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新世代船体構造強度基準の作成に関する調査研究（**MP1**）

（**2005** 年度報告書）

2006 年３月

財団法人　日本船舶技術研究協会

はしがき

本報告書は、日本財団の 2005 年度助成事業「船舶関係諸基準に関する調査研究」の一環として MP1（新世代船体構造強度）プロジェクトにおいて実施した「新世代船体構造強度基準の作成に関する調査研究」の結果をとりまとめたものである。

本プロジェクトでは、IMO において議論が開始された Goal-based Standards for New Ship Construction（GBS）に対して、造船先進国として国際的に貢献するため、その枠組み、船体構造の機能要件、構造設計基準の検証スキーム、GBS を達成するために必要なガイドライン等を検討し、その成果を IMO に提案することを目的とする GBS 草案検討ワーキング・グループ（WG１）を設置し、検討を行った。

また、欧州各国と協力してリスクベース・アプローチの検討を進める作業を行い、その成果を IMO MSC81 へ提出するために、リスクベースワーキング・グループ（WG2）を設置し、対応した。

新世代船体構造強度基準の作成に関する調査研究（MP1）委員名簿（順不同、敬称略）

ﾌﾟﾛｼﾞｪｸﾄ･ﾏﾈｰｼﾞｬｰ	宮本　武	（独）海上技術安全研究所
	矢尾　哲也	国立大学法人　大阪大学
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	井上　剛	（独）海上技術安全研究所
	平方　勝	（独）海上技術安全研究所
	有馬　俊朗	（財）日本海事協会
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	米川　佳宏	国土交通省
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事務局	中川　直人	（財）日本船舶技術研究協会（IMO 担当）
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	前中　浩	（財）日本船舶技術研究協会
	山下　優一	（財）日本船舶技術研究協会

新世代船体構造強度基準の作成に関する調査研究（**MP1**）

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新世代船体構造強度基準の作成に関する調査研究（**MP1**）

GBS 草案検討ワーキング・グループ（**WG**１）

GBS 草案検討ワーキング・グループ（WG１）委員名簿（敬称略、順不同）

主　査	矢尾　哲也	国立大学法人　大阪大学
委　員	吉田　公一	（独）海上技術安全研究所
	小川　剛孝	（独）海上技術安全研究所
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GBS 草案検討ワーキング・グループ（WG１）

目　　　次

１．はじめに

今年度は、昨年度に引き続き草案作成 WG を設置するとともに、MSC80 の審議結果を受けて、新たにリスクベース・アプローチ WG を設置した。なお、2004 年度に検討した「塗装基準に関する調査研究」は、今年度途中から独立したプロジェクト（SPC）として新たに発足した。

我が国は、IMO において議論が開始された Goal-based Standards for New Ship Construction (以下、GBS という) に対して、造船先進国として国際的に貢献するために、積極的に IMO に提案してきた。

また、国土交通省海事局安全基準課の「新構造基準検討委員会（委員長：大坪英臣法政大学教授）」では、国として広く学識経験者の意見を反映するために、GBS に対する国としての基本的考え方を議論し、その意見を本調査研究の作業に反映させるように努めた。

MP1WG-1 の開催状況と審議議題は、以下の通りである。

（１）第 1 回　2005 年 10 月４日

1. GBS に関連する審議経過
2. CG Circular3 への対応
3. 第 3 階層草案への対応
4. 第 3 階層における Acceptance Criteria
5. Ship Construction File
6. 今後のスケジュール

（２）第 2 回　2005 年 11 月 11 日

1. Ship Construction File
2. CG Circular4 への対応について
3. MSC81 への対応について

（３）第 3 回　2006 年１月 23 日

1. 経過報告
2. IACS 会合の報告
3. CG Circular5 への対応について
4. MSC81 への対応について
5. 報告書について
6. 今後のスケジュール

２．調査研究の概要

（１）目的

1990 年前後に続発したばら積み貨物船の沈没事故、さらにその後に続いたナホトカ号、エリカ号やプレティージ号の折損沈没・油流出事故など、度重なる重大な海難事故の発生に対応して、IMO で船体構造の安全対策が進められて来た。

従来、船体構造の安全性確保に関して、IMO では SOLAS 条約の中で単に「船体構造は必要十分な強度を有するよう設計・建造されるべきである。」と記述するのみで、具体的には船体構造は主管庁が認めた船級協会が定めるルールに従って設計・建造されれば良いとされてきた。

しかし、プレスティージ号事故発生以降、船級協会そのものが社会から非難を浴びる情勢となり、船級協会は新たに統一構造ルール（Common Structural Rules）を作成することでこの非難に対応しようとしている。一方、これとは別に IMO でも、船体構造の安全性を確保するための強度要件を独自に定めるべきであるとの合意が形成され、目標達成志向型新構造基準（Goal-based New Ship Construction Standards; GBS）を IMO が構築することになった。

このような背景のもと、本調査研究では、IMO における船体構造基準の合理的な概念構築を主導するために、その枠組み、船体構造の機能要件、構造設計基準の検証スキーム、GBS を達成するために必要なガイドライン等を検討し、その成果を IMO に提案することを目的とする。

（２）調査研究項目及び内容

上記目的のために、以下の内容の調査研究を行う。

IMO 新船体構造基準草案作成に対する対応

次回 MSC81 に向けて設置されたコレスポンデンス・グループ（CG）の中で作業する、第３階層の草案作成に対して、積極的に対応し、我が国意見の反映に努める。

また、GBS に対する我が国の基本的な考え方を整理し、次回 MSC81 に提案文書を作成し、今後の GBS の展開をリードする。

３．構造基準に関する審議状況

3.1 国際船級協会連合（IACS）共通構造規則（CSR: Common Structural Rule）開発の動向

3.1.1　経緯

船主、IMO、港湾関係者、その他関連する団体は、タンカーやばら積貨物船の重大事故が発生することを防止するために、船舶を、より安全で、かつ、頑健な船舶を熱望している。一方、IACS は、個別の構造規定については、統一規則を定めていた。しかし、船級協会における構造規則は、各船級協会独自の経験及び研究開発に基づき定められたものであるため、同一設計の船体構造であっても構造部材によっては要求構造寸法が異なる状態があった。このような状況を解消するとともに、船主、IMO などの要望に応えるべく、より安全で、頑健な船体構造とし、船体構造全般を網羅する共通の構造規則（Common Structural Rule: CSR)を制定することを 2003 年６月に開催された第４７回理事会で決定した。

共通構造規則開発は、IACS 理事会で開発することを決定する以前に、ABS, DNV 及び LRS の３船級協会が、2000 年末に３船級協会共同で 150m 以上の二重船殻タンカーの CSR を開発するプロジェクト（Joint Tanker Project: JTP）を発足させており、CCS, KR 及び NK は、タンカー及びばら積貨物船の直接強度計算、疲労強度評価の共通ガイドラインを開発するプロジェクト(A3 Project)を 2002 年 9 月に発足させていた。さらに、2002 年１２月に開催された IMO MSC 76 での合意事項である 150m 以上のばら積貨物船に対する船側構造の二重化を受けて、BV, GL 及び RINA は、二重船側ばら積貨物船の CSR を制定するプロジェクト（UNITAS　Project）を 2003 年に発足させていた。これらのプロジェクトは、IACS 外で行われているものであるが、それらを IACS として認知するシステムを構築するとともに、ばら積貨物船の CSR は、A3 プロジェクトと UNITAS プロジェクトを合体させ、RS を加えた Joint Bulk Carrier Project（JBP）は 90m 以上のばら積貨物船で、単船側構造及び二重船側構造の共通構造規則を開発することとが、2003 年 12 月に開催された IACS 第 48 回理事会で決定した。

IACS 第 48 回理事会以降、CSR に関する動向を表 3.1.1 に示す。

表 3.1.1　IACS 第 48 回以降の CSR に関する動向

日時	会議など	主な動向
2003 年 12 月	IACS 第 48 回理事会	・　CSR 制定スケジュールの採択 　　2004 年 12 月採択 　　2005 年 7 月施行 ・　規則間の調和を図る Review Panel of Experts の設置
2004 年 6 月	IACS 第 49 回理事会	・　CSR の詳細制定スケジュール及び手順に関する統一手続き規則（PR30: Procedure Requirements No.30）の採択 　　2004 年 6 月草案公表 　　2004 年 9 月コメント受付 　　2004 年 10 月第 2 次案公表 　　2004 年 12 月採択 　　2005 年 7 月施行 ・　RPE を強化し、規則間の調和を図る Rule Technical

		Harmonization（RTH）を設置
2004 年 6 月		CSR 第 1 次案公表及び説明会実施
2004 年 10 月	IACS 臨時理事会	上記スケジュールの 6 か月延期を決定
2004 年 12 月	IACS 第 50 回理事会	CSR 採択に係わる阻害要因の提出
2005 年 3 月	IACS 臨時理事会	阻害要因解消の検討を行うため、RTH を更に強化した Small Group Identification(SGI)の設置
2005 年 4 月		CSR 第 2 次案公表
2005 年 4 月	IACS 臨時理事会	船級協会の最高責任者による会議の開催を決定
2005 年 6 月	IACS CEO 会議 IACS 第 51 回理事会	・　スケジュールの見直し 2006 年 1 月までに採択 2006 年 4 月施行 ・　ＩＡＣＳメンバー協会すべてがＣＳＲすべてのを取り入れることに合意
2005 年 12 月	IACS 第 52 回理事会	CSR の採択
2006 年 4 月		CSR 施行

3.1.2　CSR 採択の阻害要因及び長期調和作業

(1)　阻害要因の解消

以下に示す両規則取り入れに関わる阻害要因の解消作業は、上述の SGI が実施することになり、CSR 採択までの短期間に調和作業を実施する事項と採択後に時間をかけて調和作業を実施する事項とに整理し、短期に調和すべき事項は、2005 年 11 月までに実施し、長期に解決すべき事項は、その手順などを 2005 年 11 月までに策定することとなった。

(a)　短期間で調和作業を実施する事項

①　腐食予備厚の数値及び表記方法並びに計算寸法端数の取り扱い
②　斜め波の取り扱い及び波浪縦曲げせん断力
③　縦曲げ最終強度の評価方法及び波浪縦曲げモーメントに対する部分安全係数
④　船体梁の座屈強度評価
⑤　直接強度計算

(b)　長期間で調和作業を実施すべき事項

①　波浪荷重
②　疲労強度評価
③　直接強度評価手法
④　直接強度計算結果に基づく座屈強度評価

上記（a）の短期間に調和作業を実施する事項は、以下のとおりとなった。

①　環境要因ごとに腐食予備厚を規定するばら積貨物船規則の表記に合わせ、最終的に算定される両面の腐食予備厚は、0.5mm 単位に切り上げたものにすることとなった。なお、解決にあたりギリシャ船主の強い要望もあり、岸壁などと接触しやすい船側外板及びばら積貨物船の隔壁の腐食予備厚が見直された。また、要求計算寸法の端数処理については、ネット寸法を 2 捨 3 入により 0.5mm 単位に丸めることで合意された。

② ばら積貨物船規則にハッチコーナー部の疲労強度評価をするために斜め波に対応した曲げ捩りモーメントの簡易算式を導入し、タンカー規則における波浪せん断力を現行規則（IACS UR S11）に合わせることとなった。

③ タンカー規則において、許容静水中縦曲げモーメントを使用する場合の波浪縦曲げモーメントの部分安全係数を 1.20 とし、ばら積貨物船規則に整合させるとともに、船体縦曲げ最終強度の算定方法もばら積貨物船規則と同一の方法を許容することとなった。

④ タンカー規則において、ばら積貨物船規則と同様の評価算式を取り入れることとなった。

⑤ ばら積貨物船規則において縦曲げモーメントを解析モデルに直接負荷する直接法と解析後に縦曲げモーメントによる応力を負荷する方法（間接法）との結果に差がないことを示すことで決着した。

上記(b)に関し、CSR 施行後において履行上の問題点及び疑問点の解消、業界からのコメント処理などを実施する CSR 保守作業を少なくとも 1 年間実施し、施行後 1 年経過した後調和作業を 2 ないし 4 年かけて行うこととなっている。なお、CSR 保守作業及び調和作業は、IACS の中で船体関係規則を専管して検討する組織である Hull Panel が規則施行後担当することとなる。

3.1.3 CSR の構成及び目次

(1) CSR の構成

CSR は、将来的なことも考慮して、モジュール化された構成とすることが第 48 回理事会で合意された。その構成は、第１編として、すべての船舶に共通する要求事項を記載し、第 2 編としてタンカーに対する追加要件、第３編として二重船側ばら積貨物船に対する追加要件を記載し、将来的に、他の船種に対する追加要件を定める場合は、第 4 編以降に記載することとしている。

しかし、今回採択された CSR は、共通事項を抽出する作業は行っておらず、タンカー規則及びばら積貨物船規則として独立した規則として制定された。

(2) CSR の目次

CSR の目次として各船級協会規則、UR・UI を参考に、目次案を作成したが、2005 年 2 月現在の目次は、表 3.１.2 に示すように、タンカー規則とばら積貨物船規則と異なる形になっている。

Table 3.1.2　Table of contents

CSR for Bulk Carriers		CSR for Tankers	
Chapter	Title	Section	Title
1	General Principle	1	Introduction
		2	Frame of the Rules
		3	Notations
		4	Basic Information
2	General arrangement design	5	Structural Arrangements
3	Structural design principles	6	Materials and Welding
4	Design loads	7	Loads
5	Hull girder strength	8	Scantling Requirements

		App. A	Hull Girder Ultimate Strength
6	Hull scantlings	9	Design Verifications
		App. D	Buckling Strength Assessment
7	Direct strength analysis	10	Buckling and Ultimate Strength
		App. B	Structural Strength Assessment
8	Fatigue check of Structural details	App. C	Fatigue Strength Assessment
9	Other structures	11	General Requirements
10	Hull outfitting		
11	Construction and testing		
12	Additional Class Notations		
13	Ships in Operation, Renewal Criteria	12	Ship in Operation Renewal Criteria

