
Howard L Hime USA
Hiroshi Imamota Japan
Woo-hyun Kim Korea
Nobuhisa Kitagawa Japan
Ko Koiso Japan
Ken Lax GB
Chao Lin USA
Catherine Michelle Belgium
Yanyuan Song China
Lee Twombly USA
Chao Wei USA
Likun Xu China

ISO/TC 8/SC 8(Ship design) Plenary Meeting : 15

January 27, 2016

NO	Organization	Name	E-mail address
1	Asset Integrity Services Ltd.	Ken Lax	Ken.lax@asset-integrity-services.com
2	BSI	Emelie Bratt	emelie.bratt@bsigroup.com
3	Shipbuilding Information Center of China	Yao Shi	345477346@qq.com
4	NACE International	Ed Barrett	ed.barrett@nace.org
5	PT. BIRO KLASIFIKASI INDONESIA	AGUS WIDJAJA	agus.widjaja@bki.co.id
6	PT. BIRO KLASIFIKASI INDONESIA	Muhdar Tasrief	muhdar@bki.co.id
7	Nakashima Propeller Co., Ltd.	Nobuhiro Hasuike	nobuhiro@nakashima.co.jp
8	Mitsubishi Heavy Industries, Ltd.	Kei Sato	kei_sato@mhi.co.jp
9	National Maritime Research Institute	Nobuaki Sakamoto	sakamoto@nmri.go.jp
10	Japan Ship Technology Research Association	Kosei Hasegawa	hasegawa@jstra.jp

NO	Organization	Name	E-mail address
11	Korea Marine Equipment Research Institute	Dong-hyun Kim	kdh9942@komeri.re.kr
12	Korea Research Institute of Ships and Ocean Engineering	Cheol-soo Park	parkcs@kriso.re.kr
13	POSCO	Ki-hwan Kim	kihwank@posco.com
14	SC8 Chairman(NIPA)	Sei-chang Lee	sclee@krs.co.kr
15	SC8 Secretary (Korea Offshore and Shipbuilding Association)	Byeong-cheol Choi	bcchoi@koshipa.or.kr
16			
17			
18			
19			
20			

ISO/TC8/SC8-BSI2016.1.27

ISO/TC8/SC8 (Ship design) Management & FuturePlan

January 2016

Sei-chang Lee

SC8 Chairman

1

Contents

1. Introduction
2. TC8/SC8 Management
3. TC8/SC8 Future Plan

- *Capt. Ad Van Dijk (Denmark, TC8 Chairman ~1994) :*
  "Game is won or lost by the gladiators in the arena and not the spectators in the stands"
- *Capt. Charlie Piersall (TC8 Chairman 1995~2015):*
  "With full speed way forward !"
- *Steve Jobs : "Stay hungry, Stay foolish !"*

2

1 Introduction

- **ISO/TC8/SC8** **(Title: Ship design)** –Scope: **Standardization of design and construction for ships and maritime installations for definition of interfaces and creation of interchangeability as well as for determination of safety requirements and ship performance**
- **ISO/TC8** (Ships & marine technology) –Scope: **Standardization of design, construction, structural elements, outfitting parts, equipment, methods and technology, and marine environmental matters, used in shipbuilding and the operation of ships, comprising sea-going ships, vessels for inland navigation, offshore structures, ship-to-shore interface and all other marine structures subjec to IMO requirements.**

SC8/WGs (Currently 6 WGs)

- **WG 10 : Inclinometer for LNG carriers**
  Convenor: Mr. Dong-hyun Kim (KOMERI)
- **WG 11 : Cryogenic spillage**
  Convener: Mr. Seong-hwan Min (KOMERI)
  (being developed through **TC 67/SC9/JWG 3** lead)
- **WG 12/13 : Ship vibration/noise**
  Convener: Dr. Wenwei Wu
  (China Shipbuilding Industry Corporation/Wuxi,China)
- **WG 14 : Propeller**
  Convener: Dr. Bo-ha Lee (KATS)
- **WG 15 : Cathodic protection of ships**
  Convener: Mr. James Ellor (Jellor@elzly.com)

Program of work

- Published standards: 44
- Registered work items: 9 (including 1 rev.)
- ISO/WD 19636 General requirements for inclinometers used for determination of trim and list of LNG carriers
- ISO/CD 20088-1, WD 20088-2, WD20088-3 Determination of the resistance to cryogenic spillage of insulation materials
  - Part 1: Liquid phase,
  - Part 2: Vapor phase,
  - Part 3: High pressure jet exposure

Registered work items (9) -continued

- WD 20154 Vibration isolation design method for ship machinery
- WD 20155 -Test method of hydrodynamic induced in-pipe noise source characteristics for a pump
- WD 20233 -Model test method for propeller cavitation noise evaluation in ship design
- WD 20313 -Cathodic protection of ships
- AWI Revision of ISO 21005 : 2012
  - Thermally toughened safety glass panes for windows and side scuttles

2 TC8/SC8 Management

TC8/SC8 – 7/8 th Plenary meeting

- ❖ 18 participants from 3 P members/1 observer on 12. 02. 2015 at BSI in London.
- ❖ 35 participants from 3 P members/1 observer on 17. 07. 2015 at the Pine City hotel in Shanghai/China.
- ❖ Note from TC8 Resolution (2015.10)
  Vice-Chairman for SC8 ???
  No CD stage and JWG under TC8.

8

ISO/TC8/SC8 Member/Observer/Liaison

- **P-member bodies : 14**
  Belgium(NBN), China(SAC), Germany(DIN), India(BIS), Italy(UNI), Japan(JISC), Korea, Rep. Of, (Sec./KATS), Malaysia(DSM), Netherlands(NEN), Russian Federation(GOSTR), Turkey(TSE), Ukraine(DTR), UK(BSI), USA(ANSI)
- **O-member bodies : 13**
- **Liaisons (15):** TC28/SC5, TC35, TC35/12, TC43/SC3, TC44/SC3, TC67/SC7, TC108/SC2, TC156, CLIA, IACS, IMO, ITN, SIGTTO, WMO, WSC

* IMO matters

- **Development of standards for linkage between IMO and maritime/shipbuilding industry**
- **IMO Activities**
  SC/ SDC (Ship design and construction)
- **3rd session from 18-22 Jan. 2016**
- **SC/ CCC (Carriage of cargoes and containers)**
- **2nd session from 14-18th Sept. 2015**

3 TC8/SC8 Future Plan

- **Potential future items**

✓ NWI for "Specification of high manganese steel for small scale LNG tanks"

✓ NWI for design of ships operating in Polar waters ???

11

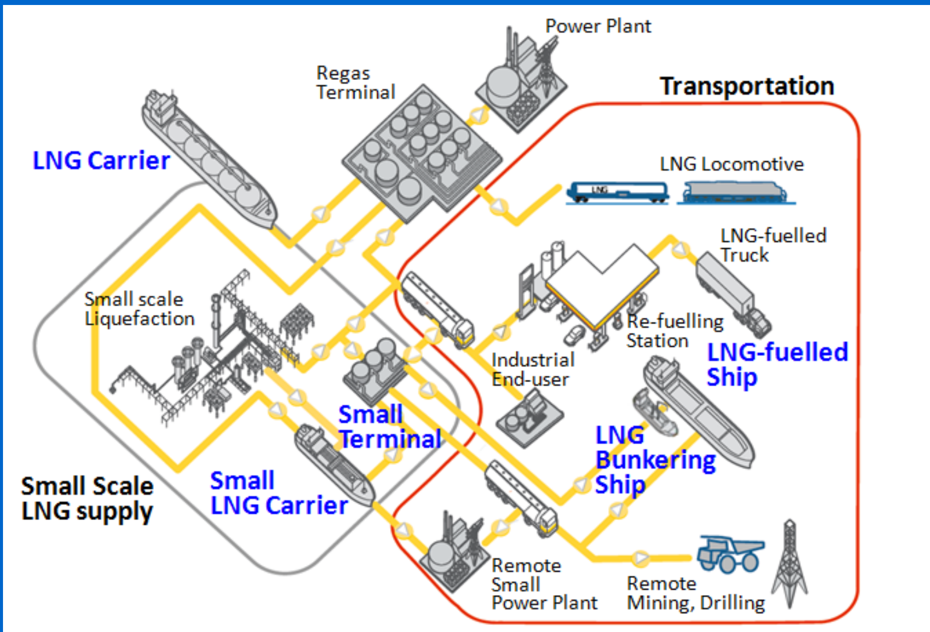
"Specification of high manganese steel for small scale LNG fuel tanks"

- High manganese steel for LNG fuel tanks could:
  - possess superior cryogenic properties useful
  - contribute to improve the safety of LNG tanks
  - compensate the nickel-based alloys in terms of economic feasibility.

12

New trends of LNG

Increasingly as transportation fuels and traded gas



- **LNG-fuelled ships**

Comply with **MARPOL** Annex VI (SOx, NOx)

IGF code adopted at MSC95 ('15.6)

Source : Shell, International Gas Union

Materials for LNG tanks

Four metallic materials registered to IGC and IGF codes

(3 materials excluding aluminum alloy are nickel-based alloys)

Min. design Temp.	Chemical composition and heat treatment	Impact test Temp.
-165 ℃	**9% nickel steel** - double normalized and tempered or quenched and tempered	-196 °C
	Austenitic steels - **such as types 304, 304L, 316, 316L, 321 and 347** solution treated	-196 °C
	Aluminum alloys - such as type 5083 annealed	Not required
	Austenitic Fe-Ni alloy (36% nickel) - heat treatment as agreed	

Benefits & Safety

High Mn steel can improve the safety of an LNG tank

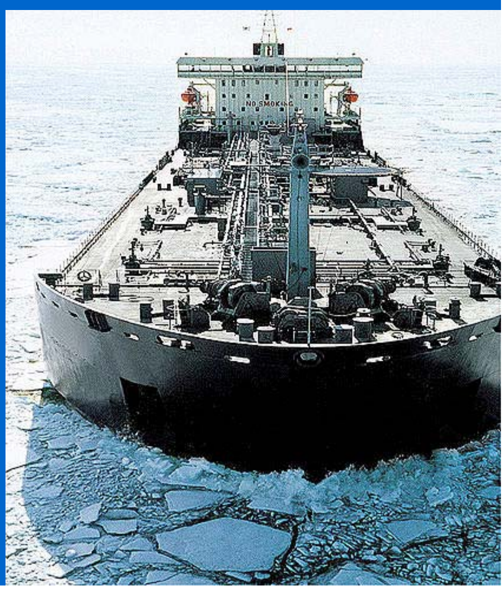
Cryogenic characteristics superior to the existing materials

※ Performance : ● > ⊚ > ◎ > ○	High Mn	Type 304	9%Ni	Al 5083	Effects on the safety of LNG tanks
Yield strength	⊚	◎	●	○	Safety on static loads - ex. LNG cargo
Ultimate tensile strength	●	◎	⊚	○	
percent elongation	⊚	●	◎	○	
Impact toughness (-196 °C)	⊚	◎	●	○	Safety on impact loads - ex. Collision
Fracture toughness (-163 °C)	⊚	●	⊚	○	Safety on pre-existing cracks - ex. Leak
Thermal expansion	●	◎	⊚	○	Safety on thermal stress - ex. LNG loading/unloading

"Standards for Safer Ship Design"

Thanks for your attention !

Q & A ?



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Title : TC 8 Ships and marine technology
/SC 8 Ship design

Secretariat : KATS(Republic of Korea)

Resolutions of ISO/TC 8/SC 8(Ship design) the 10th Plenary Meeting

at BSI in London, United Kingdom on 2016-01-27

Resolution 1/2016: WG 10(Inclinometer for LNG carriers)
Convenor shall send the clean version of WD 19636 to WG members for further comments by 2016-02-22.