3.１.4　主要な内容

(1)　IMO GBS の基本的要求事項への対応

- 環境条件
- 貨物積載能力及び運航要件
- 構造強度
- 建造品質
- 腐食対策
- 疲労寿命
- 検査及び修理のための安全交通
- 就航中の船舶の構造評価

(２) 適用及び船級付記符号

2006 年 4 月 1 日以降建造契約される船舶に適用し、CSR の規定を満足する船舶には、船級符号に“CSR”を付記する。

上記（a）に関連し、航路制限なしに運航する鋼製の船舶をより安全に、かつ、Robust にする目的で設計寿命（疲労寿命及び腐食量の評価期間）を　25 年とし、北大西洋を航行することを条件として、環境荷重、腐食予備厚の設定、疲労寿命の評価を行うこととしている。
また、すべての強度評価にネット寸法手法（腐食による衰耗を考慮した構造の強度を評価手法）を適用しているため、就航後も、評価された強度を確保するために、考慮した腐食量が構造部材の衰耗限度に対応することになる。また、船体梁やパネルの強度評価には、最終強度評価を適用することにより、どのレベルの荷重に耐えるのかを明確にしている。

3.１.４　まとめ

CSR は、技術的には、State of arts ともいえる事項も含めているため、詳細事項や評価手法について一部整合してはいないものの、構造強度をより合理的に評価することにしており、また、就航後における構造強度も合理的に評価することとしている。これにより、船体構造の安全性、Robust を求める IMO，政府機関、船主、荷主など多くの関係者の期待に沿うものになっていると思われる。しかし、

構造寸法増加に及ぼす影響や、損傷実績との対比など、未解決と思われる事項は、今後の保守作業及び長期調和作業において解決され、より合理性、説明性、透明性の高い規則に改善されていくことになる。

3.2　IMO/MSC80 における審議結果

5 月 11 日より 20 日まで、IMO 本部にて、MSC80 が開催され、議題６「ゴールベースの新造船基準」のもと、審議が行われた。今次会合では、米国の Jeff Lantz を議長にワーキンググループ（ＷＧ）が設置された。以下、審議の経緯及び結果を詳述する。

前回会合で合意された GBS の 5 階層システム（第 1 階層；ゴール、第 2 階層；機能要件、第 3 階層；適合性検証、第 4 階層；技術規則、第 5 階層；業界標準等コード）（図 3.2.1 参照）にしたがって、IMO は、第 1 階層から第 3 階層までの作業を進めていくことが、はじめにプレナリーで確認された。

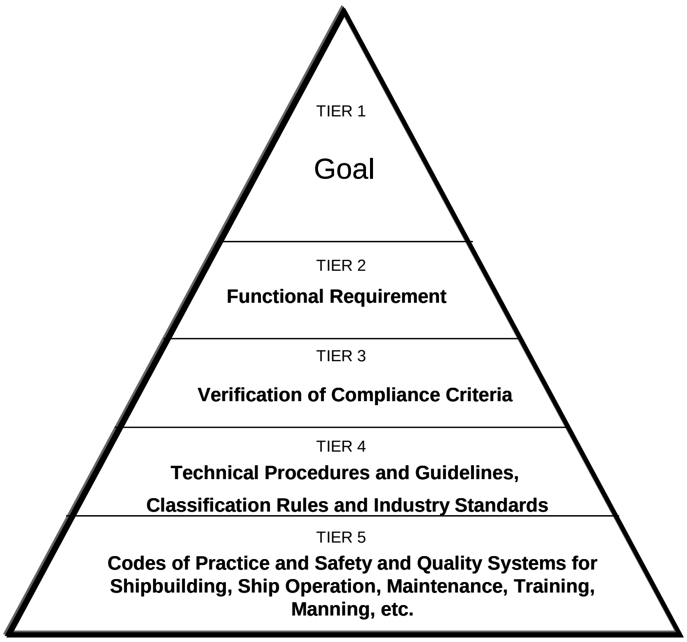

図 3.2.1 GBS 5 階層システム

下記のようなプレナリーからの作業指示に基づき、前回 WG のレポート(MSC80/6；添付資料１．参照)をベースに、各国からの提案を WG で検討した。

1. GBS の基本原理をとりまとめること（リスクベース・アプローチの取扱いも含む）
2. 第 1 階層をとりまとめること
3. 第 2 階層を見直すこと

そして、時間が許せば、

4. 第 3 階層の草案を見直すこと
5. IMO 規則への GBS の取り込み法を検討すること
6. GBS の作業計画を見直すこと
7. 次回 MSC81 に向けて、GBS 検討作業を継続する CG の設置と CG で議論すべき課題を検討すること

（１）GBS の進め方について（リスクベース・アプローチとの関連）

プレナリーでは、リスクベース・アプローチ（FSA WG）との協調の必要性を認識しているが、当面、FSA と GBS の審議は、並行して行うこととなった。WG では、リスクベース・アプローチを取り入れるべきか／当面は伝統的アプローチを採るべきか(リスクベース・アプローチの実用性)について相互に譲らぬ議論が続いた。妥協案として、リスクベース・アプローチの推進派が MSC81 に具体的な実用事例を提出すること、その結果を受けて以降の方針を決定することが合意された。

（２）ＧＢＳ草案について

ＷＧでは、文書 MSC80/6（MSC79 WG 議長；添付資料１．参照）と MSC80/6/1（日本；添付資料２．参照）を中心に、議論が進められた。以下、その審議結果について、概要を示す。MSC80 で合意された草案は、添付資料３．のとおり。

（ｉ）基本原理、及び第 1 階層（ゴール）について

基本原理の現行ドラフト（MSC80/6 Annex1）は、修正なく合意された。第 1 階層の適用について、「全ての“ 新 ”船」であることが再確認された。

（ii）第 2 階層（機能要件）

WG では適用対象を「航行に制限がないタンカー及びバルカー」の新船に絞ることが確認された。「その他の船種、及び航行に制限のあるタンカー及びバルカー」の新船については、次回以降検討することとなった。また、第２階層の構成を、設計 建造 就航中 のカテゴリーに再分類し、各要件の順番を並べ替えることとなった。審議の経緯、及び結果概要は、次のとおり。

（イ）設計

Ⅱ.1　Design life

設計寿命について、ギリシャは「30 年」を強硬に主張したが、我が国を含め大勢が「25 年」を主張したため、25 年とすることでギリシャも同意した。合意された内容は、次のとおり。
「設計寿命は 25 年未満であってはならない」

Ⅱ.2　Environmental conditions

「北大西洋」の海域を想定して疲労を含めた強度設計がなされることが合意された。合意された規定は、次のとおり。
「船舶は、北大西洋の環境条件と関連する長期波浪データを基に、設計されなければならない」

Ⅱ.3　Structural strength

「構造の冗長性」に関わる規定については、新たな項目” Structural redundancy”を設けて規定することとなった。また、第２階層でネット寸法に対して「安全マージン」を要求することで合意したが、具体的な数値については複雑であり統一的な記載が不可能との認識の下、第 3 階層以下で規定することとなった。合意された規定は、次のとおり。
「船舶は、適切な安全マージンをもって設計されなければならない。以下、省略」

Ⅱ.4　Fatigue life

我が国と IACS は、疲労は強度設計の一側面であり、敢えて「疲労寿命」を独立項目とする必要性はないと主張したが、ギリシャ、ポーランドが「疲労寿命」の項目を残すことを主張し、項目が残った。合意された規定は、次のとおり。

「設計疲労寿命は、設計寿命(25 年)未満としてはならず、Ⅱ.2「環境条件」をベースにしなければならない。」

なお、ギリシャ・バハマ等の少数を除く WG の多数意見は、「北大西洋環境条件を想定するので、設計疲労寿命を設計寿命よりも長くする必要性は無い」であり、WG 議事録に明記された。

Ⅱ.5　Residual strength

合意された規定は、次のとおり。

「船舶は、規定された損傷状態（衝突、座礁または浸水）において、波浪と内圧に耐えるように、十分な強度をもつように設計されなければならない。以下、省略」

Ⅱ.6　Protection against corrosion

ギリシャ及びバハマを除く多数意見に従い、機能要件としての「防食 “Protection against corrosion”」を新設し、その下に「塗装寿命」と「腐食予備厚」を細目として記述することで合意した。また、ギリシャ及びバハマ等少数が塗装及び腐食予備厚確保をそれぞれ強制化することを主張したが、技術進歩を阻害しない様に自由度確保に配慮する大勢は、これを否決した。また、防食法として塗装を採用する場合には塗装寿命を指定すべきこととなったが、区画によらない一律な年数は規定できないとの認識の下、15 年とか 10 年とかの具体的数値規定は削除された。また、腐食速度の設定に関しては、ギリシャ及び INTERTANKO が加速モデル試験によるデータの否定除外を主張したが、技術進歩推進に配慮する大勢からは、支持を得られなかった。

Ⅱ.7　Structural redundancy

合意された規定は、次のとおり。

「船舶は、いかなるひとつの構造部材の「局部的な損傷」も、他の構造要素の瞬時な損傷を引き起こし、構造強度の喪失・水密性の喪失など重大な損傷に至ることが無いように、冗長性をもって設計され、建造されなければならない。」

バルカーの構造 Redundancy 規則騒動を基に慎重に立案された原文となっており、対外的には小骨のみならず大骨をも含む記述ながら IACS による「解釈」の自由度(影響を極限する)を十分に確保した内容となっている。

Ⅱ.8　Watertight and weathertight integrity

新たな項目として 追加することが、合意された。合意された規定は、次のとおり。

「船舶は、就航中に十分な水密性と風雨密を保持するよう、設計され、船体開口の閉鎖装置は、十分な強度と冗長性を有するように設計されなければならない。」

Ⅱ.9　Design transparency

安全を確認するために必要な設計情報へのアクセスが要求されることとなったが、知的財産権について、配慮されることが合意された。また、“ship construction file”の内容を検討していくことも合意された。

（ロ）建造

Ⅱ.10　Construction quality procedures

工作品質標準の共通化・強制化要求は無くなった。本件についても、知的財産権について、配慮されることが合意された。

Ⅱ.11　Survey

合意された規定は、次のとおり。

「検査プランは、船種、設計を考慮して、船の建造段階に対して作成されなければならない。また、検査プランには、就航中の検査において、特に強度を必要する場所を明示するものでなければならない。」

（ハ）　就航中

Ⅱ.12　Maintenance

メンテナンスがしやすいように、設計建造されなければいけないことだけが、規定された。また、メンテナンスファイルの必要性を、今後、検討することとなった。

Ⅱ.13　Structural accessibility

合意された規定は、次のとおり。

「船舶は、概観検査、詳細検査及び板厚計測を容易にするために、すべての内部構造にアクセスできる適当な交通手段を提供するように、設計、建造、装備されなければならない。」

（３）作業計画

前回会合で合意された作業計画について見直しが行われた。内容は、以下のとおり。

1. リスクベース・アプローチを、GBS フレームワークの中で検討することを追加
2. GBS の基本原理に関する審議は(一応)終了
3. 第 1 階層（ゴール）に関する審議は(一応)終了
4. 第 2 階層（機能要件）に関し、①全ての船種に展開すること、②制限された航海に従事する船舶に展開すること
5. 第 3 階層（適合性検証）の作業を進めること、その際に、①検証のためのガイドラインを作成することの必要性、②検証は、どのように、誰が行うかを、検討すること
6. GBS の施行
7. GBS の IMO 規則への組み込み
8. “ship construction file”の作成、検査・メンテナンスファイルの必要性の検討
9. 階層をまたぐスコープの一貫性と妥当性を見直すこと

（４）プレナリーにおける審議

プレナリーは WG の報告を受けて、以下のとおり議論し、合意した。

（ア）　リスクベース・アプローチ

ドイツなどがリスクレベルの検討も CG の TOR に追加することを主張した。その結果、CG の TOR は、WG 案ととおり第 3 階層の草案作成のみとなったが、我が国はリスクベース・アプローチも併行して行うとした WG の合意に賛成して、そのような作業を推進する意向を表明し、ドイツ、デンマーク、スウェーデン、ノルウェー及び英国と協力して検討を推進し、次回に提案文書を提出することとなった。なお、ドイツが協力グループの幹事を務め、その第一回会議をコペンハーゲンで６月下旬に開催されることとなった。

（イ）　CG の設置

ＣＧの作業について、第 3 階層の草案作成に絞って議論することで合意された。CG のコーディネ

ータは、WG 議長の Jeffrey G. Lantz（米国）になった。

3.3　新構造基準検討委員会の審議経過

目標達成指向型新構造基準（Goal-based new ship construction Standards）について、IMOへの対応を検討するため、国土交通省海事局安全基準課長の私的諮問機関として新構造基準検討委員会が設けられた。本検討委員会においては、海上技術安全研究所を中心として行う新構造基準案を策定するための調査研究プロジェクトのステアリングも同時に行うこととしている。

新構造基準検討委員会での検討経緯を、IMOの動きとともに次に示す。

2002 年 11 月　*プレスティージ号事故*

2002 年 11 月　*ＩMO第８９回理事会*

- バハマ、ギリシャが構造基準を IMO 長期計画に入れるよう提案

2002 年 12 月　*ＩMO第７６回海上安全委員会*

- ギリシャがロバストシップ構想を提案

2003 年 5 月　*ＩMO第７７回海上安全委員会*

- 構造に関する Goal-Based New Ship Construction Standards を次回海上安全委員会から本格的に議論することにした。
- 部材寸法などの詳細な基準はＩMOでは作らないが、船がどのような船体構造を持たなければならないかを明確にする機能要件はＩMOで定めるというコンセンサスが形成された。

2004 年 1 月　**第１回新構造基準検討委員会**

- 次のマンデートの下に検討を進めることとした。
  1. IMO における新たな構造強度に関する国際基準の作成に関して我が国の国益を反映するための戦略を構築すること
  2. 新構造強度基準を策定するための調査研究プロジェクトのステアリングを行うこと
  3. 国際シンポジウムの開催や国際共同研究の実施など、我が国主張の多数派工作を行うための措置の企画を行うこと
- バハマ・ギリシャ・ＩACＳが作成したＩMO次回MＳCに提出予定のＧＢＳに関するベース・ドキュメントについて検討。就中、ＧＢＳは、Ｉゴール、Ⅱ機能要件、Ⅲ認証、Ⅳ詳細基準、Ⅴ実施細則の５層の基準体系で、その内、第３層までをＩMOで作成し、明確で、現実的で、定量的で、長期的な基準体系を目指すもの。
- 日本の造船・海運の技術優位性による競争力を維持するためには、画一的な設計基準は避けるべきで、この意味からも、ＩMOでの基準は、荒いメッシュで作る。
- ２５年の設計寿命を求めることに関し、設計だけでなく、メンテナンスとオペレーションは非常に重要なファクターなので、これを加味した基準を目指す。