Resolution 2/2016: WG 10(Inclinometer for LNG carriers)
Convenor shall send all the necessary documentations to SC 8 secretary by 2016-02-29 for a formal DIS ballot.

Resolution 3/2016: WG 10(Inclinometer for LNG carriers)
CD voting will not take place and document will proceed to the DIS stage.

Resolution 4/2016 : WG 12(Ship vibration)
The convenor of ISO/TC 8/SC 8/WG 12 shall circulate the revised version of WD 20154 via Email and eCommittees by the end of April, 2016.

Resolution 5/2016 : WG 12(Ship vibration)
WG 12 shall carry out CD ballot in order to collect more comments from WG members.

Resolution 6/2016 : WG 12(Ship vibration)
Ms. Yao Shi is appointed as co-convenor of this project.

Resolution 7/2016 : WG 13(Ship noise)
The convenor of ISO/TC 8/SC 8/WG 13 shall circulate the revised version of WD 20155 via Email and eCommittees by the end of April, 2016.

Resolution 8/2016 : WG 13(Ship noise)
WG shall carry out CD ballot in order to collect more comments and encourage the active participation of experts.

Resolution 9/2016 : WG 13(Ship noise)
Ms. Yao Shi is appointed as co-convenor of this project.

Resolution 10/2016 : WG 14(Propeller)
The convenor of ISO/TC 8/SC 8/WG 14 shall circulate the final ISO/WD 20233 via Email and eCommittees by the end of April, 2016.

Resolution 11/2016 : WG 14(Propeller)
CD voting will not take place and document will proceed to the DIS stage for ballot by the end of August, 2016.

Resolution 12/2016 : WG 15(Cathodic protection of ships)
SC 8 approves the change of development track from 24 months to 36 months.

Original Target Date			Changed Target Date	
AWI	2015-01-12		AWI	2015-01-12
DIS	2016-01-12		DIS	2017-01-12
IS	2017-01-12		IS	2018-01-12

Resolution 13/2016 : WG 15(Cathodic protection of ships)
Appoints Mr. Ken Lax as the Convenor/Project Leader for 3 years.

Resolution 14/2016 : WG 15(Cathodic protection of ships)
Ken Lax is appointed as liaison to CEN TC 219.

Resolution 15/2016 : (Revision of ISO 21005:2012 Glass Panes)
A new Working Group 16 (Glass panes) to revise ISO 21005:2012 shall be created.

Resolution 16/2016 : (Revision of ISO 21005:2012 Glass Panes)
Appoints Mr. Wolfgang Franzelius as the Convenor for 3 years.

Resolution 17/2016 : Next Meeting
SC 8 Intersessional Plenary Meeting and working group meetings will be held in Shanghai, from 2016-07-05 to 2016-07-08.

Resolution 18/2016 : Gratitude to BSI
SC 8 expresses its sincere gratitude to Ms. Emelie Bratt for her kind hospitality and excellent arrangements of the Plenary and Working Group meetings at BSI in London, United Kingdom. SC 8 appreciates active participation in SC 8 Plenary Meeting.

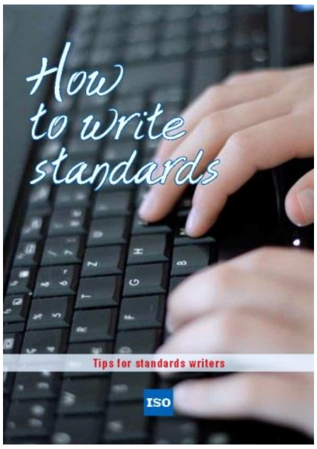
ISO/WD20233

ISO TC 8/SC 8/WG 14

Secretariat: KATS

Ships and marine technology — Model test method for propeller cavitation noise evaluation in ship design

WD/CD/DIS/FDIS stage



To help you, this guide on writing standards was produced by the ISO/TMB and is available at http://www.iso.org/iso/how-to-write-standards.pdf

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 8.

ADD INFORMATION ABOUT REPLACED STANDARDS AND OTHER PARTS AS NECESSARY

Introduction

A paragraph or more.

Ships and marine technology — Model test method for propeller cavitation noise evaluation in ship design

1 Scope

The propeller cavitation noise can be assessed by experimental and/or numerical methods in propeller design stage. The numerical method such as CFD or empirical formulae might be a good alternative to propeller cavitation noise evaluations. However, the model tests are still used widely to predict the full scale acoustic source strength of the cavitating propeller for a wide range of frequencies.

Special ships such as fishery research vessels and military vessels require propellers with less or no cavitation in their operating conditions. In this case, the noise radiated from the propeller might be less significant than the cavitating one and other mechanical noises become dominant.

This International Standard specifies a model test method for propeller cavitation noise evaluation in ship design. The objective of the test is to reduce the propeller noise in ship design by evaluating propeller cavitation noise characteristics at the early design phase via model tests.

The procedure comprises of recreation of noise source, noise measurements, data processing and scaling. The target noise source is propeller cavitation. Thus, the International Standard describes the test set-up and conditions to reproduce the cavitation patterns of the ship based on the similarity laws between the model and the ship. The noise measurements are performed at 3 stages. The measurement targets for each stage are i) propeller cavitation noise, ii) background noise, and iii) transmission loss. For the source level evaluations, corrections for the background noise and the transmission loss are applied to the measured propeller cavitation noise. Finally, the full scale source levels are evaluated from the model scale results using a scaling law.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/PAS 17208-1:2012, *Acoustics-Quantities and procedures for description and measurement of underwater sound from ship Part 1: General requirements for measurements in deep water.*

IEC 60565, *Underwater acoustics – Hydrophones- Calibration in the frequency range 0,01 Hz to 1 MHz*

IEC 61260, *Electroacoustics – Octave-band and fractional-octave-band filters*

ITTC - Recommended Procedures and Guidelines 7.5-01-01-01: *Ship Models*

ITTC - Recommended Procedures and Guidelines 7.5-01-02-02: *Propeller Model Accuracy*

ITTC - Recommended Procedures and Guidelines 7.5-02-01-05: *Model scale noise measurements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
noise source
noise generating mechanism or object

NOTE For this International Standard, main noise source is the propeller cavitation.

3.2
acoustic center
position where all the noise sources are co-located as a single point source

NOTE The acoustic center is assumed to be located at the intersection between propeller plane and hub axis.

3.3
propeller plane
imaginary plane that is formed by intersection of propeller rotation axis and generator line

3.4
reference distance
distance used for source level conversion and defined as 1 m from the acoustic center

3.5
cavitation number, σ_{n}
non-dimensional quantity defined as $(p_0 - p_{\mathrm{v}})/\left(\frac{1}{2}\rho n^2 D^2\right)$, where p_0 is the total static pressure, p_{v} is the vapour pressure, ρ is the density of the fluid, n is the propeller rotational speed (rps), and D is the diameter of the propeller

NOTE The total static pressure (p_0) consists of atmospheric pressure and submergence depth pressure which is usually taken at a specific point approximating the centre of the expected cavitation extent in the upper part of the disk, such as 0,7 R(R : radius of the propeller), 0,8 R or 0,9 R above the propeller centreline, although the propeller centreline is also used.

3.6
propeller thrust coefficient, K_{T}
Non-dimensional quantity defined as $T/\rho n^2 D^4$, where T is the thrust of the propeller

3.7
propeller torque coefficient, K_{Q}
non-dimensional quantity defined as $Q/\rho n^2 D^5$, where Q is the torque of the propeller

3.8
wake
simulated ship wake at the propeller plane. For the model test, ship wake is simulated using a wake screen or a ship model

3.9
effective frequency range
frequency rage for which the sound is measured reliably considering measurement uncertainty and background noise

3.10
background noise
noise from all sources other than the source under test

3.11
sound pressure level, SPL
ten times the logarithm to the base 10 of the ratio of the time-mean-square pressure of the measured sound pressure, in a stated frequency band, to the square of a reference value expressed in decibel by $L_{\mathrm{p}} = 10\log_{10}\left(\frac{p^2}{p_{\mathrm{ref}}^2}\right)$, where $p_{\mathrm{ref}} = 1\mu Pa$

3.12
source level, SL
converted quantity of the measured sound pressure at a reference distance 1 m from the acoustic center

3.13
reference field
sound pressure field that is measured using a virtual source located at a given position, i.e. acoustic center

NOTE The reference field shall be used to calculate the source level.

3.14
virtual source
artificial sound source of which transmitting power is known *a priori*

4 Model test setup and conditions

4.1 Test setup

In order to evaluate the propeller cavitation noise performance via model tests, it is important to reproduce accurately noise sources, i.e. the cavitation patterns, based on the similarity laws between the model and the ship. Test setup for the purpose comprises of test facilities, model propellers, and the wake fields generations.

4.1.1 Test facility

Test facilities might vary between variable pressure water tunnels and circulating water channels with a free surface in the test-section to a de-pressurized towing tank. The variable pressure water tunnels, which are called cavitation tunnels, are widely used for the model tests. Depending on their test section sizes, suitable devices to generate wake fields should be utilized.

4.1.2 Model propeller

The size of a model propeller depends on the capacity constraint of the test facilities and on the acceptable range of test section blockage. The size should be determined to achieve the highest Reynolds number within the constraints. A typical propeller diameter for a model scale propeller is 250 mm. The accuracy of the propeller geometry should be according to ITTC - Recommended Procedures and Guidelines 7.5-01-02-02 which specifies that the offsets of the blade sections should be in the range ± 0,05 mm.

4.1.3 Wake generation

For the propeller cavitation model tests, the wake fields are reproduced by the wake screen or the model ship. In general, the former is used in small-sized and medium-sized cavitation tunnels, while the latter is used in the large cavitation tunnel. The important scaling parameter for the cavitation test is the Reynolds number but its similarity cannot be achieved for practical reasons. In order to reduce scale effect, the Reynolds number should be determined as high as possible within the capacity of the test facilities.

For the medium-sized cavitation tunnels, the wake distributions are reproduced inside the cavitation tunnel by using a wake screen composed of wire meshes. When a full ship wake is required, it is obtained by extrapolating the model scale wake field or by using CFD. A dummy model in combination with wake screens can be applied in the medium-sized tunnel as well. For twin screw ships, the inclined shaft, brackets and bossing can be mounted in small to medium size test-sections.

For the large-sized cavitation tunnels, the wake can be generated typically from a full ship model installed in the test section. In some cases, the ship model with grids or the shortened model can be used as well. The model ship is manufactured of various materials with the scale ratio that is dependent on the dimensions of the ship and the tunnel. The model ship is installed inside the tunnel corresponding to the full scale draft. The free surface is covered by plates to suppress the wave interference to the model. The model ship draft in the tunnel is increased within the capacity constraint of the test facilities to compensate for the deceleration of the flow due to the boundary layer below these wave suppressing plates. The detailed configurations of the model are strictly based on the drawings of the full-scale ship. The accuracy of the ~~full ship~~ model should be according to ITTC - Recommended Procedures and Guidelines 7.5-01-01-01 which specifies a tolerance of ± 1 mm. The maximum blockage of the ship model in the test-section is in the order of 10 % - 20 %. A watertight dynamometer is to be installed together with an underwater motor aligned precisely to the propeller shaft inside the model ship. Thrust, torque and rotational ~~shaft~~ speed of the model propeller are measured through the dynamometer.

The quality of the generated wake with respect to the target wake (measured wake in the towing tank or estimated full ship wake) should be assessed by wake field measurements using velocimetries, e.g. Particle Image Velocimetry (PIV), Laser Doppler Velocimetry (LDV) or pitot tubes. Depending on the configuration one may measure the axial velocity component only, the axial and tangential velocity component or all three velocity components.

4.2 Test conditions

The cavitation test conditions are determined by the thrust identity method (or torque identity method) at discussed (or specified) self-propulsion point. In cavitation tests, the propeller operating condition is defined by the non-dimensional coefficients, propeller thrust coefficient K_{T} (or torque coefficient K_{Q}) and cavitation number σ_{n}.