2004 年 4 月　**第２回新構造基準検討委員会**

- MSC78（2004 年 5 月）への各国提案をレビュー
- GBS の検討に当たっては、設計・建造基準と並行して、メンテナンス基準、運航基準も並行して検討すべき旨ＩＭＯで主張することとした
- 北大西洋の気象海象ベースの設計寿命２５年は支持することとした

2004 年 5 月　***ＩＭＯ第７８回海上安全委員会***

- バハマ等の３カ国提案を議論のベースとして今後審議
- 我が国は、メンテナンス及び運航の基準も策定すべき旨提案(MSC78/6/5)

2004 年 6 月　**第３回新構造基準検討委員会**

- MSC78（2004 年 5 月）の結果報告
- IACS・CSR の動向レビュー（タンカー規則とバルカー規則の不整合等）
- 我が国から機能要件の包括的基準案を作ってＩＭＯに提出することとした

2004 年 11 月　**第４回新構造基準検討委員会**

- ロシア・GBS セミナー、第２回船舶安全設計会議、ＩＳＯ動向等の報告
- MSC79（2004 年 12 月）への各国提案をレビュー
- 塗装基準の動向レビュー
- GBS に関する対応方針検討

2004 年 12 月　***ＩＭＯ第７９回海上安全委員会***

- GBS の基本概念と第Ⅰ階層（目標）を作成。
- 第Ⅱ階層（機能要件）は、当面タンカーとバルクキャリアを想定した基準を作成することとした
- 我が国は、ゴールを達成すべき道筋は柔軟であるべきこと、メンテナンス及びオペレーションの基準も策定すべき旨主張(MSC79/6/22)

2005 年 1 月　**第５回新構造基準検討委員会**

- MSC79（2004 年 12 月）の結果報告
- GBS 専門家会合（於東京；2005 年 3 月）の開催準備状況報告
- 次の点を強調したＧＢＳ機能要件（第Ⅱ層）に関する基準案を独自に作成。
    - ✧ 疲労に関する環境条件は北大西洋でなく世界平均のものを用いること
    - ✧ メンテナンス、運航及び品質管理に関するガイドライン作成の必要あること

2005 年 5 月　***ＩＭＯ第８０回海上安全委員会***

- 第Ⅰ階層（目標）、第Ⅱ階層（機能要件）を作成
- 第Ⅱ階層は、「航行に制限のないタンカーとバルクキャリア」に絞ったもの
- コレスポンデンス・グループ（米国がとりまとめ役）を作って第Ⅲ階層（認証）を

作成することになった

- 北欧が主張していたリスクベース・アプローチをＧＢＳに導入することについては、現在の第Ⅱ階層案には入っていないが、併行して検討することになった。

2005 年 6 月　**第６回新構造基準検討委員会**

- MSC80（2005 年 5 月）の結果報告
- MSC81（2006 年 5 月）に向けて、以下の機関が主体で検討を進めることとした。
  - ✧ 第Ⅱ階層（機能要件）を全船種に適用を拡大した場合の影響：業界主体で検討
  - ✧ 第Ⅲ階層（認証）のコレスポンデンス・グループ対応：役所、ＮＫ主体で検討
  - ✧ リスクベース・アプローチ対応：海技研主体

2005 年 12 月　**第７回新構造基準検討委員会**

- GBS に関する動向報告
  - ✧ IMO 及び新構造基準検討委員会での検討経緯
  - ✧ 第Ⅲ階層に関するコレスポンデンス・グループの動向
  - ✧ リスクベース・アプローチに関する動向
- MSC81（2006 年 5 月）に向けての今後の方針
  - ✧ 第Ⅱ階層（機能要件）の全船種に適用を拡大：
  - ✧ 第Ⅲ階層（認証）のコレスポンデンス・グループ対応：
  - ✧ リスクベース・アプローチ対応：

４．GBS 草案の検討

4.1　CG における第 3 階層の審議

MSC80 で GBS の WG 議長を務めた Jeffrey G. Lantz（米国）が、本 CG のコーディネータを務め、MSC80 で合意された以下の付託事項にしたがって、作業が進められた。作業は、コーディネータが課題（質問）を設定し、それに対してメンバーが回答することで進められ、合計５回のメールベースによる意見交換を通して、ＣＧのレポート作成に至った（MSC81/6/1；添付資料４．参照）。

CG の付託事項は、次のとおり。

１．適合性検証のための第 3 階層クライテリアの草案作成

２．MSC81 に報告

CG に参加したメンバーは、次のとおり。

バハマ、ブラジル、カナダ、中国、サイプラス、デンマーク、フィンランド、ドイツ、ギリシャ、インド、イラン、アイルランド、イタリア、日本、マーシャル諸島、オランダ、ノルウェー、パナマ、ポーランド、韓国、ルーマニア、シンガポール、スペイン、スウェーデン、英国、米国、香港、EC、BIMCO、IACS、INTERCARGO、INTERTANKO、ICS IMarEST、OCIMF、RINA

第 3 階層の作業を進めるにあたって、まず、基本的考え（特に、第３階層の目的、適用範囲、内容、許容基準の必要性、他階層とのリンク、ガイドラインの必要性等について）がコーディネータから示された。そして、それらについて議論を深めていくことで作業が進められた。以下、課題ごとに議論の経緯と結果を整理する。

検証の範囲とフレームワーク

第 3 階層で検証すべき基準の範囲について議論した。そして、その対象は第 4 階層にあたる規則と関連する第 5 階層にあたる規則であることが合意された。

これに関連して、IACS から、「船級規則には、第１階層（目標）と第 2 階層（機能要件）すべてに対する詳細な規定が設けられていない」、とする問題提起がなされた。そこで、「船級規則は第１階層、第２階層すべての要件について、規定する必要があるか、ないか」について意見が求められたところ、我が国はじめ多数のメンバーから、「船級規則が全てを網羅する必要はない」とコメントがあった。そして、そのように回答したすべてのメンバーが、IMO において、船級協会がカバーすべき機能要件を決めるべき、とコメントした。一方、ギリシャ、バハマ、シンガポール、ＩＣＳは、船級規則は第１階層、第２階層全てを取り扱う必要があると主張した。特に、ギリシャは強硬に主張した。

また、第４階層にあたる規則として、コーディネータから、船級規則以外に、ＩＭＯ規則、国内規則が挙げられた。そして我が国からのコメントを反映して、国内規則の検証はここでの対象外として結論づけられた。ただし、韓国は国内規則の検証方法を第３階層で規定すべきとし、ポーランドは、IMO のボランタリー監査スキームの中で検証できないか、提案を行った。したがって、ＣＧレポート案では、船級規則とＩＭＯ規則の検証について、それらの検証プロセスが示されている。一方、INTERTANKO、INTERCARGO が国内規則もその対象とすることを主張、IACS はそれを支持した。

これら規則に加えて、造船所の建造品質等を規定する基準を検証のフレームワークに加えるべきで

あると INTERTANKO、INTERCARGO が主張し、IACS がこれを支持した。ただし、これらは船級規則の中に含まれるであろうから、船級規則の検証をとおしてなされるとしているが、INTERTANKO は、造船所の基準を含めるべき、と主張し続けている。

検証プロセス

検証プロセスについて、コーディネータからは、MSC81/6/1 附属書３、４のように提案があり、また、INTERTANKO、INTERCARGO は、２段階のプロセスを提案した。第１段階では、技術要件の詳細な調査とその評価、第２段階では、そのプロセスがあらかじめ決められた基準に合致しているかどうかの監査にあたる。第１段階では、IACS の代表者を含んだ技術グループから構成され、旗国主官庁による代表と組んで実施されることを提案している。第２段階では、IMO の専門家グループによって実施されることを提案している。彼らは政治的プロセスによる検証に走ることによって、技術評価がおろそかになることを懸念したため、このような提案を行ったとしている。

第４階層にあたる規則のオーナー

第４階層にあたる規則のオーナーが、検証にあたって要求される情報と文書を Verification Authority（後述）に提出することについて、ほぼ全てのメンバーが同意した。この場合、第４階層にあたる規則のオーナーとは、船級規則の場合、オーナーは船級協会である。

不服申し立ての権利

第４階層にあたる規則の検証で、当該規則が第１階層と第２階層に適合しないと判断された時の不服申し立てについて、その権利と手続きについて確立することを、ほぼ全てのメンバーが同意した。適合しないと判断された場合には、Verification Authority がそのオーナーに対して、文書でその内容を通知し、不服申し立てできる機会を持つことで合意した。

更新された規則の検証

第４階層にあたる規則に更新があった場合の検証手続きについて議論した。そして、実質的な内容の更新があった場合に、検証を行うことで合意されたが、この「実質的」の定義については詰められていない。ドイツは、この内容を、機能レベルまたは安全レベルが更新された時、と提案している。また、定期的に再評価することも確認された。

Verification Authority

Verification Authority として、IMO の専門家グループ、船舶登録国、IACS などの NGO などが挙げられたが、大多数のメンバーが IMO の専門家グループを支持した。主官庁については、専門性などの不備が指摘され、また、IACS については、検証の対象であり、不適当であるとされ、他の NGO について推薦がなかったため、IMO の専門家グループで合意された。

専門家グループの選考について、そのクライテリア、プロセス等を設けるべきとの意見で一致していたが、資格、選出方法、メンバー数、リーダーシップ、会合の頻度等課題が列挙されたが、その具体的検討は行われなかった。ただし、メンバーには十分な技術的専門性と規則に精通すること等が条件とされ、またコメントされている。今後議論されなければならない大きなテーマである。

認定とＲＯ

各国が認定団体（ＲＯ）として認定する行為と、IMO の専門家グループが行う検証と切り離して考えることが合意された。したがって、船級規則がＧＢＳに合致しているとして検証されることと、ＲＯとして認定されることのリンクは、今後検討されることとなった。また、我が国は、IMO の専門家グループが行った検証結果は、あくまで助言的位置付けであり、最終的なＲＯとしての認定はこれまでどおり、各国主官庁にあることを提案、英国、韓国がこれを支持している。

第３階層で要求する情報と文書

第３階層の草案では、船級協会が提出すべき情報と文書について、コーディネータから提案があり、我が国をはじめ、ギリシャ、ノルウェー、IACS、スペインなどがコメントしたが、合意には達しなかった。

また、検証を支援するための提出すべき情報は、第２階層の最終化により決定されることをノートした。また、スウェーデンは、第２階層を holistic approach で書き換えるべきとの従来からの主張を述べ、提案された第３階層のドラフトを支持しないことを表明した。

また、検証にあたって第４階層にあたる規則の技術的背景等を記述した「rule commentary」をノルウェーが提案し、多くのメンバーがこれを支持している。合わせて提案のあった「標準化された報告様式」についても支持があったが、これらの具体的な検討はこれから行われることとなった。

許容基準

第３階層に、許容基準を設けるべきかどうか議論されたが、結論には達しなかった。我が国からは、許容基準設定のための基本的考えを提案し（後述）、具体的な許容基準を第３階層草案に挿入する提案を行った。（MSC81/6/1 附属書５参照）

また、検証をよりクリアにするために、第２階層の見直しもまた必要とのコメントもあった。多くのメンバーから、第３階層は手続きに焦点を当て、許容基準を含めるべきでないとコメントがあった。一方、第３階層で許容基準を設けるべきとしたメンバーの多くが、第２階層に許容基準が示されていないことを理由としているので、第２階層に許容基準を設定することを含めて再度議論すべきとしている。また、検証に当たって、チェックリストの提案もあったが、項目のみに焦点が当たり、技術的検証がおろそかになる危険性があり、避けるべきとなった。

第３階層草案に対する我が国からの回答

Circular1 への日本の主なコメント

〔第３階層の内容について〕

コーディネータから、船級協会が提出すべき情報についてｺﾒﾝﾄが求められ、我が国は次のように回答した。

第 2 階層に記載されている項目について、①第 4 階層規則の中にどのように組み込んだかを明示する情報、②船級協会が具体的に規定した数値基準の妥当性を検証するための情報が考えられる。②の情報は、例えば、以下のものが考えられる。

・波浪頻度ダイアグラム及びその発行年

・不確実性を含む設計パラメータに対する安全率及びその根拠

例えば、

・ネット寸法及びその根拠

・主要区画の腐食予備厚及びその根拠
・適切な水密性と風雨密に対する対応及びその根拠

しかし、船級協会規則の全ての数値基準について、その妥当性を検証することは不可能かつ不必要と考える。日本は当該情報のスコープを船舶の安全性と環境に重大な影響を与える構造部材に限定することが現実的であると考える。

〔許容基準〕

コーディネータから、第 3 階層に許容基準を含むべきか否か、コメントが求められ、我が国は次のように回答した。

ＧＢＳスキームの透明性を確保する観点から、具体的な許容基準を規定すべきである。しかし、第 2 階層で規定された全ての項目について、定量的な許容基準を設けることは不可能であり、その必要はないと考える。

どの項目について、現実的に、定量的な許容基準を与えることが可能かどうかを検討することも必要であると考える。例えば、船舶の安全性と環境に特に重大な影響を与える破壊モードについては、最低限、定量的な許容基準を設けることが必要と考える。

Circular2 への日本の主なコメント

〔第３階層で許容基準は必要か？〕

コーディネータから、第 3 階層に許容基準を含むべきか否か、改めてコメントが求められ、我が国は次のように回答した。

許容基準は、船体強度に関連する重大な課題にについて与えられるべきである。そこで、許容基準に関する基本的考え方を、以下のように提案した。

許容基準に関する基本的な考え方

第 3 階層の目的は、海上における人命の安全、財産の保護、海洋環境保護及び海上保安を考慮して定められた第 1 階層及び第 2 階層に記載する船体構造強度に関する安全目標及び機能要求を、船級協会、業界などが定める記述的構造基準、指針、手順書などが満たしていることを確認するための手順と許容基準を明らかにすることにある。

第 3 階層の構造強度に関する許容基準は、致命的な構造崩壊並びにその結果としての人命／財産の喪失及び海洋汚染の防止の観点から、船級規則等が要求する強度に関連する記述的構造基準がどのように与えられるべきかをクリアにするためのものである。ここでは、致命的な構造崩壊は、船体梁の折損及びそれに多大な影響を及ぼすような、主要構造の崩壊を意味する。