During the propeller cavitation observations and noise measurements the pressure in the cavitation tunnel is adjusted according to the local cavitation number at a specific point approximating the centre of the expected cavitation extent in the upper part of the disk, such as 0,7 R, 0,8 R or 0,9 R above the propeller centreline, although the propeller centreline is also used.

In the cavitation tunnel tests, inclusion of the effect of stern wave heights and sea margins for service conditions can be determined based on discussions with customers and/or experience of the model basin.

The air content of the water and the number and distribution of the cavitation nuclei play important roles in the cavitation inception and its development. Therefore, one or both of them should be considered based on experience of the test facilities.

For Froude scaled cavitation testing in a facility with a free surface, such as a depressurized towing tank or a free surface circulating water channel, the standard results of a Froude scaled towing basin powering test may be used directly to set the propeller RPM and speed for the various operating conditions of the experiment. It is noted that the usual procedure for scaling model powering results to full scale is based on satisfying the thrust loading coefficient at full scale Reynolds number, which is equivalent to a thrust identity approach.

For the measurement of cavitation noise in cavitation tunnel and depressurized towing tank, it is necessary to stabilize the extent of cavitation since the cavitation noise slightly varies depending on the stability of cavitation extent[1]. There are several methodologies for stabilizing the extent of cavitation. One methodology is to add nuclei such as hydrogen microbubble in the water. Another methodology is to add roughness at leading edge of the propeller blades at least on back side.

Such treatments should be discussed in each facility by taking their standard experimental procedure into consideration, i.e. operation condition including shaft speed and target velocity to be achieved, the scale of the model, water quality and so on.

Although the extent of cavitation is stabilized by enough air content, depressurization in cavitation tunnel and towing tank increases the number and the volume of bubbles in the water. Since the bubble attenuates the sound pressure, attention should be paid for air content of water in cavitation tunnel and depressurized towing tank.

There are two definition of air content, i.e.

α/α_s : the air content under atmospheric pressure (1 atm).

$(\alpha/\alpha_s)_{TS}$: the air content under hydrostatic pressure at the test section after depressurization

These two values are different each other, and thus it is necessary to state the definition of the air content used in the noise measurement in cavitation tunnel and depressurized towing tank.

5 Noise measurement instrumentation

5.1 Hydrophone and signal conditioning

The terms “hydrophone”, “underwater electro-acoustic transducer” and “underwater microphone” may be used synonymously, but for the purposes of this International Standard, hydrophone is used. The hydrophone includes any signal conditioning electronics such as pre- or charge amplifiers either within or exterior to the hydrophone. The piezoelectric type hydrophones are usually used for measurement of underwater sound pressure levels in a test facility. Recommended specifications of the hydrophones and their mount method in the facility are listed in Table 1.

Table 1 — Recommended specification of the hydrophones and their mount method

Receiving sensitivity	• -220 dB re 1 V/μPa or higher
Frequency range	• 1 Hz to 100 kHz or wider
Directivity	• Omni-directional
Operating static pressure	• 40 atm to 100 atm
Mount method	• Acoustic chamber below the test section • Outside of the walls or windows • Flushed to walls or windows • To a rake in the flow • Inside the basin

For the measurement, one can use single hydrophone or multiple hydrophones. For the reliable result, multiple hydrophone measurements are recommended. The test setups including hydrophone positioning might depend on the test facility. However, typically at least one hydrophone is recommended to be located at the propeller plane. Additional hydrophone positions could be up- and down-stream as well as abeam. Unwanted acoustic phenomena such as a resonance might occur depending on the mount method and the hydrophone setup. Therefore the acoustic characteristic of the hydrophone setup needs to be assessed after hydrophone installation by using a virtual source.

The use of a hydrophone array, which is not included in this International Standard, enables noise measurement with high directivity to scan the model and to detect local noise sources.

The hydrophone should be individually calibrated before the test and periodically (typically every 12 months) with respect to the manufacturer's calibration reference, e.g. by use of a hydrophone calibrator, or in accordance with IEC 60565.

5.2 Data acquisition

Data acquisition is performed using analogue-digital converters (A/D). Followings should be considered for the A/D converter.

5.2.1 Sampling frequency

Sampling frequency should satisfy the Nyquist-Shannon sampling theorem, i.e. it should be at least two times of highest frequency under test. If possible, it is recommended to be over four times of the highest frequency.

5.2.2 Resolution

The A/D converter should have more than 12-bit resolution. 16-bit resolution is recommended.

5.2.3 Syncronization for multiple channel sampling

The number of channels corresponds to the number of hydrophones and the data should be sampled simultaneously for entire channels especially when using a hydrophone array.

5.2.4 Filtering

In order to prevent the data aliasing, the low-pass filter should be applied before A/D converting. The cut-off frequency should be set to the highest frequency at least.

5.2.5 Acquisition time

More than 20 seconds of the measurement time are recommended in order to have sufficient data for the analysis.

6 Noise measurement procedure

6.1 Propeller cavitation noise measurement

Propeller cavitation noise should be measured in accordance with 4.1 and 4.2 by using noise measurement instrumentation in Clause 5.

6.2 Background noise measurement

The background noise comes mainly from the propeller drive system, the tunnel operation or towing carriage, the water flow, the measurement chain, etc. To check the quality of the noise measurements, i.e. of the cavitating propeller, the background noise level should be determined.

The background noise shall be measured in absence of the propeller cavitation - propeller replaced by a dummy boss or increase of tunnel pressure to suppress cavitation - but with all other operating conditions as similar as possible. Both procedures to measure background noise have specific pros and cons. The increase of tunnel pressure allows to keep the propeller load condition, $K_\mathrm{T}/K_\mathrm{Q}$ and to detect propeller non-cavitating noise (e.g. propeller singing) but changes the air content. It also removes or at least reduces the cavitation from the wake screen and/or appendages of the ship model, which should be included in the background noise if it exists. The replacement of the propeller by a dummy boss keeps the same air content but changes the load of the propeller drive system. Thus it would alter mechanical noise characteristics from the propeller drive system.

If flush mounted hydrophones or pressure transducers are used on the tunnel wall or ship hull, the contributions of the vibrations of the wall or hull to the noise measurements need to be assessed as part of the background noise measurements. The influence of hull vibrations on hull mounted pressure transducers is discussed in ITTC – Recommended Procedures and Guideline 7.5-02-03-03.3[2].

It is noted the disadvantage of using wake screens for noise measurement is that they may increase background noises due to the vibrations and cavitation from themselves. The increase of tunnel velocity yields singing of the wire-mesh screen when it is utilized as a wake generator [3]. Under such experimental configuration, the noise originated from the wire-mesh screen must be measured as a background noise.

The background noise can be measured before or after measuring cavitation noise of the propeller.

6.3 Reference field measurement

6.3.1 Objective

When the noise is measured in model test facilities, it should be noted that the situation differs from the free-field environment. For the cavitation tunnels, the test section including acoustic chamber is enclosed by the tunnel walls. The influence of multiple reflections due to the walls should be considered. For facilities with a free surface, the influence of this free surface on the noise measurements should be also assessed and, if necessary, corrected with an acoustic calibration test. In general, the free surface gives a reduction of the measured noise levels at low frequencies where the influence increases with decreasing frequency. The hydrophone setups would also cause reflections depending on the mount methods which cannot be easily known *a priori*.

In order to assess the influence of these reflections, an acoustic calibration could be made using a known virtual source which is located at a specific point, i.e. acoustic center. The acoustic center is assumed to be located at the intersection between propeller plane and hub axis, i.e. at the end of the propeller shaft. The acoustic field measured using a virtual source and the measurement system is called a reference field in this International Standard.

6.3.2 Virtual source and input signal

For the reference field measurement, the propeller is replaced by a virtual source. The underwater transducer, which converts the electrical input to the pressure signal with its own transmitting voltage response (TVR), can be used as the virtual source. The source strength of the virtual source can be calculated directly from the known input signal (voltage) and TVR. The input signal is usually generated using a function generator and is amplified, if necessary. Broadband signals such as white noise and linearly frequency modulated signal can be used as the input signal. The input signal should fully cover the frequency range of interest. However, it is noted that generating low frequency signal is difficult due to the low TVRs of the most commercial underwater transducers. Thus, the effective frequency range for the reference field measurement should be specified in the report as in Clause 9. Below the lower limit of the effective frequency range, the reference field should be estimated by the other methods such as a simple geometrical spreading as defined in (6) of Clause 7.

6.3.3 Measurement condition

During the reference field measurements, the pressure should be kept as the same as the propeller cavitation noise measurement in order to prevent change of air contents. However, the reference field can be measured without flows due to low Mach number of the cavitation test.

7 Post processing and scaling

When noise measurement as given in Clause 6 has been completed, post processing will be required to adjust sound pressure levels for background noise conditions and to convert the background-noise-corrected sound pressure levels to the source levels by using measured reference fields. Finally, scaling procedures are required to obtain full-scale noise levels of a cavitating propeller measured at model scale.

In general, all the quantities in decibels are evaluated in the one-third-octave band in accordance with ISO/PAS 17208-1:2012 and IEC 61260. The narrow band (1 Hz bandwidth) analysis can be performed especially when the discrete frequency components are important.

7.1 Sound pressure level

In the context of noise assessment, the sound pressure level is the fundamental quantity of sound pressure, and it is defined by (1):

$$L_{\mathrm{p}} = 10\log_{10}\left(\frac{p^2}{p_{\mathrm{ref}}^2}\right) \text{ [dB re 1 μPa]} \quad (1)$$

where

p^2 is time-mean-square pressure of the measure sound pressure in one-third-octave band;

p_{ref} is the reference pressure [1 μPa].

7.2 Background noise adjustment

The background noise shall be corrected in accordance with ISO/PAS 17208-1:2012 and ITTC - Recommended Procedures and Guidelines 7.5-02-01-05.

The signal-plus-noise-to-noise ratio (ΔL) for each one-third-octave band is defined by (2):

$$\Delta L = L_{\mathrm{p_{s+n}}} - L_{\mathrm{p_n}} = \log_{10}\left(\frac{p_{\mathrm{s+n}}^2}{p_{\mathrm{n}}^2}\right) \text{ [dB]} \quad (2)$$

where

$L_{\mathrm{p_{s+n}}}$ is the sound pressure level of the propeller cavitation noise;

$L_{\mathrm{p_n}}$ is the sound pressure level of the background noise.

If ΔL is greater than 10 dB then no adjustments are necessary. On the contrary, if ΔL is less than 3 dB then measurements are dominated by background noise and cannot be used. Finally if 3 dB ≤ ΔL <10 dB, adjustment on measurements are required. The following expression can be used:

$$L'_{\mathrm{p}} = 10\log_{10}\left[10^{(L_{\mathrm{p_{s+n}}}/10)} - 10^{(\mathrm{L_{p_n}}/10)}\right] \text{ [dB re 1μPa]} \quad (3)$$

where L'_{p} is the background-noise-adjusted sound pressure level of the cavitating propeller, computed in one-third-octave band.

7.3 Transmission loss

The effects of reflections from tunnel walls, free surface and hydrophone mount setups can be adjusted using the reference field described in 6.3.

At first, the time-mean-square pressure, p_{i}^2, of the virtual source at the distance of 1 m can be calculated from the input voltage signal and TVR by (4):

$$p_{\mathrm{i}}^2 = V_{\mathrm{i}}^2 \frac{p_{\mathrm{ref}}^2}{V_{\mathrm{ref}}^2} 10^{\mathrm{TVR}/10} \quad (4)$$

where

V_{i}^2 is the time-mean-square voltage input to the virtual source for each one-third-octave band;

V_{ref} is the reference voltage [1 V];

p_{ref} is the reference pressure [1 μPa];

TVR is the transmitting voltage response of the virtual source for each one-third-octave band [dB re 1 μPa/V @ 1 m].

Using the reference field data, the transmission loss for each one-third-octave band is defined by (5):

$$TL = -10\log_{10}\left(\frac{p_{\mathrm{r}}^2}{p_{\mathrm{i}}^2}\right)\ [\mathrm{dB}] \quad (5)$$

where

p_{r}^2 is the time-mean-square pressure of the measure reference field in one-third-octave band;

If the measurement of reference field is not available, the transmission loss can be simply estimated by:

$$TL_{\mathrm{est}} = 10\log_{10}\left(\frac{r^2}{r_{\mathrm{ref}}^2}\right)\ [\mathrm{dB}] \quad (6)$$

where r is the distance from the acoustic center to the measurement point in meters. However, the measurement of reference field is recommended in order to adjust the propagation effects accurately in the test facilities.

7.4 Model scale source level

The model scale source level, L_{s}, is calculated by (7):

$$L_{\mathrm{s}} = L_{\mathrm{p}}' + TL\ [d\mathrm{B\ re\ 1\ \mu Pa\ @\ 1\ m}]. \quad (7)$$

When the multiple hydrophones are used, the averaged source level can be obtained by (8):

$$L_{\mathrm{s}} = 10\log_{10}\left[\frac{1}{\mathrm{N}}\sum_{\mathrm{i=1}}^{\mathrm{N}} 10^{(L_{\mathrm{s_i}}/10)}\right]\ [\mathrm{dB\ re\ 1\ \mu Pa\ @\ 1m}] \quad (8)$$

where N is the number of hydrophones.

7.5 Scaling to the full-scale noise levels

A prediction of the full-scale noise levels can be made using scaling laws recommended by the Cavitation Committee in ITTC (1987)[3] . These laws concern only differences in dimensions and operating conditions of the model and full scale propellers and therefore do not reflect the Reynolds scaling effect.

The increase in noise levels from model to full scale is given by (9):

$$\Delta L_{\mathrm{s}} = 20\log_{10}\left[\left(\frac{D_{\mathrm{s}}}{D_{\mathrm{m}}}\right)^{\mathrm{z}}\left(\frac{r_{\mathrm{m}}}{r_{\mathrm{s}}}\right)^{\mathrm{x}}\left(\frac{\sigma_{\mathrm{s}}}{\sigma_{\mathrm{m}}}\right)^{\mathrm{y}/2}\left(\frac{n_{\mathrm{s}}D_{\mathrm{s}}}{n_{\mathrm{m}}D_{\mathrm{m}}}\right)^{\mathrm{y}}\left(\frac{\rho_{\mathrm{s}}}{\rho_{\mathrm{m}}}\right)^{\mathrm{y}/2}\right]\ [\mathrm{dB}] \quad (9)$$

and the frequency shift relation is given by (10):

$$\frac{f_{\mathrm{s}}}{f_{\mathrm{m}}} = \frac{n_{\mathrm{s}}}{n_{\mathrm{m}}} \quad (10)$$

where the subscripts s and m refer to full-scale and model-scale, respectively.

The exponent factors x, y and z in (9) are differently determined attributed to test facility differences, range of tested Reynolds number, and the model test method

7.6 Other option for full-scale noise prediction

To evaluate noise in full scale, utilizing empirical formula accompanied with experimental / computational methods can be one option and some of these methods can be found in [4]. Since the input parameters for these formulae are major design parameters of hull and popeller, they are useful at the early design stage.

As a computational tool, both of potential-based method and computational fluid dynamics (CFD) can be applied. Utilizing computational fluid dynamics (CFD) could be benefitial in that i) it can take the full-scale ship wake into consideration as the inflow condition to the propeller, and ii) it may contribute to resolve tip and hub vortex cavitation, yet the rigorous validations for CFD are inevitable.

8 Uncertainty

The overall uncertainty is mainly due to i) hydrodynamic phenomena introduced by approximations made in a model test, ii) measurement uncertainty, and iii) scaling to the full-scale.

The hydrodynamic phenomena result in lack of similarity between model and full scale cavitation and its noise, a fact implying that analysis and interpretation of model results become complex and can result in errors difficult to quantify.

Measurement uncertainty for determining the sound pressure level (L_{p}) is the result of combined effect of measurement chain such as calibration, sensitivity, data processing, and amplifier gains. According to ISO/PAS 17208-1:2012, typical values for each error sources are between 0,5 to 1 dB and the combined uncertainty will be 1,3 dB.

Determining the source level (L_{s}) will have increased uncertainty because of the transmission loss (TL) adjustment errors. When measuring TL, both instrumentation errors to generate and amplify the input voltage signal and TVR uncertainty of the virtual source will be added to the above measurement uncertainty. In addition, assumption of the acoustic center will affect the overall uncertainty. When estimating TL_{est}, the unconsidered acoustic effects such as the reverberation due to the bounded test facility cause a significant error.

The uncertainty of the scaling methods presented in Clause 7 is not trivial to be assessed due to the complicated hydrodynamic effects. Therefore the limitations to apply a typical scaling law should be kept in mind.

The overall uncertainty will inevitably depend on the particular implementation of the measurement method, the characteristic of the test facility and the scaling method. It is recommended for the users of this International Standard to determine their own assessment of uncertainty based on the methods described in the related references [5, 6].

9 Reporting

The test report should include as much of the following information as possible.

1. Ship characteristics

1.1 Principal dimensions of the hull

1.1.1 Scale Ratio

1.1.2 Length between perpendiculars [m]

1.1.3 Breadth [m]

1.1.4 Draft at FP and AP [m]

1.2 Principal particulars of the propeller

1.2.1 Propeller diameter [m]

1.2.2 Number of shafts

1.2.3 Number of blades

1.2.4 Hub-diameter ratio , d_{H}/D

1.2.5 Mean pitch-diameter ratio, $(P/D)_{\mathrm{mean}}$

1.2.6 Expanded area ratio, $A_{\mathrm{E}}/A_{\mathrm{O}}$

2. Test conditions

2.1 Load condition

2.2 Delivered power of full-scale propeller [kW]

2.3 Rotational speed of full-scale propeller [rpm]

2.4 Shaft submergence of full-scale propeller [m]

2.5 Sea margin

2.6 Flow speed at test section, V_{S} [m/s]

2.7 Rotational speed of model propeller [rps]

2.8 Advance coefficient, $J = V_{\mathrm{S}}/nD$

2.9 Thrust/Torque coefficient, $\boldsymbol{K_{\mathrm{T}}/K_{\mathrm{Q}}}$

2.10 Cavitation number, σ_{n}

2.11 Air content, $\alpha/\alpha_{\mathrm{s}}$

3. Test results

3.1 Model-scale source level in one-third octave bands

3.1.1 Effective frequency range [Hz]

3.1.2 Source level [dB re 1 μPa/V @ 1 m]

3.2 Full-scale source level in one-third octave bands

3.2.1 Scaling method

3.2.2 Effective frequency range [Hz]

3.2.3 Source level [dB re 1 μPa/V @ 1 m]

3.3 Cavitation patterns and extents

Annex A (Informative) Wake extrapolation methods

In manufacturing wire-mesh screen which aims to reproduce full scale ship wake, several extrapolation methods have been practically utilized in order to estimate full scale ship wake from model scale ship wake as reviewed by the 26th ITTC "The Specialist Committee on Scaling of Wake Field"[7]. Two representative extrapolation methods recommended by the committee are "Sasajima-Tanaka's Method"[8] and "Hoekstra's Method"[9]. The committee also states that the best approximation of the full scale nominal wake can be obtained using high resolution CFD calculations[7].

Bibliography

[1] Ikebuchi et al. (1984), *Effects of air content in the cavitation tunnel and leading edge roughness of propeller blades upon the cavitation performance, Technical Bulletin of Ship Research Center of Japan, Vol. 12, pp.9-19*

[2] ITTC – Recommended Procedures and Guideline 7.5-02-03-03.3, *Cavitation Induced Pressure Fluctuations Model Scale Experiments*

[3] ITTC (1987). *Cavitation committee report, 18th International Towing Tank Conference, Kobe, Japan*

[4] 27th International Towing Tank Conference (2014), *Specialist Committee on Hydrodynamic Noise Final Report and Recommendations to the 27th ITTC, Proceedings of the 27th ITTC, Vol. 2, pp. 639-679*

[5] ISO/IEC Guide 98-3:2008, Uncertainty of measurement – Part 3: *Guide to the expression of uncertainty in measurement*

[6] ITTC 2008 , Recommended Procedures and Guidelines, 7.5–02–01–01: *Guide to the Expression of Uncertainty in Experimental Hydrodynamics*

[7] The Specialist Committee on Scaling of Wake Field (2011), *Final Report and Recommendations to the 26th ITTC, Proceedings of 26th ITTC-Volume II*

[8] Sasajima H., Tanaka I and Suzuki T. (1966), *Wake Distribution of Full Ships, Journal of the Society of Naval Architects of Japan, Vol.120, pp.1-9*

[9] Hoekstra M. (1975), *Prediction of Full Scale Ship Wake Characteristics Based on Model Wake Survey, International Shipbuilding Progress, Vol. 22, Issue 250, pp.204-219*

Wittekind氏コメントに対するISOロンドン会合時の対応 ISO WD “Chapter 8”および”Chapter 9”に対する対応

日本WG委員の皆様：

コメントを頂き，有難うございました．
スライド中，
黒文字：初版から変更なし
緑文字：委員各位からのコメント反映部分
赤文字：検討が必要な部分

平成28年1月21日
海上技術安全研究所

1

コメント原文

From: Wittekind氏
To: NK宋氏

Dear Dr. Song,

in the meantime I had the opportunity to read through ISO/WD20233. My comments are as follows:

1. In general the contents is ok. The relationships and assumptions are taken from cavitation test model/full scale conversion of ITTC
2. It is simply assumed that the noise generation follows the same scaling laws. I am not sure whether there is unanimous understanding of this. This concerns in particular frequencies below 100 Hz in broad band in full scale where experience is not sufficient, in my opinion. The Brown formula in 7.6. is inaccurate at low frequencies. We also know that noise from cavitation starts at significantly lower speeds before cavitation is visible.
3. In Bark, G. Prediction of Propeller Cavitation Noise from Model Tests and its Comparison with Full Scale Data (Journal of Fluids Engineering 1985) for equation 9, x, y and z are recommended to be 1, 2, 1 respectively, with good success. Maybe this can be referred to in the standard

I see the following shortcomings

4. This method can only be used for cavitation on the blade like sheet cavitation, bubble cavitation and cloud cavitation. It is not suitable for tip vortex cavitation (because of the different scaling), hub vortex and root cavitation (because of their very different location not covered by the range laws mentioned in the standard). This must be mentioned in the standard
5. In table 1 the Mounting Method "In ship hull" is missing. The method is mentioned in 6.2 as a permissible one
6. For any mounting method with the sensor close to the propeller (see 5) assuming the acoustic center at 0.7R (para 7.3) may lead to big errors. If other cavitation occurs (see 4) like root cavitation the center is really very much more distant if e.g. the hydrophone is in the hull. This leads to large conversion errors to full scale

Minor items

7. 6.3 last sentence "filed" should be "field"
8. The reference value should be selected according to standard. E.g. source level is 1 μPa m, Ls in the Brown equation in 7.6. has to be 1 $\mu Pa^2/Hz$ m
9. In 7.6. "Z is the number of propeller blades"

With this standard all kinds of cavitation tunnels (even small ones) and depressurized tanks are allowed, I would recommend to at least use a dummy and a mesh (if no full model is used) to ensure three directional inflow.

2

コメント2

2. It is simply assumed that the noise generation follows the same scaling laws. I am not sure whether there is unanimous understanding of this. This concerns in particular frequencies below 100 Hz in broad band in full scale where experience is not sufficient, in my opinion. The Brown formula in 7.6. is inaccurate at low frequencies. We also know that noise from cavitation starts at significantly lower speeds before cavitation is visible.