致命的な構造崩壊といったリスクを防止できる基準であるかどうかは、以下の強度要件が、第 3 階層の許容基準にしたがって、作られているかどうかを確認することで評価できる。

i. 船体梁の耐荷能力
ii. 船体梁の崩壊に多大な影響を及ぼす重要区画の二重底構造や隔壁構造などの主要な構造部材の耐荷能力

また、貨物油の海洋への漏洩、または、大区画への浸水に影響を及ぼす船体梁および重要区画の主要部材の亀裂を防止できる基準であるかどうかは、以下の強度要件が、第３階層の許容基準にしたがっ

て作られているかどうかを確認することである。
iii. 疲労強度

Circular3 への日本の主なコメント

Circular2 で、コーディネータから提案された第 3 階層草案（情報と文書の要求　ー船級規則）に対して、我が国は修正提案を行った。主な修正提案は次の通り（詳細は、MSC81/6/1 Annex5 に示す）。

Ⅲ.2　Structural strength

〔変形の許容値〕

変形の許容値を Verification Authority に提示する提案を削除することを提案した。その理由として、変形の影響は、疲労、座屈強度評価に含まれ、変形を単独では評価できないためとした。

〔安全率〕

安全率とその根拠を Verification Authority に提示する提案を修正することを提案した。その理由として、安全率の妥当性は、想定荷重のレベルと強度計算法のレベルが一緒に検証されなければならないためとした。

〔連続性〕

連続性の許容値を Verification Authority に提示する提案を削除することを提案した。その理由として、疲労強度の検討で自動的にカバーされ、連続性の許容値を検討することは意味がないからとした。

〔評価部材〕

評価する構造部材を Verification Authority に提示する提案を削除することを提案した。その理由として、ほとんど全ての構造部材が対象となるためとした。

〔冗長性〕

冗長性に関する情報を Verification Authority に提示する提案を修正することを提案した。その理由として、第 2 階層で合意された内容に忠実でないためとした。

〔許容基準〕

強度（降伏、座屈、疲労、最終強度、残存強度）に関する許容基準を挿入することを提案した。許容基準の主な内容は、次の通り。

船体梁の縦強度要件

- 曲げ強度、せん断強度を規定
- 船体梁を構成する部材は、適切な余裕をもって、原則降伏しないことを規定
- 曲げ強度の許容基準として、断面係数を規定
- 船体梁を構成する部材では、腐食による強度劣化を考慮、妥当な控除寸法を規定
- サギング状態、ホギング状態の両方を想定した規定
- 計画したすべての積み付け状態を想定した静水中曲げモーメントを規定
- 波浪発現頻度表から波浪中曲げモーメントの長期予測値を規定
- 適切な余裕をもち、安全率を明示することを規定

主要構造部材（二重底構造や隔壁構造等）の縦強度要件

- 原則降伏しないことを規定
- 考慮する主要構造部材では、腐食による強度劣化を考慮、妥当な控除寸法を規定
- 適切な余裕をもち、安全率を明示することを規定

疲労強度要件

疲労損傷により、貨物油が海洋に漏洩すること、または、大区画に浸水することが予想される部位を対象に、

- 代表的な箇所の累積疲労被害度で評価することを規定
- 腐食を考慮した寸法を想定することを規定
- 頻度の高い積み付け状態を想定した規定
- 設計寿命の間に遭遇すると予想される繰り返し数以上を規定
- 積み付け状態に応じた応力頻度分布を要求する規定
- 適切なＳ－Ｎ曲線を要求する規定

最終強度要件

- 適正な余裕をもって、船体梁の縦曲げモーメントに耐えることを規定
- 船体梁を構成する部材では、腐食による強度劣化を考慮した規定
- サギング状態、ホギングのどちらか、または両方を考慮した規定
- 計画したすべての積み付け状態を想定した静水中曲げモーメントを規定
- 波浪発現頻度表から波浪中曲げモーメントの極値統計値を規定
- 適切な余裕をもち、部分安全係数を明示することを規定

浸水時の船体梁の残存強度要件

乾貨物を運搬するばら積み貨物船を対象に、

- 一貨物倉に浸水した状態で、適正な余裕をもって、最終強度を維持することを規定
- 腐食による強度劣化を考慮
- 適切な余裕をもち、部分安全係数を明示することを規定

浸水時の重要区画の主要構造体の残存強度要件

乾貨物を積載するばら積み貨物船を対象に、

- 重要区画に浸水後、主要構造体の崩壊から逐次崩壊が起こらないことを規定
- 想定した浸水に対して、重要区画の主要部材が最終強度に達しないことを規定

Circular5 への日本の主なコメント

　ギリシャが CG でコメントした内容について、技術的観点からコメントした。主な内容は以下のとおり。

〔設計思想〕

　ギリシャは設計思想について、”safe life design”と”fail safe design”を紹介、”safe life design”を主張した。そこで我が国は、船体構造設計は、決められた検査とメンテナンスレジームで修復すること

で対応可能であり、技術限界と経済性の面から、”safe life design”ではなく、”fail safe design”が現実的であると反論した。

〔設計波浪〕
ギリシャは、”steep wave”を考慮して設計することを主張した。そこで我が国は、”steep wave”の発生メカニズムが研究途中であり、設計荷重として採用することは適当でないとコメントした。

〔疲労強度の安全率〕
ギリシャは、疲労強度に影響を与える”criticality factor”を１以上と提案した。そこで我が国は、北大西洋の波浪データを用いることは、十分な安全率を考慮しているため、１で十分であるとコメントした。

〔腐食予備厚〕
ギリシャは、腐食予備厚の設定に関連して、腐食速度のデータを提示した。そこで、我が国は、腐食予備厚の要件は、腐食環境を考慮して決定されるべきで、ギリシャが提示した Pre-MARPOL 船をベースとしたデータは適当でないとコメントした。

4.2　Ship Construction File の検討

MSC 80 において Goal Based Standards for New Ship Construction についての検討を行う中で、設計の透明性を確保するための情報の保持についてその重要性は広く認識されたが、何を、どのようにといった議論はなされなかった。また、こうした情報は Ship Construction File (SCF) に含まれるべきとの意見もあったが、SCF についてこれまでも MSC 80 においても具体的な議論はなされてこなかった上、コレスポンデンス・グループでもスコープ外とされた。

そこで実現可能な SCF の基本原則案を日本から示すべく本研究の中で検討を行った。

GBS は個船を建造する際に参照されるルールを作るためのルールであり、GBS そのものには個船が GBS に定められた機能要件を満たしているかどうかを判定する機能は持たない。そのため船舶の健全性は GBS に準拠したルールに基づいて設計、建造されたことを確認することで担保されることになる。

しかし、今後建造される船舶が、GBS に定められた機能要件を満たしていることを求められる以上、船舶は就航後（就航中）もその健全な状態が維持されることを確実なものとしなければ海上安全の確保や海洋環境の保護といった目標を達成することは難しい。

就航後（就航中）の船舶の健全性を確実なものとする手段は従来から行われてきた検査制度があり、既に高度に完成された制度として確立され充分な機能を有しており、その海上安全と海洋環境保護に対する有効性については一定の評価が得られているところである。そのため、就航後（就航中）船舶の健全性維持という目標が効率的に達成できるような仕組みは、既存の検査制度を有効に活用しつつ、GBS という枠組みにシステムの一部としてビルトインされるようにすることが現実的かつ効率的であると考えられる。

一方、就航後（就航中）の船舶の健全性を確保する手段の一つとして日常の点検や不具合が生じた場合の手入れが重要かつ有効であることは言うまでもなく、それを確実なものとするために設計の透明性の確保が必要であることも明白である。

この点に着目し、現在検討している新造船 GBS では設計の Tier II 中「II. 9 設計の透明性」の項目において、船舶に備置する文書について言及するとともに、同「II. 11 検査」の項目では Survey plan

について規定し、船主等船舶の使用者側への適切な情報提供を促し、日常の点検や手入れの実施を支援しようとしている。

こうしたことを踏まえ、日本はMSC 81において、MSC 81/6/4（添付資料５．参照）に示すようなSCFについての基本理念を提案した。

この提案文書では、SCFをTier IV以下の階層で定められるべきものとした上で、SCFで扱う情報を活用するための措置はTier I又はIIと密接に関連するものであり、IMOで検討すべきものであると指摘し、委員会に対し日本の提案を勘案しながら SCF のコンセプトを取りまとめるよう求めている。また、Annexとして SCFに含まれるべき重要項目の簡単な一覧を示した。

この表は、新造船GBSで要求される機能要件を各個船が生涯にわたって満たしていることを確実にするためにどこに着目しておく必要があるか、という視点でまとめたもので、各個船について、ここに掲げた項目を把握することでTier IIの機能要件に適合した状態を容易に維持できるようになることを期待している。また、この表の欄外には、これら項目のいくつかについて履歴を把握することでさらに効果的なシステムとして運用することが期待できる等註書きし、このファイルが船舶の新造時に作られることのみで目的が達成される訳ではないことを入念に示した。

５．MSC81 への対応

5.1　GBS に対する我が国の基本的考え方

国土交通省海事局に設置された「新構造基準検討委員会」の場において、日本がこれまで GBS についての考え方や方針を国内にも海外にも分かり易い形で発信してこなかったことを指摘されたことから、GBS に対する我が国の基本的考え方を MSC 81 への提案文書としてとりまとめるため、安全基準課と海技研が中心となり本研究の中で議論を行った。

議論は、各国に示す我が国の方針は産業政策等国内政策に反しないものとする一方で各国にとって受け容れ可能な論理でも説明できる必要があることにも配慮しながら進められ、添付資料に示す文書（MSC81/6/3；添付資料６．参照）として完成させた。

この文書の骨子は、

①GBS の策定にあたっては充分な船体強度、少ない環境負荷、受容可能な社会コストの最適な組み合わせが実現できるようにすべきである。

②GBS の策定にあたりリスクベース・アプローチを導入することは有効と考えられる。

③GBS の策定にあたりプレスクリプティブなアプローチを採る場合、Tier III には委員会で慎重に検討された最小限度のアクセプタンス・クライテリアが必要である。

④GBS は SOLAS の枠に適合したものであるべきである。Tier III は Tier IV には法的な強制要件と主管庁の責任に基づく強制要件との二種類あることを考慮に入れて策定されるべきである。

⑤RO の承認についてのガイドラインを、GBS に適合した構造基準を持っている機関について主管庁が委ねることができるよう改正すべきである。

の五点からなっている。そのうち、我が国が当初から主張している船舶の一生涯に亘りその構造安全を確保するための機能要件、それを達成するためには新造時の構造強度のみで安全を確保するのは、過度な構造部材寸法の船を要求することとなり、メンテナンスや運航まで考慮した合理的な構造基準の枠組みを作るべきであることは①として特に力点を置いた。

5.2　MSC81 における GBS の審議への対応方針

また(1)の検討と併せ、GBS の今後の展開とそれを踏まえた MSC 81 への対処方針についても議論を行った。当然のことながら提案文書の内容と重複する部分もあるが概ね以下に示す七項目である。なお、リスクベース・アプローチに関しては、本研究の WG2 を中心に EU の SAFEDOR Project の動向を見極めつつ我が国の GBS 研究の主要課題として取り組んでいるところである。本件は GBS の枠組みの再構築を促すものでもあることから影響するところが大きく、欧州勢と協調しながら我が国意見を反映していく方針が確認された。

①リスクベース・アプローチの方向を支持すること。

②Tier III は基本的に手続論に限定する方向で臨む。

③他の船種への拡張の動きが具体化した場合は客船を支持するなどして欧州を巻き込む方向で考える。

④航行制限付きの船舶への拡張の動きが具体化した場合はリスクベース・アプローチの導入を主張する。

⑤タンカー、バルカーに関し早期発効の動きについて積極的に反対はしないものの、時間はかかってもリスクベース・アプローチで対応すべきとの動きがあれば後者を支持する。

⑥メンテナンスの重要性は引き続き主張し、その中で Ship Construction File の必要性、有用性をアピールしていく。
⑦GBS の運用に関連した法的な枠組みについての我が国の考えと方向性を表明する。

６．今後の GBS の課題

CG では、第３階層の草案作成に焦点を絞り作業が進められた。ＣＧ内で活発な意見交換が行われ、我が国も積極的にコメントしたが、“規則の検証”スキーム作成という、IMO におけるはじめての試みに取り組んでいることから、現在、検討すべき課題が多数残されている。第３階層の主な今後の課題を整理すると、以下のようになる。

〔責任と権限に関する事項〕

第４階層にあたる規則のオーナーは？

現在、船級協会の規則（第４階層にあたる規則）は、第１／第２階層で要求される要件全てをカバーしていない。船級協会は全ての要件をカバーすべきであると主張するＣＧメンバーもいたが、大勢はこのような現状を受け入れ、今後 IMO において、船級協会がカバーすべき要件の特定、カバーされていない要件をどうするか、誰が第１／第２階層の全てをカバーさせるかなど議論していくこととなる。船級協会が規定しない要件については、最終的には旗国の責任のもとカバーすることが考えられるが、旗国の能力も考慮しなければならない。

検証を行うのは誰？

第３階層の議論で大きなテーマの一つである。規則の検証には、専門性と経験が必要とされることから、現在 CG では、MSC の指揮下におく“エキスパート・グループ”で合意している。

しかしながら、エキスパート・グループについて、資格、選出方法、メンバーの数、リーダーシップ、会合の頻度等、課題が CG コーディネータから示されているものの、現在、具体的内容について合意に至っていない。今後議論する大きな課題である。

〔技術的要件に関する事項〕

IMO が規定すべき許容基準は？

第３階層の草案で許容基準を設定するべきとする CG メンバーもいたが、CG のなかで合意に達しなかった。第３階層は手続きに限定すべきであると主張するメンバーも多くいることから、第２階層の草案について再度議論することも考えられる。上位の階層では“設定すべき”要件を明記することが望ましいと考えるが、技術的な観点から、下位階層にあたる規則で“規定できる”、“規定できない”の議論も想定される。その際には、“許容できない構造損傷”、“許容してさしつかえない構造損傷”など“目標レベル”を合意して作業をすすめることが必要となる。リスクベース・アプローチの手法は、目標設定（第１階層）、機能要件の整理（第２階層）、合理的な検証（第３階層）などで、有用な手法と期待される。

これら第３階層の課題は、次回 MSC81 における今後の中心的な審議課題であるが、我が国は、前節で述べたように、GBS に対する基本的な考え方を整理、主張している。検討すべき審議事項は多く、次回 MSC81 で第 3 階層の草案について審議した後、どのように展開していくか、現時点では不透明である。次のような審議事項が想定されるが、我が国提案文書の主張が、今後の展開に当たって活用されることを期待する。

〇第２階層の審議

ータンカー、バルカー以外の船舶

　　ー航路制限のある船舶
〇タンカー及びバルカーの規則最終化
〇設計・建造以外のＧＢＳ規則（検査／メンテナンス、オペレーション、その他関連事項）
〇リスクベース・アプローチによる現行草案の見直し

７．添付資料リスト

資料１．MSC80/6; GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS (WG Chairman)

資料２．MSC80/6/1; Proposal Tier Ⅰ and TierⅡ of the goal-based new ship construction standards (JAPAN)

資料３．MSC80/WP.8; Report of the Working Group

資料４．MSC81/6/1; Report of the Correspondence Group (CG Coordinator)

資料５．MSC81/6/5; Basic concept of a Ship Construction File(SCF) (JAPAN)

資料６．MSC81/6/4; Japan's position on goal-based new ship construction standards (JAPAN)

INTERNATIONAL MARITIME ORGANIZATION

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IMO

MARITIME SAFETY COMMITTEE
80th session
Agenda item 6

MSC 80/6
22 December 2004
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GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Report of the Working Group on Goal-Based Standards at MSC 79

Submitted by the Chairman of the Working Group

Introduction

1 The Working Group on goal-based new ship construction standards (GBS) met from 1 to 9 December 2004 under the chairmanship of Mr. J. Lantz (United States). As requested in the terms of reference (see paragraph 3), an oral report on the outcome of the group's discussion was given to the Committee on 10 December 2004 (MSC 79/23, paragraphs 6.18 and 6.19).

2 The group was attended by representatives from the following countries:

AUSTRIA
AUSTRALIA
BAHAMAS
BELGIUM
BRAZIL
BULGARIA
CAMBODIA
CANADA
CHINA
CYPRUS
DENMARK
GERMANY
GHANA
GREECE
INDIA
IRAN (ISLAMIC REPUBLIC OF)
IRELAND
ITALY
JAPAN
LIBERIA
LITHUANIA
MALAYSIA
MALTA
MARSHALL ISLANDS
NETHERLANDS
NEW ZEALAND
NORWAY
PANAMA
POLAND
REPUBLIC OF KOREA
ROMANIA
RUSSIAN FEDERATION
SAUDI ARABIA
SINGAPORE
SPAIN
SWEDEN
TURKEY
UKRAINE
UNITED KINGDOM
UNITED REPUBLIC OF TANZANIA
UNITED STATES
VENEZUELA

the following Associate Member of IMO:

HONG KONG, CHINA

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observers from the following intergovernmental organization:

EUROPEAN COMMISSION (EC)

and observers from the following non-governmental organizations:

INTERNATIONAL CHAMBER OF SHIPPING (ICS)
INTERNATIONAL CONFEDERATION OF FREE TRADE UNIONS (ICFTU)
BIMCO
INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)
OIL COMPANIES INTERNATIONAL MARINE FORUM (OCIMF)
INTERNATIONAL MARITIME PILOTS' ASSOCIATION (IMPA)
FRIENDS OF THE EARTH INTERNATIONAL (FOEI)
INTERNATIONAL ASSOCIATION OF INSTITUTES OF NAVIGATION (IAIN)
COMMUNITY OF EUROPEAN SHIPYARDS' ASSOCIATION (CESA)
INTERNATIONAL ASSOCIATION OF INDEPENDENT TANKER OWNERS (INTERTANKO)
INTERNATIONAL ASSOCIATION OF DRY CARGO SHIPOWNERS (INTERCARGO)
THE INSTITUTE OF MARINE ENGINEERING, SCIENCE AND TECHNOLOGY (IMarEST)
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS (RINA)
INTERNATIONAL MARINE TRANSIT ASSOCIATION/INTERFERRY (IMTA)

Terms of reference

3 Taking into account the comments and decisions made in plenary and the relevant documents submitted, the working group was instructed to proceed with its work in accordance with the following terms of reference:

.1 prepare an outline of the basic principles of "goal-based standards";

.2 develop the framework of a five-tier system for goal-based new ship construction standards, using document MSC 78/6/2 as a basis, and in particular:

.2.1 the safety objectives in Tier I, including a working description of each objective;

.2.2 the functional requirements in Tier II, including a working description of each requirement, relating them to the safety objectives in Tier I; and

.2.3 the associated Tier III verification compliance criteria for the functional requirements in Tier II;

.3 identify any other subjects which are fundamental to be considered by the Committee at this early stage in the context of the goal-based standards and provide appropriate recommendations;

.4 give preliminary consideration to the issue of how the provisions of the goal-based standards could be incorporated in the appropriate IMO instruments;

.5 develop a plan for the future work to be carried out under the item;

.6 submit an oral report to the Committee on Thursday, 9 December 2004; and

.7 prepare a written report immediately after the meeting for submission to MSC 80.

Basic principles of goal-based standards

4 As instructed, the group commenced its work with a discussion and debate in order to develop the basic principles for goal-based standards. The Chairman began the discussion by repeating the summary of responses to the first issue for consideration identified in document MSC 79/6/1, which was provided in plenary, to be considered as the basis for the principles. In general, this was supported by a number of representatives in the group. In addition, other points of view and other items to be included in the basic principles were brought forward by other participants.

5 Based on the results of this discussion, the group developed basic principles for IMO goal-based standards as shown in annex 1. In developing the principles, the group did not spend an extensive amount of time on the matter in order to be able to give appropriate consideration to the other items in the terms of reference and consequently agreed that, at this time, the basic principles are not considered a final recommendation. Instead, the group agreed that they should be generally considered as a working definition and that they need to be further considered in the future work under this agenda item as more experience is gained.

6 These basic principles were developed to be applicable for all goal-based standards developed by IMO and not only goal-based new ship construction standards. This is in recognition that, in the future, IMO may develop goal-based standards for other areas, e.g. machinery, equipment, fire-protection, etc. and that all goal-based standards developed by IMO should follow the same basic principles.

Framework of a five-tier system for goal-based new ship construction standards

General

7 The group agreed that, as the basic framework for goal-based standards, the five-tier system proposed in document MSC 78/6/2 should be used. However, it was noted that, for the purposes of development by IMO, the goal-based new ship construction standards would consist of Tiers I, II and III, as Tiers IV and V are developed by the classification societies, other recognized organizations and other industry standards organizations.

8 The group recognized early on that the development of Tier I goals and Tier II functional requirements is an iterative process. Thus, while development of Tier I leads to the development of Tier II; the results of the development of Tier II will lead to further consideration and development of Tier I.

Goals (Tier I)

9 The group proceeded to develop Tier I safety objectives by considering the proposals in document MSC 78/6/2 as a basis. There was discussion on the applicability of Tier I, with some delegations proposing that, for the current effort, Tier I should be developed only for bulk carriers and tankers. This was not supported and it was agreed to develop a Tier I that is applicable to all ships. However, the group concluded that Tier I should more appropriately be considered “Goals” instead of “Safety objectives” as originally proposed and therefore agreed to change the title of Tier I to “Goals”.

10 The scope of the goal-based new ship construction standards was discussed and it was agreed that these are standards for new construction of the ship's structure. Some members of the group expressed the view that standards for operation and maintenance of ships in service should be included, however, this was not accepted by the majority of the group.

11 In general it was agreed that the Tier I goals should address safety and environmental friendliness with respect to structural integrity and strength, dismantling and recycling and the need for design and construction to provide for safe access, inspection and proper maintenance. Tier I should also include provisions regarding operating and environmental conditions and specified design life. In considering the proposal in document MSC 78/6/2 that Tier I should include structural accessibility and quality of construction, it was concluded that these items are more functional in nature and, as such, they should be considered for Tier II.

12 The issue of whether or not Tier I should include specific values, i.e. design life of 25 years, was debated and it was agreed that this was not appropriate for Tier I as Tier I should contain high level goals and specific values should be included in the lower tiers.

13 The Tier I goals with working descriptions that were developed by the group are shown in annex 2.

Functional requirements (Tier II)

14 The group then discussed the functional requirements in Tier II, again using the proposals in document MSC 78/6/2 as a basis, noting that the Tier II functional requirements will define the requirements that need to be satisfied in order to meet the Tier I goals. The Tier II functional requirements along with a working description for each as developed by the group are shown in annex 2.

15 The issue of applicability of Tier II was discussed and there was general agreement within the group that Tier II should apply to all ships. However, for the purposes of discussion and to help focus the efforts of the group in order to develop Tier II, the group agreed to limit consideration to tankers and bulk carriers. Therefore, at this time, the Tier II functional requirements should be considered only relevant to tankers and bulk carriers.

16 In developing the Tier II functional requirements, the group noted the importance of ensuring each functional requirement was linked to Tier I. Some members of the group expressed the view that this linkage needed to be specifically noted in the description of each Tier II functional requirement. However, while reemphasizing the need to ensure that Tier II is linked to Tier I, the group generally decided that specific wording was not necessary.

17 The issue of Tier II containing quantitative values was discussed. The group noted that, from the discussion in plenary, the majority of responses to document MSC 79/6/1 agreed that Tier II should include quantitative acceptance criteria. However, some members of the group were of the view that quantitative values should be in Tier III or lower, which would provide more flexible standards and would allow ship builders and owners different options for meeting Tier I and Tier II, in consideration of their needs and provided it was clearly documented and transparent. Other members of the group supported the need to include quantitative values in Tier II as it was appropriate for IMO to establish minimum acceptance criteria and not leave it to market and economic considerations. Therefore, in developing the Tier II functional requirements, the group identified where specific quantitative values could be included, however, due to the differing views in the group they were kept in square brackets. The group also concluded that, at this point in the work on the goal-based standards, it was premature to

determine what the quantitative values would be, noting that additional information would need to be collected and evaluated in order to make those determinations.

18 The group generally expressed the view that the 12 items identified as Tier II functional requirements were appropriate, however, as indicated by the square brackets around some of the text, agreement could not be reached on all working descriptions. The group decided that, based on this being the first detailed discussion on the goal based standards, it was more important to move on in order to spend time on the other items in the terms of reference, including a discussion on Tier III, than continue with the debate on the final text which needed to be considered further at the next session. The group noted that this was the first effort in what would probably be a multi-session effort and that the results of this work could be taken away and used by members to make submittals for consideration at future sessions.

19 When discussing the functional requirements "Coating life" and "Corrosion addition", a number of comments were made that these should not be two separate functional requirements and instead should be included under one requirement, generally referred to as "Corrosion control". The group noted that, irregardless of whether the two functional requirements were separate or separately included under one functional requirement, both needed to be addressed and thus agreed to leave them as separate at this time and invited submission of views on this issue for future consideration. In addition, it was noted that the DE Sub-Committee had on its agenda the development of performance standards for protective coatings and that the outcome of this work would need to be accounted for in the future work on the issue.

20 There was a proposal to include "Reserve strength" as a functional requirement and as proposed it would have meant that ships would be designed such that, when in operation, the stresses did not exceed a certain value of the allowable stress. After discussion, this concept was generally accepted to mean a safety margin and it was decided to include it within the functional requirement "Structural strength".

Status of Tier I and Tier II development

21 It is important to note the status of the Tier I goals and the Tier II functional requirements, as developed up to this point. The discussion and debate that took place in the working group exposed a wide range of divergent views held by different delegations. A number of delegations did not agree with the development up to this point. They were of the view that the group did not use the correct methodology and that the results were not adequately risk-based. In addition, a number of delegations were of the view that the Tier II functional requirements were not necessarily goal based, and instead were too prescriptive. It was also expressed by a number of delegations that, in their view, there was no universal understanding by all members of the group of what was meant by the goal based standards, including the terminology. Therefore, the group agreed that the Tier I goals and the Tier II functional requirements, as developed to this point, are to be considered preliminary, to be used as input for consideration in the future work and effort in the development of goal-based new ship construction standards.

Verification compliance criteria (Tier III)

22 The group had a brief and preliminary discussion on Tier III verification and compliance criteria, not with a view to arriving at any conclusions or agreement, but to hear the views of delegates in order to assist in the future work. It was noted that, in general, verification would consist of the following four steps:

.1 verify that prescriptive rules by classification societies are in accordance with the goal-based standards;

.2 verify that the design of individual ships meets classification societies' rules;

.3 verify that the construction of ships meets classification societies' rules; and

.4 verify that the ship throughout its life meets rules.

Of these four steps, the new item is the verification that classification societies' rules meet the goal-based standards. However, it was also pointed out that, in developing Tier III, it would be necessary to look closely at "who" would be required to show that Tiers I and II have been met. For instance, as shown in annex 2, Tier II includes functional requirements on quality of construction and transparency of design which relate to shipyards and designers; two entities that IMO has not previously included in the regulatory scheme. There were also a number of comments related to the roles of IMO and Administrations when verifying that the classification societies' rules comply with the goal-based standards, with some advocating a strong IMO role while others were commenting that was the responsibility of Administrations. There was general agreement that verification needed to be credible, transparent and auditable.

Work plan for future work on goal-based standards

23 Based on the work done to date in the development of the basic principles of the goal-based new ship construction standards and Tiers I, II and III, the group developed a work plan, as shown in annex 3, for use in the future work on the agenda item. The plan notes the need to consider the work done to date along with reflecting the differing views expressed within the group concerning the development of the goal-based new ship construction standards as noted above in paragraph 22. It acknowledges that IMO is at an early stage in this effort to develop these goal-based standards and that this will, to a certain extent, be an iterative process. The work plan also reflects the discussion held in plenary under agenda item 15 on the formal safety assessment and includes an item to explore the possibility of a linkage between formal safety assessment and goal-based standards.

Other subjects for consideration

24 The group considered the issue of the human element as submitted in document MSC 79/6/7 by Denmark and the United Kingdom and noted that the delegation of Denmark stated that, based on the work done at this session and on the fact that the focus of the goal-based standards was on ships' structure, they would reconsider this issue and make a submission to MSC 80, if necessary.

25 The group considered the environmental issues raised in plenary by the delegation of Japan. The delegation of Japan noted the progress in the work done at this session which included consideration of the environmental issue and expressed the expectation that it would be appropriately considered in the further development of the goal-based standards.