日本としての対応案:

- 最新のISO提案文書において，Brownの式の明文化は避けている．
- Brownの式が，低周波数帯域において合わないのには同意．(そもそも，音響測位船等に搭載されているスラスターのデータを元にした推定式だから．) とはいえ，使用目的によっては十分実用的ではあることは，言及しても良いかもしれない．
- Scaling lawは，注目する船種等によって使い分けが必要なのではないか．(ISO提案には書けないが．) 特にTVC noiseのScaling lawは，種々の方法が提案され実用的に用いられてはいるものの，汎用的に用いることのできる方法は未だ存在しない．従い，現時点でISO規格に載せられる段階ではない．
- Wittekind (2014, JSPD)に，低周波数帯域モデルの言及があるが，この論文は27th ITTCではReferされていない．
- 28th ITTC SCに，Wittekind(2014, JSPD)の論文に加え，数値計算による推定結果等もReferしてもらうよう働きかける．
- Tip Vortex Cavitationがvisibleになる前に，noiseが初生するのは周知のこと．

→Wittekind(2014, JSPD)にあるような，cavitation inception speed（設計パラメター）を簡易推定式のパラメターに入れるのは妥当．本件については，最新のISO提案文書の”7.6”でも言及してある．ただ，今回のISO規格のターゲットが一般商船で、海洋生物保護の観点からのIMO規制が大きな議論の対象であるとすれば、このような細かいキャビの初生の話をISOで詳しく言及する必要はなく、どちらかといえばITTCにまかせておくべきテーマではないか?

3

コメント3

3. In Bark, G. Prediction of Propeller Cavitation Noise from Model Tests and its Comparison with Full Scale Data (Journal of Fluids Engineering 1985) for equation 9, x, y and z are recommended to be 1, 2, 1 respectively, with good success. Maybe this can be referred to in the standard

日本としての対応案:

- (x,y,z)=(1,2,1)が”good success”であると証明(=can be comprehensively applied to any types of merchant ships)するには，相当数のデータが必要．
- Bark (1985, JFE)の論文自体は，27th ITTCにReferされているので，わざわざ「 (x,y,z)=(1,2,1)が”good success” 」をISO規格に明文化する必要は無く，ISO規格使用者matterとするのが良い．（本質的に，Brownの式の扱いと同じ）

4

コメント4・5

4. This method can only be used for cavitation on the blade like sheet cavitation, bubble cavitation and cloud cavitation. It is not suitable for tip vortex cavitation (because of the different scaling), hub vortex and root cavitation (because of their very different location not covered by the range laws mentioned in the standard). This must be mentioned in the standard
5. In table 1 the Mounting Method "in ship hull" is missing. The method is mentioned in 6.2 as a permissible one

日本としての対応案：

■ TVC初生のscaling lawに関する論文は，

- A Note on the Scaling of Tip Vortex Cavitation Inception; L.Noordzij, Int. Ship Prog. Vol24 Issue NO.277 (1977)
- Modelling of Tip Vortex Cavitation on Ship propeller; G.Kuiper, 4th Lips Prop. Symp.(1981)
- プロペラチップボルテックスキャビテーション騒音の相似則; 大島　明, 三菱重工技報Vol.31 No.2(1994)

■ 但し，初生のScaling lawは直接，騒音のscalingには使用出来ず，また雑音のscalingと同様に，係数等の値の標準化は現時点では困難．(MHI 大島氏の論文結論と同様)

■ "in ship hull"は，Flat-mountedのハイドロホンのことを指しているのではないか．

■ 今回規定しようとするノイズに関するscalingを，プロペラ作動点の範囲を低速域からカバーするのであれば，Wittekind氏の提案式も妥当．

コメント6

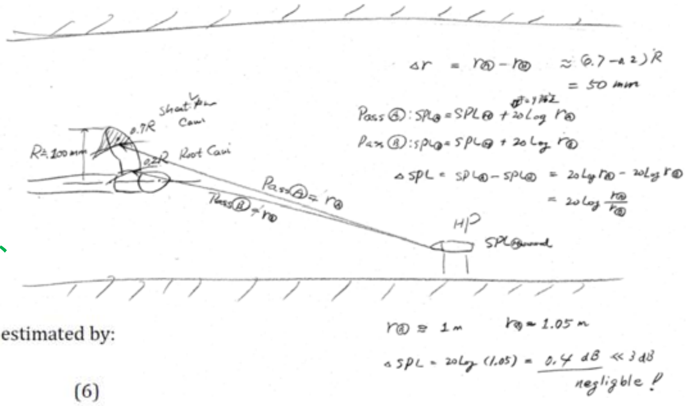
6. For any mounting method with the sensor close to the propeller (see 5) assuming the acoustic center at 0.7R (para 7.3) may lead to big errors. If other cavitation occurs (see 4) like root cavitation the center is really very much more distant if e.g. the hydrophone is in the hull. This leads to large conversion errors to full scale

日本としての対応案：

■ 最新版のISO WDには，acoustic centerをどこに取るかという記述は，削除されている．

■ キャビテーションの形態（発生場所）の影響が大きく、Acoustic centerを一意に規定することはできないので、キャビテーションの発生状況等から、運用者にてacoustic centerを設定する等の工夫が必要、といった程度の記載になり得る．

■ 船内設置のハイドロフォンがプロペラ近傍に設置される場合、(6)式でTLを評価することの誤差を指摘したものではないか？



If the measurement of reference field is not available, the transmission loss can be simply estimated by:

$$TL_{est} = 10\log_{10}\left(\frac{r^2}{r_{ref}^2}\right) \text{ [dB]} \qquad (6)$$

where r is the distance from the acoustic center to the measurement point in meters. However, the measurement of reference field is recommended in order to adjust the propagation effects accurately in the test facilities.

generalコメント

With this standard all kinds of cavitation tunnels (even small ones) and depressurized tanks are allowed, I would recommend to at least use a dummy and a mesh (if no full model is used) to ensure three directional inflow.

日本としての対応案：

- 2015年2月のISOロンドン会議で日本として述べた意見"tangential・radial成分を水槽試験で再現したとしても，それが実船wakeと整合（例えば，船尾縦渦の位置や強さが，実船相当となっているか）している保証は，どこにもない"を引き続き主張する.
- ワイヤーメッシュ法は，模型船を用いる方法に比べ，軸方向成分に対する尺度影響を容易に考慮できる利点がある．両方法は一長一短であり，各方法を用いたキャビ試験結果と実船との相関(キャビパターン，船尾変動圧)が取れていることが，第一義的に重要であることを主張する.

ISO WD "Chapter 8"に対する対応案

- 新規に記入されている"Chapter 8 Uncertainty"については， 模型スケール・試験水槽での不確かさ評価には，様々な方法があり， 不確かさの定量化も難しい．つまり解決すべき課題が多いため，現時点でISO規格に載せることは不適当で，削除すべき.
- 現ドラフト案から，無理に確定的な内容を追加することが無いよう主張する.

<u>参考意見</u>

- 文面からも，ISO規格として有効ではない(=Uncertainty assessmentを義務化しようとしている文面ではない)ので，載せる意味があるか？
- 文中に照会している"ISO/PAS 17208-1:2012"は，実船計測用のISO規格である．本会議で議論している規格は水槽試験用なので，実船計測用のISO規格は適用可能なのか？
- どうしてもUncertainty assessmentに言及したいのであれば，"ITTCをreferしろ"程度にした方が良いのではないか．ここでいうITTCとは，

ITTC 2008 , Recommended Procedures and Guidelines, 7.5–02–01–01: *Guide to the Expression of Uncertainty in Experimental Hydrodynamics*

ITTC 2014, Recommended Procedures and Guidelines 7.5-02-01-05: *Model scale noise measurements*

ISO WD "Chapter 9"に対する対応案

・"2.6 Flow Speed at test section"と、"2.8 Advance coefficient"は、削除。
試験条件は、"2.9"に記載のKT、もしくはKQで設定されており、
また、"2.6", "2.8"はKT(KQ) と"2.7 Rotational speed of model propeller"の結果に過ぎず、明示する意味が無いと考えます。

・"2.9 Thrust/Torque coefficient, KT/KQ"は、誤解の無いよう、
"Thrust (or Torque) coefficient, KT (or KQ)"とするのが良いと考えます。

・"2. Test conditions"に、hydrophoneの配置を追加。
例えば、"2.12 Arrangement of hydrophone and propeller"
hydrophoneとプロペラの配置関係は、source levelの推定で重要です。

・"3.1 Model-scale source level in one-third octave bands"は、
"Model-scale measured and background noise level in narrow bands"としては如何でしょうか？
model-scale source levelは、full-scale source level推定の経過として意味がありますが、
model-scaleの値の記載としては、measured levelとbackground noise levelの方が、よりfundamentalと考えます。

・"3.1.2 Source level"は、"3.1"の変更とあわせて、"Measured level"に変更。

MHI 佐藤氏案をそのまま抜粋

1.1 Principal dimensions of the hull
1.1.1 Scale Ratio
1.1.2 Length between perpendiculars [m]
1.1.3 Breadth [m]
1.1.4 Draft at FP and AP [m]
1.2 Principal particulars of the propeller
1.2.1 Propeller diameter [m]
1.2.2 Number of shafts
1.2.3 Number of blades
1.2.4 Hub-diameter ratio, d_H/D
1.2.5 Mean pitch-diameter ratio, $(P/D)_{mean}$
1.2.6 Expanded area ratio, A_E/A_O
2. Test conditions
2.1 Load condition
2.2 Delivered power of full-scale propeller [kW]
2.3 Rotational speed of full-scale propeller [rpm]
2.4 Shaft submergence of full-scale propeller [m]
2.5 Sea margin
2.6 Flow speed at test section, V_s [m/s]
2.7 Rotational speed of model propeller [rps]
2.8 Advance coefficient, $J = V_s/nD$
2.9 Thrust/Torque coefficient, K_T/K_Q
2.10 Cavitation number, σ_n
2.11 Air content, α/α_s
3. Test results
3.1 Model-scale source level in one-third octave bands
3.1.1 Effective frequency range [Hz]
3.1.2 Source level [dB re 1 μPa/V @ 1 m]
3.2 Full-scale source level in one-third octave bands
3.2.1 Scaling method
3.2.2 Effective frequency range [Hz]
3.2.3 Source level [dB re 1 μPa/V @ 1 m]
3.3 Cavitation patterns and extents

9

ISO WD "Chapter 9"に対する対応案

もしChapter 9の議論になった場合は,
- そもそも, Reporting formatをなぜISO規格に入れる必要があるのか, その意図は？を明確にしてもらう必要がある.
- 仮に, Chapter 9が採用されてしまった場合には, 記載内容について詳細な議論が必要.

MHI 佐藤様の意見に追加で, 細かい議論になってしまいますが…
- "1. Ship characteristics"には, 例えばdesign draft d[m], depth D[m], block coefficient C_B等が入っていても良い.
- 1.2.7として, boss ratio も入っていて良い.
- 模型船材質, プロペラ回転方向
- 2.2, 2.3は, MCRかCSOか.
- 2.6の"test section"とは, モデル入りかモデル無しか.
- 2.12として, target wake vs simulated wakeの比較が必要ではないか.