26 The group considered the submittal by Poland in document MSC 79/6/5 on a ship safety assurance system and noted that the delegation of Poland stated that, based on the work done a this session, they would reconsider whether or not to make a submission in this regard to MSC 80.

27 The group considered the proposal by India in document MSC 79/6/6 to use the goal tree-success tree methodology to develop the goal-based standards and noted the statement by the delegation of India that the goal tree-success tree methodology could be adapted for the three tiers of the goal-based standards, based on the work done to date. The group noted that a submission to MSC 80 in this regard could be helpful.

Incorporation of goal-based standards in IMO instruments

28 The group gave preliminary consideration to the issue of how the goal-based standards could be incorporated in the appropriate IMO instruments. In general, the group expressed the view that, since it was so early in the development of goal-based standards, it was difficult to give this item much consideration. There were comments that the goal-based standards could be placed in SOLAS chapter II-2 or perhaps as a separate new SOLAS chapter. Other comments noted that the goal-based standards were an umbrella for existing instruments, noting for instance that both SOLAS chapter XII and the Load Line Convention had structural standards, and therefore consideration for a more global placement was needed.

Action requested of the Committee

29 The Committee is invited to consider the report and take action as appropriate, and in particular to:

.1 note the view of the group that the basic principles of goal-based standards (annex 1) and the Tier I goals and Tier II functional requirements (annex 2), as developed to this point, are considered preliminary and should be used as input for consideration in the future work and effort in development of goal-based new ship construction standards (paragraphs 5 to 21);

.2 note the work plan for future work on goal-based standards developed by the group (paragraph 23 and annex 3); and

.3 consider this report in the further development of goal-based new ship construction standards at MSC 80.

***

ANNEX 1

BASIC PRINCIPLES OF GOAL-BASED STANDARDS

IMO goal-based standards are:

.1 broad, over-arching safety, environmental and/or security standards that ships are required to meet during their lifecycle;

.2 the required level to be achieved by the requirements applied by class societies and other recognized organizations, Administrations and IMO;

.3 clear, demonstrable, verifiable, long standing, implementable and achievable, irrespective of ship design and technology; and

.4 specific enough in order not to be open to differing interpretations.

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ANNEX 2

FRAMEWORK OF A FIVE-TIER SYSTEM FOR GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

TIER I (GOALS) AND TIER II (FUNCTIONAL REQUIREMENTS)

Goals (Tier I)

(Applicable to all ships)

Ships are to be designed and constructed for a specified design life to be safe and environmentally friendly, when properly operated and maintained under the envisaged operating and environmental conditions, in intact and foreseeable damage conditions, throughout their life.

.1 Safe and environmentally friendly means the ship will have adequate strength, integrity and stability to minimize the risk of loss of the ship or pollution to the marine environment due to structural failure, including collapse, flooding or loss of watertight integrity.

.2 Environmentally friendly also includes the ship being constructed of materials for environmentally acceptable dismantling and recycling.

.3 Safety also includes the ship's structure being arranged to provide for safe access, inspection and proper maintenance.

.4 Envisaged operating and environmental conditions are defined by the operating area for the ship throughout its life and cover the conditions, including intermediate conditions, arising from cargo operations and ship transit in all foreseeable sea-going and port conditions.

.5 Specified design life is the nominal period that the ship is assumed to be exposed to operating and/or environmental conditions and/or the corrosive environment and is used for selecting appropriate ship design parameters. However, the ship's actual service life may be longer or shorter depending on the actual operating conditions and maintenance of the ship throughout its life cycle.

Functional requirements (Tier II)

(Applicable to tankers and bulk carriers)

II.1 Design life

The ship should remain safe and environmentally friendly, if properly operated and maintained, for its expected design life, which, [unless otherwise specifically stated,] shall not be less than [*to be determined*] years.

II.2 Environmental conditions

Ships intended for unrestricted navigation should be designed in accordance with foreseeable [North Atlantic] environmental conditions and relevant long-term sea state scatter diagrams.

II.3 Fatigue life

The design fatigue life shall be [substantially longer than the ship's design life]. The actual fatigue life may be different from the design fatigue life, depending on a number of factors.

II.4 Coating life

[Coating, where required, should be selected as a function of the intended use of the compartment, materials and application of other corrosion prevention systems, e.g. cathodic protection or other alternative means. The design life of protective coating systems, applied and maintained in accordance with manufacturers' specifications concerning steel preparation, coating selection, application and maintenance, should be equal to [10 years]. The actual coating life may be longer or shorter than the design coating life, depending on the actual conditions and maintenance of the ship to be assessed at periodic surveys, and relevant damage, i.e. coating breakdowns, and repair records.]

II.5 Corrosion addition

[The corrosion addition to be added to the net scantling required by structural strength calculations should be adequate for the expected design life. The corrosion addition should be assigned in accordance with the use and exposure of each internal and external structure to corrosive agents, such as water, cargo or corrosive atmosphere, and whether the structure is protected by corrosion prevention systems, e.g. coating, cathodic protection or by alternative means. The design corrosion rates (mm/year) should be evaluated in accordance with statistical information established from service experience and/or accelerated model tests. The actual corrosion rate may be greater or smaller than the design corrosion rate, depending on the actual conditions and maintenance of the ship to be assessed at periodic surveys, and relevant thickness measurement and repair records.]

II.6 Structural strength

Ships shall be designed with a suitable safety margin to withstand, at net scantlings, construction workmanship errors, material imperfections and, in the intact condition, the environmental conditions anticipated during their design life, for the loading conditions appropriate for them. Such loading conditions shall include full homogeneous and alternate loads, partial loads, multi port and ballast and ballast management condition loads and occasional overruns/overloads during loading/unloading operations, as applicable to the class designation. Structural strength shall be assessed against excess deformation and failure modes including but not limited to buckling, yielding and fatigue. Ultimate strength calculations shall include ultimate hull girder capacity and ultimate strength of plates and stiffeners. The ship's structural members shall be of a design that is compatible with the purpose of the space and provides a degree of structural continuity. The structural members of ships shall be designed to facilitate load/discharge for all contemplated cargoes to avoid damage by loading/discharging equipment which may compromise the safety of the structure. Ships shall be of redundant construction so that failure of any one structural [stiffening] member does not create progressive damage to the ship's structure. All welds and other structural connections shall be designed for the stresses they will be required to withstand.

II.7 Residual strength

Ships shall be designed to have sufficient strength to withstand the wave and internal loads in damaged conditions [that are reasonably foreseeable for their type,] such as collision, grounding or flooding. Residual strength calculations shall take into account the ultimate reserve capacity of the hull girder, including permanent deformation and post-buckling behaviour. Actual foreseeable scenarios shall be investigated in this regard as far as is reasonably practicable.

II.8 Structural accessibility

The ship should be designed, constructed and equipped to provide adequate means of access to all internal structures to facilitate overall and close-up inspections and thickness measurements.

II.9 Construction quality procedures

Ships should be built in accordance with controlled [common] quality production standards. The ship construction quality procedures should include, but not be limited to, specifications for material manufacturing, alignment, assembling, joining and welding procedures, surface preparation and coating.

II.10 Maintenance

Ships should be designed and constructed to facilitate ease of maintenance [in particular avoiding the creation of spaces too confined to allow for adequate maintenance activities].

II.11 Design transparency

Ships should be designed under a reliable, controlled and transparent process made accessible to the extent necessary to confirm the safety of a new ship [and its robustness], with due consideration to intellectual property rights.

[II.12 Survey

A survey plan shall be developed for the lifecycle of the ship, taking into account the type, design and actual construction. The survey plan shall be kept updated throughout the life of the ship. The survey plan shall contain a set of requirements concerning inspection intervals necessary to maintain a ship within its design and construction limits, including fatigue, corrosion, structural strength and residual strength.]

***

ANNEX 3

WORK PLAN FOR THE DEVELOPMENT OF GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Further develop, taking into account the report of the working group on goal-based standards (MSC 80/6) and relevant submissions to MSC 79, the following, keeping in mind the iterative nature of the process:

.1 the basic principles of goal-based standards, including:

.1.1 methodology;

.1.2 establishment of definitions [common terminology];

.1.3 concept to extend to a holistic approach at a later stage;

.2 the exploration of the possibility of a linkage between FSA and GBS;

.3 the Tier I – Goals;

.4 the Tier II - Functional requirements;

.5 the Tier III – Verification of compliance criteria, and in particular:

.5.1 the need for the development of guidelines for verification; and

.5.2 how verification will be carried out and by whom, i.e. Administrations, IMO, any other bodies;

.6 the implementation of GBS;

.7 the incorporation of GBS into IMO instruments; and

.8 the need for a ship construction file and a ship inspection and maintenance file.

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INTERNATIONAL MARITIME ORGANIZATION

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MARITIME SAFETY COMMITTEE
80th session
Agenda item 6

MSC 80/6/1
4 February 2005
Original: ENGLISH

GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Proposal for Tier I and Tier II of the goal-based new ship construction standards

Submitted by Japan

SUMMARY

Executive summary:	This document proposes a draft Tier I and Tier II of the goal-based new ship construction standards for the consideration of the Committee.
Action to be taken:	Paragraph 14
Related documents:	MSC 79/23, MSC 80/6

Background

1 The Committee, at its seventy-ninth session, considered the goal-based new ship construction standards. The report of the working group established during that session was orally presented to the plenary. The note of the chairman of the working group was submitted to MSC 80 (MSC 80/6). At that session of the Committee, Japan expressed its fundamental opinion, as is reported in paragraph 6.20 of document MSC 79/23.

Comments to the note of the chairman of the working group established at MSC79

2 Japan is of the opinion that goal-based new ship construction standards should be applicable to all types of new ship. It should be noted that, in IMO, the term “all ships” usually means all existing and new ships. Therefore, the terms “all ships” and “all types of ship” should be carefully used and differentiated.

3 Japan supports the general agreement within the working group that Tier I should more appropriately be considered as “goals” rather than “safety objectives” (see latter part of paragraph 9 of MSC 80/6). Therefore, Japan is of the opinion that Tier I should include only clear goals. In this connection, the first draft of the standards contained in annex 2 of document MSC 80/6 shall be further considered as a whole.

4 Japan also supports the general agreement of the working group that Tier II should apply to all types of new ships (see the first sentence of paragraph 15 of document MSC 80/6). Tier II of the standards shall be developed based on this agreement and shall not be for any particular type of ship.

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Proposal for the standards

5 Japan believes that Tier I of the standards should contain the goals of construction of new ships and goals of safety and marine environmental protection in regard to the new ship construction, and that the goals may contain conditions.

6 Japan also believes that Tier II should contain explanations and specifications of the conditions which lie in Tier I and fundamental requirements of new ship construction strength to achieve the goals specified in Tier I.

7 The conditions which should be specified in Tier II are:

- Design life;
- Environmental conditions;
- Structural accessibility;
- Maintenance;
- Operating conditions;
- Construction; and
- Design transparency.

8 The fundamental requirements for strength of ships are:

- Fundamental principle;
- Fatigue strength;
- Residual strength; and
- Ultimate strength.

9 Japan proposes drafts for Tier I and Tier II of the standards as set out in the annex to this document. These drafts have been developed based on the opinion expressed in paragraphs 3 to 8 above, taking into account the draft provided in document MSC 80/6.

Fatigue strength

10 Japan is of the opinion that special consideration should be given to fatigue strength. The fatigue strength is dominated by the long-term accumulation of working loads throughout the ship's service period. Being quite different from ultimate strength, a small number of extreme loads do not connect with fatigue strength directly. This means that the fatigue strength is different from yield strength, buckling strength or ultimate strength.

11 It is, therefore, appropriate that a ship's fatigue strength should be designed in accordance with "suitable safety margin" and "individual environmental condition", which, unless otherwise specifically stated, shall be based on the statistics of actual operating patterns of the ships of same type and size, i.e., so-called "worldwide" operating pattern in principle. It should be noted that any ship satisfying worldwide fatigue design condition has been guaranteed to enter into the severest sea area, e.g., North Atlantic, when the design condition to the ship covers one of the subjected worldwide operating patterns, within a reasonable period for ship's life.

12 According to rough estimates for a crude oil tanker with a designed fatigue life of 25 years in the North Atlantic, the equivalent fatigue life of the subject tanker is 50 years and 75 years in the real worldwide and Persian Gulf-Far East operating patterns, respectively. The actual fatigue life could be longer than these expectations as a result of adequate maintenance.

As pointed out, the fatigue life is so sensitive to environmental conditions that unreasonably fixed environmental conditions can result in excessive margin or even unbreakable design deadlock, depending on the ship types and sizes. The impractical requirements do bring the shipping industry into significant inflexibility. The structural safety of every ship can rationally be ensured without unified and/or unrealistic design environmental conditions.

13 Japan also supports the idea presented in paragraph 19 of document MSC 80/6 that "corrosion addition" and "coating life" should not be two separate functional requirements and instead should be included in one requirement referred to as "corrosion control". Japan is of the opinion that "corrosion control" is an important measure for safety, which should include selection of materials, corrosion addition, coating requirements with coating life and coating maintenance. In other words, the requirement for corrosion control should be fulfilled by any combination of such sub-requirements.

Action requested of the Committee

14 The Committee is invited to consider the proposed draft Tier I and Tier II of the goal-based new ship construction standards, as set out in the annex to this document, and take action as appropriate.

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ANNEX

DRAFT TIER I AND TIER II OF GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Goals (Tier I)

Ships shall be designed and constructed for a specified design life to be safe and environmentally friendly, when properly operated and maintained under the envisaged operating and environmental conditions, intact and foreseeable damage conditions throughout their life.

- Safe and environmentally friendly means that the ship shall have adequate strength, integrity and stability to minimize the risk of loss of life or the ship, or pollution to the marine environment due to structural failure including collapse, flooding or loss of watertight integrity.

- Environmentally friendly also includes the ship being constructed of materials environmentally acceptable at the stage of construction, operation, maintenance, repairing, dismantling and recycling.

- Safety also includes the ship's structure being arranged to provide for safe access, inspection and proper maintenance.

Functional Requirements (Tier II)

In order to achieve the goals specified in Tier I, the following key requirements shall be satisfied.

1 Design life

Design life shall be specified for each ship in order to develop appropriate design. Design life is the nominal period that the ship is assumed to be exposed to operating and environmental conditions. However, the ship's actual life may be longer or shorter than the design life depending on the actual conditions of the structure of the ships under the actual operating and environmental conditions. Unless specifically stated otherwise, the design life shall be 25 years. A document showing the design life shall be kept on board throughout the life of the ship.

2 Environmental conditions

Design environmental conditions shall be specified for each ship in order to develop an appropriate design for the ship. The environmental condition shall be determined taking into account the foreseeable voyage routes and operating conditions of the ship. The document showing the design environmental condition shall be kept on board throughout the life of the ship. For ships intended for operation in unspecified sea area(s), foreseeable North Atlantic environmental conditions and its long-term sea state scatter diagram shall be used for yielding, buckling and ultimate strength assessments, and world-wide environmental conditions and its long-term sea state scatter diagram shall be used for fatigue strength assessment. For ships intended for operation in specified sea area(s), the foreseeable environmental conditions and long-term sea state scatter diagram of the sea area(s) shall be used for all strength assessments of the ship.

3 Structural integrity

3.1 Fundamental principle

Ships shall be designed with sufficient safety margins at net scantlings to withstand foreseeable environmental and operating conditions throughout their design life. Ships shall be inspected, surveyed, maintained and repaired to keep net scantlings throughout their actual life. Structural strength shall be assessed against excess deformation and all failure modes. Sufficient wastage margins shall be determined, taking into account the design life, usage of the space, the environmental conditions, coating, operation and maintenance, and added to net scantlings.

Net scantlings and wastage margins of the main structural members shall be recorded and kept onboard throughout the life of the ship. In addition, actual thickness of main structural members obtained from periodical surveys and actual structural condition assessed from results of such surveys shall be recorded and kept onboard throughout the life of ship.

3.2 Fatigue strength

Ships shall be designed against fatigue, taking into account the mean static stress and cyclic stress to prevent fatigue cracks which cause a loss of the function of the structural members.

3.3 Residual strength

Ships shall be designed not to create immediate progressive damage to the ship's structure under accidental conditions, including flooding, collision and grounding, that are reasonably foreseeable for their type.

3.4 Ultimate strength

Ships shall be designed to prevent the total collapse of the structure against foreseeable maximum extreme loads throughout their design life under the design environmental conditions. Ultimate strength calculations shall include ultimate hull girder capacity.

4 Structural accessibility

Ships shall be designed, constructed and equipped to provide adequate means of access to all internal structures to facilitate overall and close-up inspections, thickness measurements and maintenance.

5 Maintenance

Ships shall be designed presuming the proper maintenance for keeping the structural integrity against corrosion, wear down and fatigue. Such maintenance shall be prescribed at the design stage. Procedures for agreed maintenance* shall be documented and kept on board of the ship throughout its life. Ships shall be designed and constructed to facilitate the maintenance.

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* Standards for maintenance procedures to be developed by the Organization.

6 Operating conditions

Ships shall be designed taking into account the operating conditions including safety navigation and loading, unloading, and ballasting. Such conditions* shall be documented and kept on board of the ship throughout its life.

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* Standards for operation conditions to be developed by the Organization.

7 Construction

Ships shall be built in accordance with controlled quality production standards.* The ship construction quality procedures shall include, but not be limited to, specifications for material manufacturing, alignment, assembling, jointing and welding procedures, surface preparation and coating.

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* Guidelines for the standards for quality production standards to be developed by the Organization.

8 Design transparency

Ships shall be designed under a reliable, controlled and transparent process, made accessible to the extent necessary to confirm the safety of the ship, with due consideration to intellectual property rights.

9 Survey

A survey plan* shall be developed for the life the ship, taking into account the type, design and actual construction. The survey plan shall be kept up-dated and kept on board throughout the life of the ship. The survey plan shall contain a set of requirements concerning inspection intervals necessary to maintain a ship within its design and construction limits, including fatigue, corrosion, structural strength and residual strength.

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* Standards for survey plan to be developed by the Organization.

10 Information keeping

Documented information on design life, operational and environmental conditions, structural strength including net scantlings, wastage margins, actual thickness and conditions of main structural members, maintenance procedures and survey plans shall be kept onboard and well known by the seafearers, the operator, the company and the owner, and this shall be available for surveyors when they survey the ship.

INTERNATIONAL MARITIME ORGANIZATION

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MARITIME SAFETY COMMITTEE
80th session
Agenda item 6

MSC 80/WP.8
18 May 2005
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GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Report of the Working Group

Introduction

1 The Working Group on goal-based new ship construction standards (GBS) met from 12 to 18 May 2005 under the chairmanship of Mr. J. Lantz (United States) and was attended by representatives from the following Member Governments:

AUSTRALIA
BAHAMAS
BRAZIL
CANADA
CHINA
CYPRUS
DENMARK
EGYPT
FINLAND
FRANCE
GERMANY
GREECE
INDIA
IRAN (ISLAMIC REPUBLIC OF)
IRELAND
ITALY
JAPAN
LIBERIA
LITHUANIA
MARSHALL ISLANDS
NETHERLANDS
NIGERIA
NORWAY
PANAMA
POLAND
REPUBLIC OF KOREA
ROMANIA
RUSSIAN FEDERATION
SINGAPORE
SPAIN
SWEDEN
TURKEY
UKRAINE
UNITED KINGDOM
UNITED REPUBLIC OF TANZANIA
UNITED STATES
VENEZUELA

the following Associate Member of IMO:

HONG KONG, CHINA

observers from the following intergovernmental organization:

EUROPEAN COMMISSION (EC)

and observers from the following non-governmental organizations:

INTERNATIONAL CHAMBER OF SHIPPING (ICS)

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INTERNATIONAL CONFEDERATION OF FREE TRADE UNIONS (ICFTU)
BIMCO
INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)
OIL COMPANIES INTERNATIONAL MARINE FORUM (OCIMF)
INTERNATIONAL MARITIME PILOTS' ASSOCIATION (IMPA)
COMMUNITY OF EUROPEAN SHIPYARDS' ASSOCIATIONS (CESA)
INTERNATIONAL ASSOCIATION OF INDEPENDENT TANKER OWNERS (INTERTANKO)
INTERNATIONAL ASSOCIATION OF DRY CARGO SHIPOWNERS (INTERCARGO)
THE INSTITUTE OF MARINE ENGINEERING, SCIENCE AND TECHNOLOGY (IMarEST)
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS (RINA)
INTERNATIONAL MARINE TRANSIT ASSOCIATION/INTERFERRY (IMTA)

Terms of reference

2 The working group was instructed to consider the documents submitted to this session, taking into account decisions and comments and proposal made in plenary, and in particular to:

.1 finalize the basic principles of goal-based standards, for approval by the Committee, including consideration of how the risk-based approach could be considered in the framework of goal-based standards;

.2 finalize Tier I – Goals, for approval by the Committee;

.3 further develop Tier II - Functional requirements, including a working description of each requirement, for approval by the Committee;

and, as time permits, to:

.4 develop draft Tier III criteria for the verification of compliance with the functional requirements in Tier II, including a proper title for the tier, for the consideration of the Committee;

.5 consider how the provisions of the goal-based new ship construction standards could be incorporated in the IMO framework;

.6 review the work plan for the development of GBS, as contained in annex 3 of document MSC 80/6, for approval by the Committee;

.7 consider the establishment of a correspondence group to progress work intersessionally and draft terms of reference for the group, as appropriate, and advise the Committee accordingly; and

.8 submit a written report to plenary on Thursday, 19 May 2005.

Methodology

3 The group noted documents MSC 80/6/4 (Germany) and MSC 80/6/6 and MSC 80/6/7 (Denmark and Norway) which proposed the use of a risk-based approach instead of the deterministic methodology used at MSC 79. The group also considered those portions of

documents MSC 80/6/5 (Greece) and MSC 80/6/12 (United States) which in principle supported the risk-based approach but recommended that for pragmatic reasons the group should proceed on the basis of the methodology used at MSC 79.

4 The group had an extensive and wide ranging discussion on this issue with active participation by many different Administrations. During the discussion, support for both methodologies was expressed.

5 The Chairman summed up the discussion, noting that the current task was the development of goal-based standards for new ship construction. At this time, this did not include maintenance and surveys. He noted from the discussions in plenary that, while there was support for the risk-based approach, there also was wide support to continue using the same methodology as applied at MSC 79. He also noted that the GBS for new ship construction were not to be limited to bulk carriers and tankers, but were meant to address all ship types and that in the future, as part of completing this task, the results to date would have to be expanded in order to make them applicable to all ship types. He also noted from the terms of reference, that the group was instructed to consider the risk-based methodology and, as stated by the MSC Chairman, also to consider how the issue could be addressed at MSC 81. Based on this, the Chairman proposed that further development of the GBS for new ship construction using the risk-based methodology be postponed to the next session. However, for this to continue on a parallel track, it would be advantageous for countries supporting this methodology to take the opportunity and make submittals to MSC 81 that would more clearly demonstrate the elements of the different tiers. The Chairman also noted that, looking forward, the risk-based approach may be needed in order to expand the current effort to include all ship types. He also noted that in the future, if it was decided to adopt the risk-based approach, this would require a revisit of the goal-based standards developed under the deterministic methodology to verify consistency and make changes where necessary. There was majority agreement within the group with the Chairman's summing-up.

6 The delegation of Germany reserved its position with regard to the inclusion of the risk-based approach in the work of the working group. They stated that even though reiterated at various occasions in plenary and subsequently in the working group, the group did not give any consideration to the possible inclusion of the risk-based approach in the framework of the draft goal-based standards. The delegation of Germany wished to reiterate the need for a parallel approach, i.e. to provide a set of functional requirements for tankers and bulk carriers to be built in the short-term but, at the same time, to develop risk-based considerations, with a possible starting point being the establishment of the current safety levels. The delegations of Denmark, the Netherlands, Norway and Sweden associated themselves with this statement.

Basic principles of goal-based standards

7 The group considered document MSC 80/6/3 (Bahamas), which proposed that the basic principles as developed by the working group at MSC 79 and shown in document MSC 80/6 were adequate with no further change needed. The group also considered document MSC 80/6/11 (Republic of Korea), which recommended some changes, including the need to include "construction" which was in line with the title of the agenda item. The group did not accept this change, noting that the concept of the ship's lifecycle, which is currently included in the basic principles, also encompassed the design and construction of the ship. The other changes proposed by the Republic of Korea were also discussed, along with additional recommended changes proposed by others during the discussion. In conclusion, the group decided that the original wording as contained in document MSC 80/6 was adequate and did not need to be changed. The basic principles of goal-based standards as agreed by the group are set out in annex 1.

Goals (Tier I)

8 As instructed, the group further considered the Tier I goals on the basis of annex 2 of the report of the working group at MSC 79 (MSC 80/6) and in consideration of the submissions by Japan (MSC 80/6/1) and Bahamas (MSC 80/6/3) which contained specific proposed changes to Tier I. The final version agreed by the group after extensive debate, which except for relatively few changes is the same as agreed to at the last session, is set out in annex 2. Major points brought out in the discussion are described in the following paragraphs.

9 In beginning the discussion, the Chairman raised the issue of applicability, noting that it was addressed in a number of the papers submitted to this session, and that it was important to make sure it was clearly understood. The goal-based standards for new ship construction are being developed for all types of new ships. This means they would apply to all types of ships that would be considered new, as based on an entry into force date, to be decided when the standards become mandatory. They are not being developed to apply retroactively.

10 The general format, which consists of a chapeau and five bullet points, was discussed in conjunction with the proposal by Japan that Tier I should consist of specific statements of goals. The group agreed that, as written, the five bullet points, although written as definitions rather than as goals, were needed to complete and clarify the chapeau which is the overarching statement of the goals and that without them, they would be open to different interpretations, which would not be in line with the guiding principles.

11 In considering the chapeau, it was proposed that "specified design life" was not needed, but others noted that an element of time needed to be included or it would need to be replaced with the concept of maintaining a level of safety, which was more in line with proposals for a risk-based option. In line with the agreement to not consider the risk-based option at this session, the group agreed to retain the wording, including the term "specified design life".

12 The group also considered concepts contained in "envisaged operating and environmental conditions" and "foreseeable damage conditions" and whether or not they were too open-ended and thus subject to differing interpretations. It was pointed out that in writing the goals, IMO needed to specify the limits, and, taking damage conditions as an example, it would be unreasonable to expect ships to be designed to withstand damages beyond those specified in SOLAS chapter II-1. Therefore, the group agreed that both "envisaged" and "foreseeable" needed to be replaced with "specified".

13 The group considered a proposal by Japan to include in bullet point 2 the words "construction, maintenance and repair" in addition to dismantling and recycling. In discussing this proposal, the group did not agree with it and concluded it was not needed as these phrases were included within the chapeau and bullet point 1. The group noted that this bullet point was added because dismantling and recycling is considered to be beyond the life of the ship.

14 In bullet point 3, the group agreed to add "escape", noting that there is a need to consider more than just access to conduct inspection and maintenance, especially in the event of an emergency. The consideration of this concept was also very important for another reason. It resulted in the group discussing and reconfirming the scope of the current effort. In the discussion, the question was raised if the ship's structure included superstructure and accommodations, which was agreed it did. As such, it would then follow that "escape" would include the need to consider such issues as crew and passenger egress and evacuation along with the human element factors associated with these issues. Noting that this had not been done to

this point, the group felt that this would mean a considerable expansion. It was also noted that the original purpose of this work programme item of the Committee was to rectify the absence of IMO standards and/or regulations pertaining to ships' hull structure. This is not the case for egress and evacuation, where considerable regulations currently exist and therefore these should not be considered as part of this effort. It was also noted that the human factors were currently being addressed by a joint MSC/MEPC working group, which will be meeting at the upcoming MEPC session. The group agreed and reconfirmed that the scope of this effort is the ship's hull structure as opposed to the entire ship's structure.

15 With regard to bullet point 5, the group discussed design life and service life, noting the need to ensure these terms were understood, especially in light of the comment made by the MSC Chairman concerning the number of different terms used to describe ship's life and in consideration of the submittal by IACS (MSC 80/6/8). The group noted the purpose of the design life in relation to selecting design parameters whereas service life, while dependent on the original design, is also dependent on many factors, including operation and maintenance, and that therefore the two can be quite different.

16 In response to the proposal by Bahamas (MSC 80/6/3) to include an additional bullet item noting the need for transparency, the group agreed that the need for transparency was very important, but did not agree a specific bullet item was needed in Tier I. The group noted there was a specific Tier II functional requirement addressing transparency (II.11 in annex 2 of document MSC 80/6).