1.1 Principal dimensions of the hull
1.1.1 Scale Ratio
1.1.2 Length between perpendiculars [m]
1.1.3 Breadth [m]
1.1.4 Draft at FP and AP [m]
1.2 Principal particulars of the propeller
1.2.1 Propeller diameter [m]
1.2.2 Number of shafts
1.2.3 Number of blades
1.2.4 Hub-diameter ratio, d_H/D
1.2.5 Mean pitch-diameter ratio, $(P/D)_{mean}$
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2. Test conditions
2.1 Load condition
2.2 Delivered power of full-scale propeller [kW]
2.3 Rotational speed of full-scale propeller [rpm]
2.4 Shaft submergence of full-scale propeller [m]
2.5 Sea margin
2.6 Flow speed at test section, V_s [m/s]
2.7 Rotational speed of model propeller [rps]
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3.2 Full-scale source level in one-third octave bands
3.2.1 Scaling method
3.2.2 Effective frequency range [Hz]
3.2.3 Source level [dB re 1 μPa/V @ 1 m]
3.3 Cavitation patterns and extents

10

Template for comments and secretariat observations

Date: 2016-01-25	Document: **ISO20233**	Project:

MB/ NC[1]	**Line number** (e.g. 17)	**Clause/ Subclause** (e.g. 3.1)	**Paragraph/ Figure/ Table/** (e.g. Table 1)	**Type of comment**[2]	**Comments**	**Proposed change**	**Observations of the secretariat**
JP1	7.6			te	Some of the effective methods using empirical formula can be found in the ITTC documents. It will be beneficial to utilize them because they can practically estimate full scale cavitation noise in design stage. This sentence should be changed to refer ITTC documents.	Change to "To evaluate noise in full scale, utilizing empirical formula accompanied with experimental/computational methods can be one option (Some of these methods can be found in 1)). Since the input parameters for these formulae are major design parameters of hull and popeller, they are useful at the early design stage.As a computational method, utilizing computational fluid dynamics (CFD) could be benefitial in that i) it can take the full-scale ship wake into consideration as the inflow condition to the propeller, and ii) it may contribute to resolve tip and hub vortex cavitation, yet the rigorous validations for CFD are inevitable. Reference 1) 27th International Towing Tank Conference, 2014, Specialist Committee on Hydrodynamic Noise Final Report and Recommendations to the 27th ITTC, Proceedings of the 27th ITTC, Vol. 2, pp. 639-679. "	Agreed, Additional references will be added,
JP2	8			te	Although ITTC2008_7.5-02-01-01 describes the uncertainty assessment in experimental hydrodynamics, it is still difficult to quantify the experimental uncertainty in noise measured at cavitation tunnel/depressurized towing tank, for instance, uncertainty in reverberation and background noise. ISO/PAS 17208-1:2012 referenced in the draft is the standard for the sea trial and not for the model tests. Further investigations are necessary for the validity of this standard in model scale.	Delete clause 8. - Some discussions on uncertainty could be found in Annex B as for information only,	1. The 1st and 2nd sentences remain as it was. 2.Agreed on moving to **Annex B** (Informative) from 3rd sentence, 3, The new sentence (left) will be added at the end of the 2nd sentence. 4.3rd sentence: typical values for each error

1 **MB** = Member body / **NC** = National Committee (enter the ISO 3166 two-letter country code, e.g. CN for China; comments from the ISO/CS editing unit are identified by **)

2 **Type of comment:** **ge** = general **te** = technical **ed** = editorial

MB/ NC[1]	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations of the secretariat
							sources -> typical values for each instrumentation error sources. 5. 5th sentence : delete “presented in Clause 7”
JP3	9			te	Reporting format seems not to be necessary as it does not affect directly to the model testing method. It also depends on institutes, in the meantime, no such descriptions can be found in ITTC. Detail and sufficient discussion are necessary for its standardization.	Delete clause 9.	Agreed
GE1		5.25		Te	It is common praxis to evaluate 1000 propeller rounds. That would mean the acquisition time in a cavitation tunnel would be abt. 15 seconds in a deep pressurised towing tank (at lower model propeller speed) the acquisition time would be abt. 200 seconds.	Add a note that includes the special case deep pressurised towing tank, as here the acquisition time has to be much longer.	Agreed
GE2		9		ge	The data to be provided should be seen as a recommendation		Agreed to delete
KR1					The propeller cavitation noise can be assessed by experimental and/or numerical methods in propeller design stage. The numerical method such as CFD or empirical formulae might be a good alternative to propeller cavitation noise evaluations. However, the model tests are still used widely to predict the full scale acoustic source strength of the cavitating propeller for a wide range of frequencies. Special ships such as fishery research vessels and military vessels require propellers with less or no cavitation in their operating conditions. In this case, the noise radiated from the propeller might be less significant than the cavitating one and other mechanical noises become dominant.	Move to **Introduction**	Agreed
				ed	The name “ITTC” in bibliography should be consistent		Agreed

1 **MB** = Member body / **NC** = National Committee (enter the ISO 3166 two-letter country code, e.g. CN for China; comments from the ISO/CS editing unit are identified by **)

2 **Type of comment:** **ge** = general **te** = technical **ed** = editorial

Template for comments and secretariat observations

Date: 2016-01-25	Document: **ISO20233**	Project:

MB/ NC[1]	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations of the secretariat
				ed	The accuracy of the propeller geometry should be according to ITTC - Recommended Procedures and Guidelines 7.5-01-02-02 which specifies that the offsets of the blade sections should be in the range ± 0,05 mm.	The accuracy of the model propeller geometry should be in accordance with ITTC - Recommended Procedures and Guidelines 7.5-01-02-02[reference No] as follows;1.,,2.	Agreed
				ed	The accuracy of the full ship model should be according to ITTC - Recommended Procedures and Guidelines 7.5-01-01-01 which specifies a tolerance of ± 1 mm.	The accuracy of model ship geometry should be in accordance with ITTC - Recommended Procedures and Guidelines 7.5-01-01-01 [reference No] as follows;1,,,2,,,	Agreed

1 **MB** = Member body / **NC** = National Committee (enter the ISO 3166 two-letter country code, e.g. CN for China; comments from the ISO/CS editing unit are identified by **)
2 **Type of comment:** **ge** = general **te** = technical **ed** = editorial

Meeting result of ISO/TC 8/SC 8/WG 14
(Propeller) Meeting

2016-01-25

Dr. Cheol Soo Park, Project Leader

- The third WG 14 meeting was held in London on 2016-01-25 mainly discussing the draft standard of Model test method for propeller cavitation noise evaluation in ship design, namely ISO/WD 20233.

- Participants: Totally 11 representatives from China, Indonesia, Japan, and Korea (see the appendix).

- The WG 14 participants discussed the comments on ISO/WD 20233.

- WG 14 convener is advised to circulate the final WD documentation by the end of April 2016 for further members' comments.

- The members of WG 14 propose to SC8 for skipping CD stage of ISO/ WD 20233 in order to meet the industry needs for this standard.

- WG 14 has discussed the possibility of the next meeting in conjunction with SC 8 plenary meeting in Shanghai, China in July of this year.

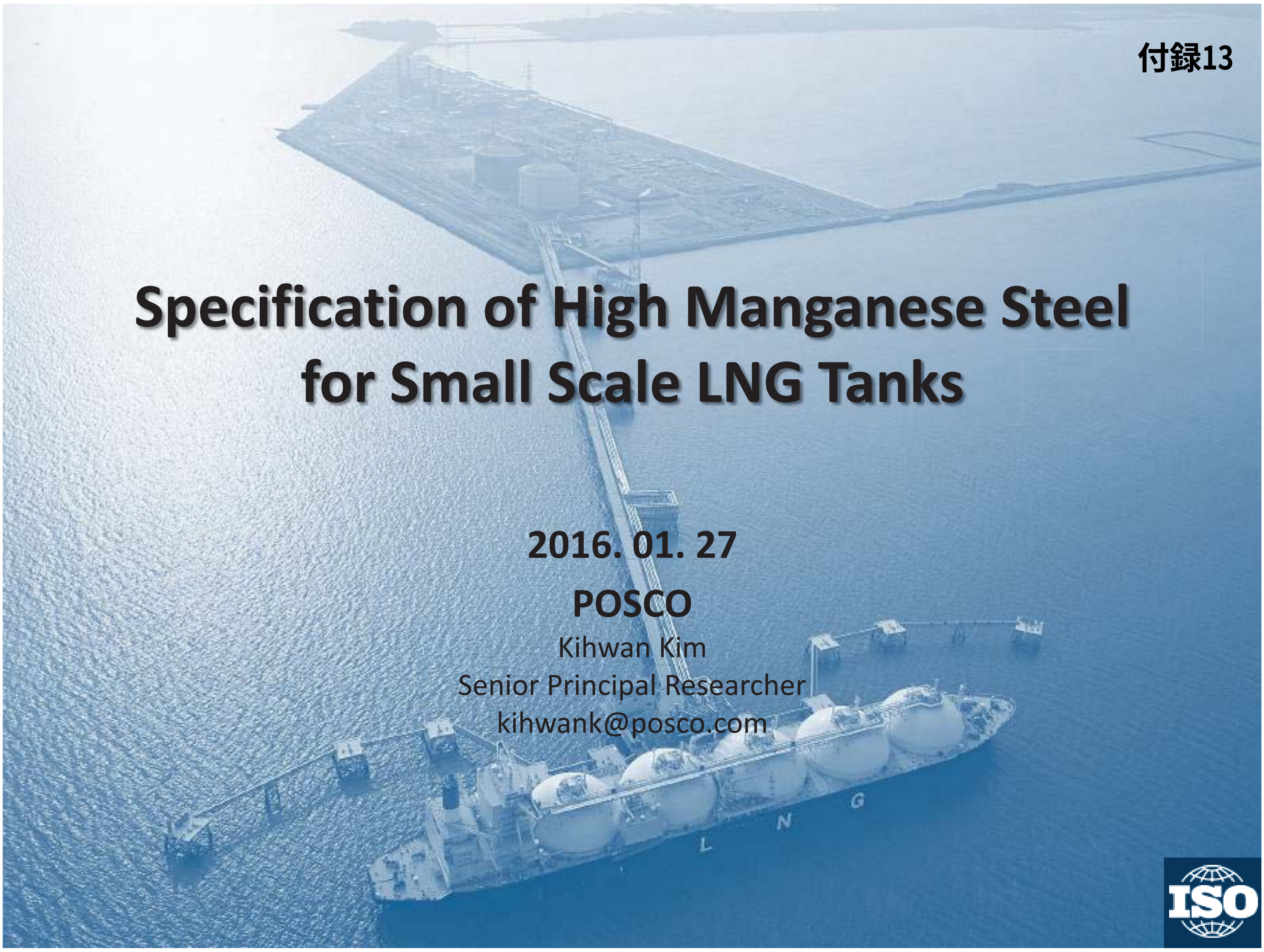
- The convener of WG 14 expresses sincere appreciation for the members for active participation and contribution during the discussions at the WG meeting.

- WG 14 expresses its sincere gratitude to BSI for making excellent arrangements of the working group meeting.

Appendix:

List of WG14 participants

NO	Organization	Name	E-mail address
1	Korea Research Institute of Ships and Ocean Engineering	Cheol-soo Park	parkcs@kriso.re.kr
2	SC8 Chairman	Sei-chang Lee	sclee9411@gmail.com
3	SC8 Secretary (Korea Offshore and Shipbuilding	Byeong-cheol Choi	bcchoi@koshipa.or.kr
4	Japan Ship Technology Research Association (JSTRA)	Kosei Hasegawa	hasegawa@jstra.jp
5	National Maritime Research Institute (NMRI)	Nobuaki Sakamoto	sakamoto@nmri.go.jp
6	Nakashima Propeller Co., Ltd.	Nobuhiro Hasuike	nobuhiro@nakashima.co.jp
7	Mitsubishi Heavy Industries, Ltd.	Kei Sato	Kei_sato@mhi.co.jp
8	Korea Marine Equipment Research Institute (KOMERI)	Dong-hyun Kim	kdh9942@komeri.re.kr
9	PT. BIRO KLASIFIKASI INDONESIA	Agus Widjaja	agus.widjaja@bki.co.id
10	PT. BIRO KLASIFIKASI INDONESIA	Muhdar Tasrief	muhdar@bki.co.id
11	Shipbuilding Information Center of China	Yao Shi	345477346@qq.com



Specification of High Manganese Steel for Small Scale LNG Tanks

2016. 01. 27

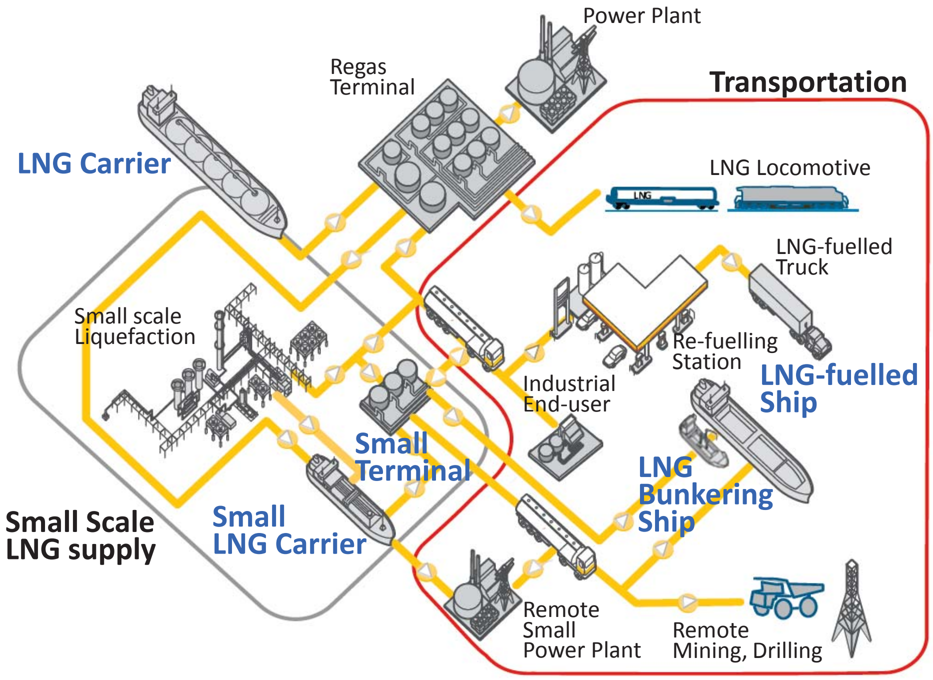
POSCO
Kihwan Kim
Senior Principal Researcher
kihwank@posco.com

Contents

- New trends of a natural gas
- High manganese austenitic steel
- Welding Consumables
- Applications
- Summary

New trends of a natural gas

LNG increasingly as transportation fuels and a form of traded gas



- **LNG-fuelled ships**
  - Comply with MARPOL Annex VI (SOx, NOx)
  - 73 in operation and 80 new-builds ('15.10)*
    * Excluding LNG carriers and inland waterway vessels
  - IGF Code will take effect on Jan., 2017

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Source : Shell, International Gas Union

Materials for LNG tanks

Four metallic materials registered to IGC and IGF codes

Three materials excluding aluminum alloy are nickel-based alloys

Plates, sections and forgings for cargo tanks, secondary barriers and process pressure vessels for design temperatures below -55°C and down to -165°C (IGC and IGF Codes)

Min. design temperature	Chemical composition and heat treatment	Impact test temperature
-165 ℃	**9% nickel steel** - double normalized and tempered or quenched and tempered	-196 °C
	Austenitic steels - such as types 304, 304L, 316, 316L, 321 and 347 solution treated	-196 °C
	Aluminum alloys - such as type 5083 annealed	Not required
	Austenitic Fe-Ni alloy (36% nickel) - heat treatment as agreed	

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High manganese austenitic steel

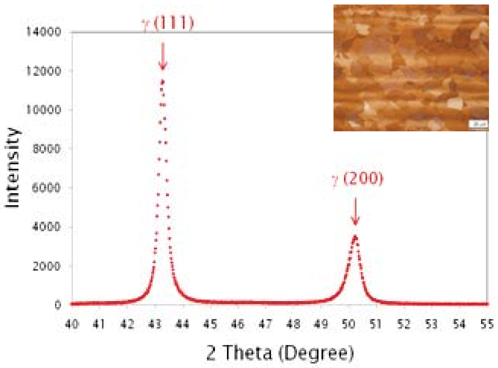
Manganese-based alloy steel for cryogenic applications

Sharing the same crystal structure with austenitic stainless steel

- **Chemical composition (ASTM Draft)**

	C	Mn	P	S	Cr	Cu
%	0.35 ~ 0.55	22.5 ~ 25.5	< 0.03	< 0.01	3.0 ~ 4.0	0.3 ~ 0.7

- **Technical specification**
  - Crystal structure : Face-centered cubic (γ-Fe)
  - Allowable temperature > -196 °C
  - Yield strength > 400 MPa (58 ksi)
  - Tensile strength : 800 ~ 970 MPa (116-141 ksi)
  - Charpy V-notch test > 41 J at -195 °C (–320 °F)



Phase identification by X-ray diffraction
- Microstructure at 25°C

High manganese austenitic steel

Under consideration of ASTM committee

Expected to be approved by 1st half of 2016

INTERNATIONAL Designation: Axxx

Date: November 16, 2015
To: A01.11 Subchairman
Tech Contact: Taejin Hwang (hwangtaejin@ktc.re.kr)
Work Item #: WK 42681
Ballot Action: New standard

Rationale: A new high manganese austenitic steel has been developed for pressure vessels in cryogenic services and therefore a new standard for this material is needed for use. The patent of KR is registered and the PCT (CN, CP, EN, JP and US) has been applied.

Standard Specification for
Standard Specification for Pressure Vessel Plate, Alloy Steel, Austenitic High Manganese for Cryogenic Application[1]

1. Scope

1.1 This specification[2] covers austenitic high-manganese alloy steel plates produced by hot rolling and controlled cooling. The plates are intended primarily for use in welded pressure vessels

1.2 Controlled cooling shall be at a rate sufficient to prevent precipitation of grain boundary carbides.

1.3 Due to the inherent characteristics of the rolling and of cooling processes, the plates should not formed or post-weld

High manganese austenitic steel

In preparation of IMO Document for MSC 96 (May, 2016)

Informational document submitted to CCC 2 (Sep., 2015)

INTERNATIONAL MARITIME ORGANIZATION

E

SUB-COMMITTEE ON CARRIAGE OF CARGOES AND CONTAINERS
2nd session
Agenda item 14

CCC 2/INF.18
10 July 2015
ENGLISH ONLY

ANY OTHER BUSINESS

Introduction to High Manganese Steel for Cryogenic Applications

Submitted by the Republic of Korea

SUMMARY

Executive summary: This document provides information on a feasibility study for high manganese austenitic steel, a material that could be used for cryogenic applications such as cargo tanks, fuel tanks and piping of LNG carriers and LNG-fuelled ships

High manganese austenitic steel

- **Test items**

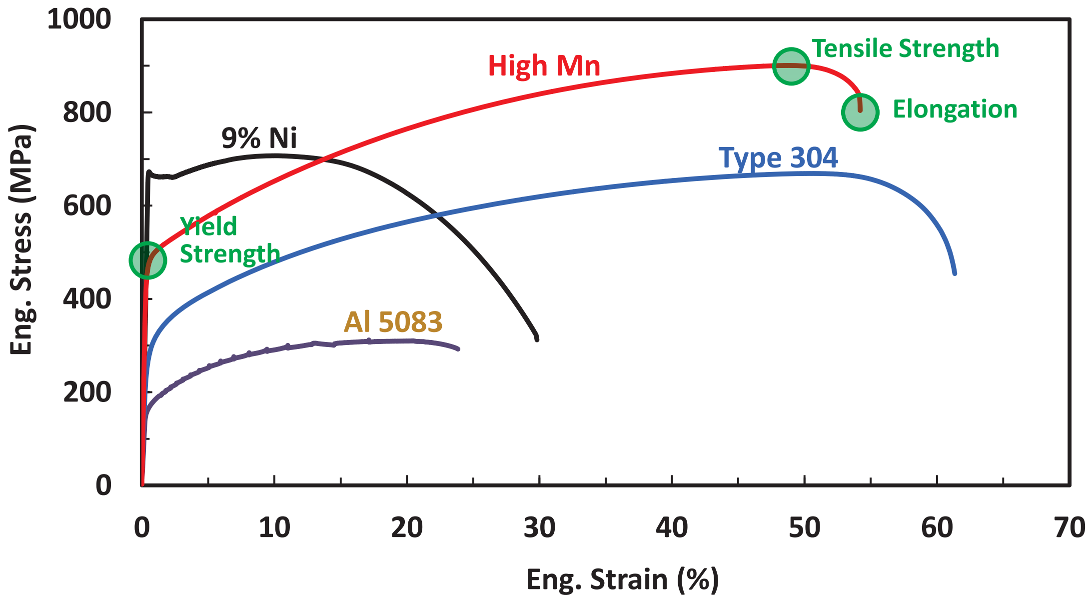
● Temperature at which the item was tested

Items	Temperature (℃)							Standard
	-196	-165	-150	-100	-50	0	25	
Tensile test		●		●			●	IACS UR W2.4.2.2
CVN (Charpy V-notch) test	●		●	●	●	●	●	IACS UR W2.7
CTOD (Crack Tip Opening Displacement) test		●		●			●	BS 7448
Drop weight test	●							ASTM E208
S-N fatigue test		●					●	ASTM E466
Fatigue crack growth rate test		●					●	ASTM E647
Corrosion resistance test							●	ASTM G31
Thermal expansion test	●	●	●	●	●	●	●	ASTM E228
Thermal conductivity test	●	●		●	●		●	ASTM C518
Elastic modulus test							●	ASTM E494

Mechanical properties

■ Tensile test

- Evaluation of **yield strength, ultimate tensile strength, and percent elongation**
- Relevant to the structural safety of an LNG tank on static loads (ex. LNG cargo)

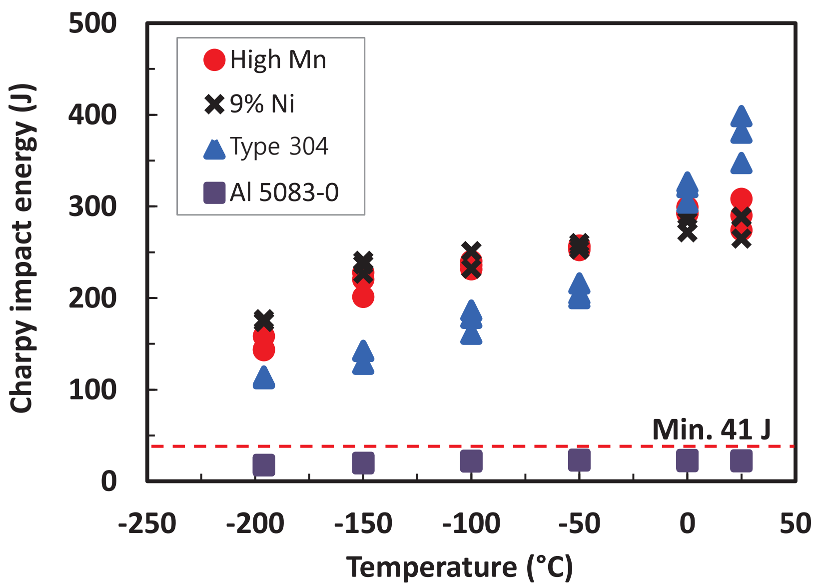


Stress-strain curves of 4 different cryogenic materials (25 °C).

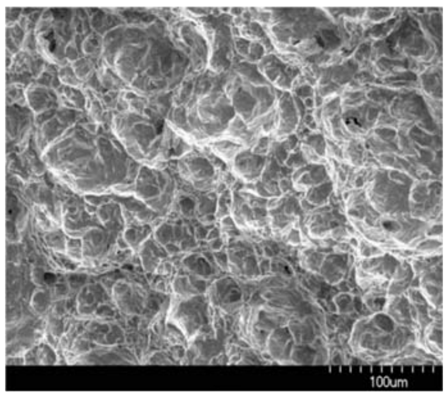
Mechanical properties

■ CVN (Charpy V-notch) test

- Evaluation of **impact toughness** from energy level
- Relevant to the structural safety of an LNG Tank on impact loads



CVN test results of 4 different cryogenic materials.

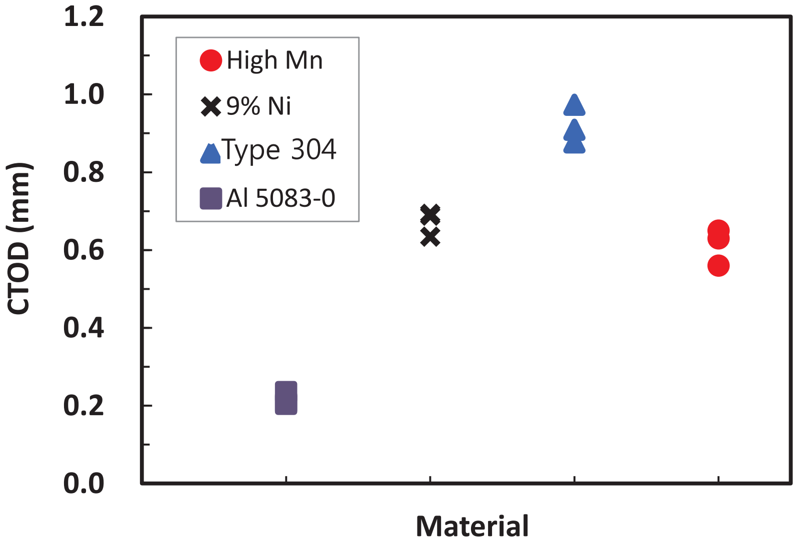


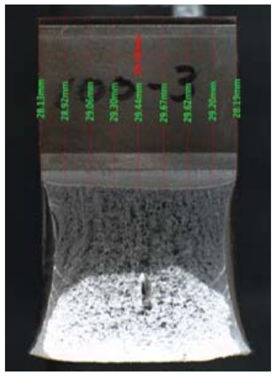
<SEM fractography at -196°C >
- Fibrous section

Mechanical properties

CTOD (Crack Tip Opening Displacement) test

- Evaluation of **fracture toughness** from resistance to crack propagation
- Relevant to the safety of an LNG Tank on pre-existing cracks under static loads





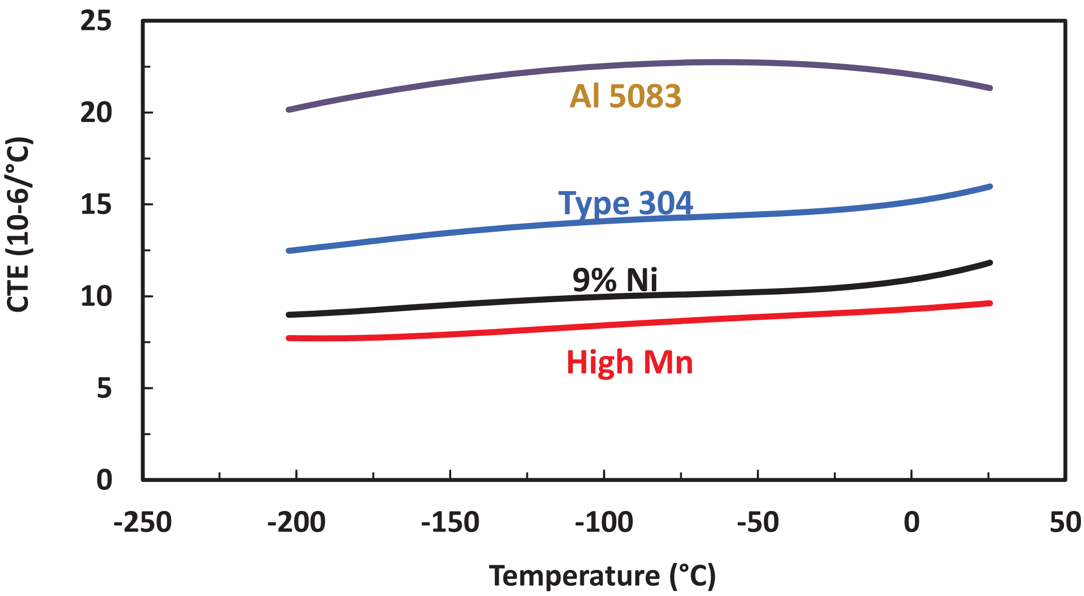
< Fractured face of a high Mn specimen >

CTOD test results of 4 different cryogenic materials (-165 °C).

Mechanical properties

Thermal expansion test

- Evaluation of CTE (Coefficient of thermal expansion) : ΔL/(L•ΔT)
- Relevant to the safety of an LNG tank on thermal stress (ex. LNG loading-unloading)



Coefficients of thermal expansion for 4 different cryogenic materials.

Welding consumables

Welding Consumables for FCA, SA, GTA are available

Commercialized by POSWELDING

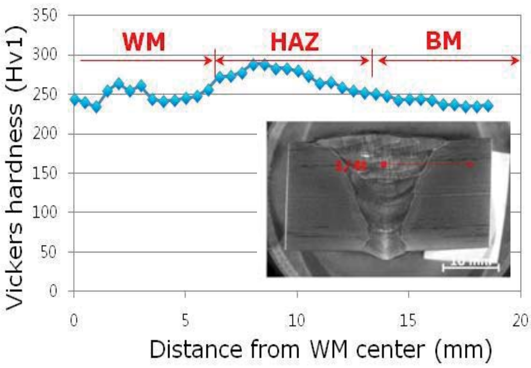
Process	Chemical composition (wt.%)				Mechanical properties (All weld metal)			
	C	Mn	Ni	Cr	YS (MPa)	TS (MPa)	El. (%)	CVN(J) @ -196
Flux Cored Arc Welding	0.1~0.5	≤10.0	**25~40**	≤ 5.0	≥ 360	≥ 600	≥ 22	≥ 27
	0.1~0.5	**15~25**	≤ 10.0	≤ 5.0	≥ 400	≥ 660	≥ 22	≥ 27
Submerged Arc Welding	0.2~0.8	**15~25**	≤ 10.0	≤ 5.0	≥ 400	≥ 660	≥ 22	≥ 27
Gas Tungsten Arc Welding	0.05~0.4	**15~25**	≤ 15.0	≤ 10.0	≥ 400	≥ 660	≥ 22	≥ 27

Properties of welded joint (FCAW)

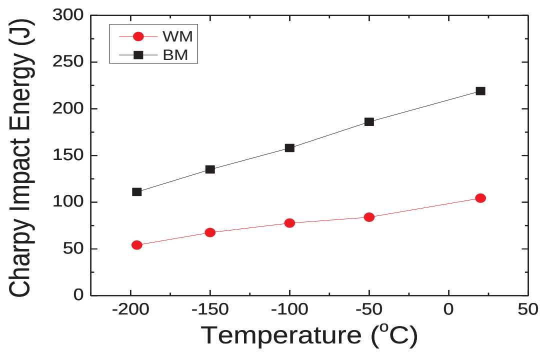
Welded joint satisfies the cryogenic requirements

Undermatching WM, tensile strength over 660MPa.

▪ **Hardness distribution**



▪ **Impact toughness (Chary impact test)**



▪ **Strength (Tensile test, 25 ℃)**

YS (MPa)	TS (MPa)	Fracture
520	681	WM

▪ **Fracture toughness (CTOD test, -165 ℃)**

Notch location	Specimen no.	CTOD (mm)
Fusion line	1	0.37
	2	0.36
	3	0.44

Comparison

(min. design temperature of -165°C)

		Conventional alloys				High Mn
		9%Ni [1]	Type 304 [2]	Al 5083-O [3]	Invar [4]	
Base Metal	Chemical Composition	Fe-9Ni	Fe-18.5Cr -9.25Ni	Al-4.5Mg	Fe-36Ni	Medium C - High Mn
	Microstructure	α' (+ γ)	γ (FCC)	FCC	γ (FCC)	γ (FCC)
	YS(MPa)	≥ 585	≥ 205	124~200	230~350	≥ 400
	TS(MPa)	690~825	≥ 515	276~352	400~500	800~970
	CVN(J,-196°C, L-dir.)	≥ 41	≥ 41	Not req.	Not req.	≥ 41
Weldment	Consumable	Inconel [5]	Type 308 [6]	ER5356 [7]	-	FCA, SA, GTA
	YS(MPa)	-	-	-	-	≥ 400
	TS(MPa)	≥ 690	≥ 550	-	-	≥ 660
	CVN(J,-196°C, T-dir.)	≥ 27	≥ 27	-	-	≥ 27

1: ASTM A553 type I
2: ASTM A240
3: ASTM B209, thickness range of 0.051-1.5in
4: ASTM F1684 for plate
5: AWS A5.34 ENiCrMo4Tx-y
6: AWS A5.22
7: AWS A5.10

Rules and regulations

- **KS** (Korean Industrial Standards)
  - Plates : KS-D-3031, High manganese austenitic steel plate for pressure vessels of low temperature service
  - Welding consumables : KS-D-7142 (SMAW), 7143 (FCAW), 7144 (SAW)
- **ASTM** (American Society for Testing and Materials)
  - In process, expected to be registered by 1st half of 2016
- **ASME** (American Society of Mechanical Engineers)
  - In process, expected to be registered by 2016
- **Class Societies**
  - Approval for manufacturing (plates and welding consumables)
  - ABS, BV, DNV-GL, KR, Lloyd
- **Etc.**
  - AWS, API, IMO, ISO

Applications

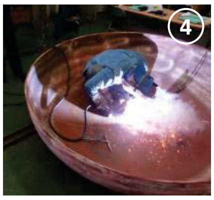
Weldability and workability examined by tank fabrication

- **Welding consumable: PT-400M (FCAW, Dia. 1.2mm)**
- **Manufacturing process**

Plasma cutting and grinding on beveled face

Long seam welding

PT check after head forming



Welding pin part on head

Inside & outside welding of top head

Applications

Cryogenic test of High-manganese-steel LNG tanks

- **Cryogenic test of prismatic vessel ('15.6)**
  - Tank spec. : 2,074 × 2,224 × 11,814 mm, 52 m^3
  - Material : High manganese steel
  - Test liquid : Liquid nitrogen (-196 °C)
  - Witness : Korean Register

Applications

LNG tank for a small-scale LNG power plant

Natioal R&D project at the "Baengnyeong-do" in Korea

- **Project overview**
  - Storage volume and pressure
    : 20 m^3, 15 bar

- **Development status**

Lab scale tank fabrication and LN_2 circulation test (2 cycles/day)

- **Future plan**

Fabrication of high Mn LNG tank (20m^3, '16. 1Q) → Tank installation and operation ('16. 4Q)

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Applications - LNG-fuelled ship

New building of an LNG-fuelled bulk carrier planned

An LNG fuel tank made of high Mn steel will be implemented

Source : Wikipedia

- **Specification of an LNG-fuelled bulk carrier**
  - 32,000 DWT (LOA - 177 m, B - 28 m)
  - Navigation area : Korean coastal-going service
    . Limestone, Donghae ↔ Gwangyang
  - Main engine : Dual fuel (LNG-HFO)
  - LNG fuel tanks : C type 350 m^3 × 2
- **It will be delivered by 2017.**

Source : Bing maps

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Summary

- High manganese steel **possesses superior cryogenic properties**.
- High manganese steel can **contribute to improving the safeties** of LNG cargo tanks, fuel tanks and piping systems.
- High manganese steel may **complement existing cryogenic metallic materials**.

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