Functional requirements (Tier II)

17 As instructed, the group further considered the Tier II functional requirements on the basis of annex 2 of the report of the working group at MSC 79 (MSC 80/6) together with the submissions to this session and the comments in plenary. The final version agreed by the group after extensive debate is set out in annex 3. Among the points brought out in the discussion were the following.

Applicability

18 The group confirmed agreement that Tier II, when completed, will apply to all types of new ships but also agreed that, for the time being, it would continue, as begun at the last session, to consider bulk carriers and tankers as a means of focussing the discussion. The issue was raised if this meant all tankers, including chemical tankers. While some delegations did not think the impact of also considering chemical tankers was that significant, the group agreed that it would consider oil tankers and not pure chemical tankers.

Design life

19 Much of the discussion on this functional requirement was devoted to whether or not it was appropriate to include a specific quantitative value. The group agreed it was appropriate to include a specific value for oil tankers and bulk carriers engaged in unrestricted navigation, but that for others, i.e. those not in unrestricted navigation, it was not appropriate. The difficulties as well as variations of text to accommodate both those with unrestricted navigation and others were discussed. It was also noted that the same difficulties would exist when developing the other Tier II functional requirements. It was also brought out that the ships' hull structural issues are primarily related to ships engaged in unrestricted navigation. It was therefore agreed that Tier II, at this time, should only be applied to oil tankers and bulk carriers engaged in unrestricted navigation.

20 The group agreed on 25 years as the appropriate design life for oil tankers and bulk carriers engaged in unrestricted navigation. The group also noted the service life data pertaining to tankers and bulk carriers as provided by the Japanese delegation in presenting their paper (MSC 80/6/1).

Environmental conditions

21 The discussion focused on whether or not it was appropriate to specify environmental conditions and if so, should it be North Atlantic conditions since, in general, ships do not exclusively trade in the North Atlantic environment for their service life. The group agreed that, based on the Tier II functional requirements being applicable only to bulk carriers and oil tankers in unrestricted navigation at this time, the North Atlantic was the appropriate environmental condition.

Fatigue life

22 The issue at the centre of discussion was whether or not the fatigue life should be longer than the design life. The argument was presented by some delegations that due to the uncertainties in calculating fatigue life, it needed to be longer than the design life in order to account for the uncertainties, while at the same time providing an appropriate safety margin. Other delegations noted that using the North Atlantic as the environment provided a suitable safety margin since, in general, ships do not trade exclusively in the North Atlantic. It was also noted that the issue of safety margin was addressed under the functional requirement on structural strength, and therefore it would be redundant to also include it here. The majority of the group agreed that the fatigue life need not be longer than the specified design life.

Structural strength

23 The group agreed to two changes to this functional requirement. First, it was decided that the issue of structural redundancy needed to be a separate functional requirement and agreement was reached on the appropriate text for this new functional requirement. In addition, the group agreed that additional text to properly address safety margins needed to be included. In the course of the discussions on safety margins, some delegations supported the need to specify a value for the safety margin for different failure modes, whereas other delegations expressed the view that this was too specific and not suitable for Tier II. The views expressed on this issue were relatively evenly split and lacking a clear majority, the Chairman proposed to leave the text as it existed which contained not specific values and this was accepted by the group.

Residual strength

24 The group agreed that the purpose of this functional requirement is for the ship's hull to have sufficient residual strength to withstand certain damage conditions. However, the group agreed that including "foreseeable" damage conditions was too open-ended and subject to differing interpretations and therefore agreed it should be "specified" damage conditions which means those damage conditions specified by IMO in SOLAS chapter II-1. It was also noted that this would be consistent with the Tier I goals. The text was adjusted accordingly.

Construction quality procedures

25 In agreeing upon the text for this functional requirement, the group considered the proposal by Japan (MSC 80/6/1) to include a footnote stating that the Organization would

develop guidelines for the standards for quality construction standards and agreed that this would not be appropriate.

Maintenance

26 The group considered a proposal by Japan (MSC 80/6/1) proposing revised text for this functional requirement along with the proposal that IMO develop standards for maintenance procedures. The group did not agree with Japan.

Design transparency

27 The group agreed that the purpose of this functional requirement is to make design information necessary to verify the as-built new ship complies with safety standards, which includes the goal-based parameters as well as other relevant design parameters that may limit the operation of the ship. The group also recognized that intellectual property rights needed to be considered when making this information available.

28 There was considerable discussion on how this information should be made available. Some delegations expressed the view that it should be included in a Ship Construction File and this needed to be included as an element of this functional requirement. The Bahamas, along with their proposal (MSC 80/6/3), expressed the view that a Ship Construction File could be a large collection of documents and therefore, it would also be appropriate to have a shorter and concise document that provides the important design parameters. The majority of delegations expressing a view on this issue generally agreed that there may be a need for a Ship Construction File as well as the document proposed by Bahamas, but however that this was too specific and thus not appropriate for inclusion at the Tier II level, but was more appropriate at a lower tier. The group was in wide agreement that the issue of how this information is documented is very important and will need further consideration at a later time.

Survey

29 In discussing this functional requirement the group recalled that time spent discussing this item at the last session was somewhat limited, as indicated by the entire text being in square brackets. The group agreed that it was appropriate to have a functional requirement addressing ship survey and that it needed to focus on those issues of survey related to ship construction, and not issues related to surveying the ship during its operating life. The group also agreed that during the design and construction areas that needed special attention during in-service surveys may be identified, which needed to be documented for future use during in-service surveys.

Protection against corrosion

30 The group had an extensive discussion on this item, primarily on two separate but related issues. A number of delegations strongly expressed the view that this needs to be addressed with two separate functional requirements: "corrosion addition" and "coating life", as shown in the outcome of the discussions at the last session (MSC 80/6). In expressing this view, they maintained that the corrosion addition is needed in addition to other corrosion protection measures, such as coating, cathodic protection, etc. as the corrosion addition, besides being provided to counteract the effects of corrosion is also included as an integral component of the scantlings in determining compliance with strength requirements. They concluded that since the inclusion of a corrosion addition, in addition to other corrosion protection measures, would not necessarily be required in the future, this could lead to unsafe ships.

31 However, the majority of the group did not agree with this position. In their view it was appropriate that the issue of protection against corrosion should be addressed by one functional requirement, with separate sub-items for both corrosion addition and coating life. They also did not agree that it was appropriate at this level (Tier II) to have the specific requirement that a corrosion addition always be included. They noted that in reality, there will always need to be a corrosion addition because to date it is highly unlikely that any corrosion protection measure (coating, cathodic protection, impressed current, etc.) will be able to provide complete protection against corrosion for the specified design life. They also noted that the functional requirement "structural strength" adequately addressed required net scantling.

Watertight and weathertight integrity

32 The group considered a proposal for a new functional requirement on "watertight and weathertight integrity" (MSC 80/6/11 by the Republic of Korea) and agreed on its inclusion in Tier II. The final agreed text of the requirement is set out in annex 3.

Definitions

33 The group agreed to establish a list of definitions and included it as an appendix to Tier II.

Organization of functional requirements

34 The group agreed that it would be useful to organize the functional requirements in a more logical manner and, following a proposal by the delegation of Liberia, agreed to re-order and group them as shown in annex 3 under the headings "Design", "Construction" and "In-service considerations".

"Should" and "shall"

35 The group agreed that, at this point, it was premature to reach a decision on whether to use "should" or "shall" to denote either recommendatory or mandatory requirements and that this issue will need further consideration once the final version of the goal-based standards for new ship construction has been decided. The group also agreed to use "should" at this point only as a means of maintaining consistency.

Work plan for future work on goal-based standards

36 The group discussed the work plan for future work on the GBS, taking into account the progress made at this session. The revised work plan is set out in annex 4.

Establishment of a correspondence group

37 The group agreed that, in order to progress work on the goal-based standards for new ship construction intersessionally, it would be advantageous to establish a correspondence group and consequently agreed to recommend to the Committee to establish such a group. The delegation of the United States* offered to co-ordinate the work.

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38 The group agreed that the correspondence group should focus on developing Tier III, criteria for the verification and compliance, and agreed on the following terms of reference:

.1 develop draft Tier III criteria for the verification of compliance for the consideration of the Committee;

.2 submit a report to MSC 81.

Terms of reference not completed

39 Due to lack of time the group was not able to do any work on items 4 (Criteria for the verification of compliance) and 5 (incorporation of GBS in the IMO framework) of its terms of reference.

Action requested of the Committee

40 The Committee is invited to approve the report in general and take action as appropriate, in particular to:

.1 note the discussion of the group with regard to the methodology (paragraphs 3 to 6);

.2 note completion, at this time, and agree in principle with the basic principles of goal-based standards as set out in annex 1 (paragraph 7);

.3 note completion, at this time, and agree in principle with the Tier I goals as set out in annex 2 (paragraphs 8 to 16);

.4 note the progress made on the Tier II functional requirements as set out in annex 3 (paragraphs 17 to 35);

.5 approve the work plan for future work on GBS as set out in annex 4 (paragraph 36);

.6 agree with the recommendation of the group to establish a correspondence group in order to progress the work intersessionally and approve the terms of reference proposed by the group for the above correspondence group (paragraphs 37 and 38); and

.7 note that due to lack of time the group had not been able to consider Tier III verification of compliance criteria and the incorporation of goal-based new ship construction standards in the IMO framework (paragraph 39).

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ANNEX 1

BASIC PRINCIPLES OF GOAL-BASED STANDARDS

IMO goal-based standards are:

.1 broad, over-arching safety, environmental and/or security standards that ships are required to meet during their lifecycle;

.2 the required level to be achieved by the requirements applied by class societies and other recognized organizations, Administrations and IMO;

.3 clear, demonstrable, verifiable, long standing, implementable and achievable, irrespective of ship design and technology; and

.4 specific enough in order not to be open to differing interpretations.

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ANNEX 2

TIER I (GOALS)

(Applicable to all types of new ships)

Ships are to be designed and constructed for a specified design life to be safe and environmentally friendly, when properly operated and maintained under the specified operating and environmental conditions, in intact and specified damage conditions, throughout their life.

.1 Safe and environmentally friendly means the ship shall have adequate strength, integrity and stability to minimize the risk of loss of the ship or pollution to the marine environment due to structural failure, including collapse, resulting in flooding or loss of watertight integrity.

.2 Environmentally friendly also includes the ship being constructed of materials for environmentally acceptable dismantling and recycling.

.3 Safety also includes the ship's structure being arranged to provide for safe access, escape, inspection and proper maintenance.

.4 Specified operating and environmental conditions are defined by the operating area for the ship throughout its life and cover the conditions, including intermediate conditions, arising from cargo and ballast operations in port, waterways and at sea.

.5 Specified design life is the nominal period that the ship is assumed to be exposed to operating and/or environmental conditions and/or the corrosive environment and is used for selecting appropriate ship design parameters. However, the ship's actual service life may be longer or shorter depending on the actual operating conditions and maintenance of the ship throughout its life cycle.

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ANNEX 3

TIER II (FUNCTIONAL REQUIREMENTS)

(Applicable to new oil tankers and bulk carriers in unrestricted navigation*)

DESIGN

II.1 Design life

The specified design life is not to be less than 25 years.

II.2 Environmental conditions

Ships should be designed in accordance with North Atlantic environmental conditions and relevant long-term sea state scatter diagrams.

II.3 Structural strength

Ships should be designed with suitable safety margins:

.1 to withstand, at net scantlings**, in the intact condition, the environmental conditions anticipated for the ship's design life and the loading conditions appropriate for them, which should include full homogeneous and alternate loads, partial loads, multi-port and ballast voyage, and ballast management condition loads and occasional overruns/overloads during loading/unloading operations, as applicable to the class designation; and

.2 appropriate for all design parameters whose calculation involves a degree of uncertainty, including loads, structural modelling, fatigue, corrosion, material imperfections, construction workmanship errors, buckling and residual strength.

The structural strength should be assessed against excess deformation and failure modes, including but not limited to buckling, yielding and fatigue. Ultimate strength calculations should include ultimate hull girder capacity and ultimate strength of plates and stiffeners. The ship's structural members should be of a design that is compatible with the purpose of the space and ensures a degree of structural continuity. The structural members of ships should be designed to facilitate load/discharge for all contemplated cargoes to avoid damage by loading/discharging equipment which may compromise the safety of the structure.

II.4 Fatigue life

The design fatigue life should not be less than the ship's design life and should be based on the environmental conditions in II.2.

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* See definition for "unrestricted navigation" in the appendix.
** See definition for "net scantling" in the appendix.

II.5 Residual strength

Ships should be designed to have sufficient strength to withstand the wave and internal loads in specified damaged conditions such as collision, grounding or flooding. Residual strength calculations should take into account the ultimate reserve capacity of the hull girder, including permanent deformation and post-buckling behaviour. Actual foreseeable scenarios should be investigated in this regard as far as is reasonably practicable.

II.6 Protection against corrosion

Measures to protect against corrosion are to be applied to ensure that net scantlings required to meet structural strength provisions are maintained throughout the specified design life. Additional measures include, but are not limited to, coatings, cathodic protection, impressed current systems, etc.

II.6.1 Coating life

Coatings should be applied and maintained in accordance with manufacturers' specifications concerning surface preparation, coating selection, application and maintenance. Where coating is required to be applied, the design coating life is to be specified. The actual coating life may be longer or shorter than the design coating life, depending on the actual conditions and maintenance of the ship. Coatings should be selected as a function of the intended use of the compartment, materials and application of other corrosion prevention systems, e.g. cathodic protection or other alternatives.

II.6.2 Corrosion addition

The corrosion addition should be added to the net scantling and should be adequate for the specified design life. The corrosion addition should be determined on the basis of exposure to corrosive agents such as water, cargo or corrosive atmosphere, and whether the structure is protected by corrosion prevention systems, e.g. coating, cathodic protection or by alternative means. The design corrosion rates (mm/year) should be evaluated in accordance with statistical information established from service experience and/or accelerated model tests. The actual corrosion rate may be greater or smaller than the design corrosion rate, depending on the actual conditions and maintenance of the ship.

II.7 Structural redundancy

Ships should be of redundant design and construction so that localized damage of any one structural member will not lead to immediate consequential failure of other structural elements leading to loss of structural and watertight integrity of the ship.

II.8 Watertight and weathertight integrity

Ships should be designed to have adequate watertight and weathertight integrity for the intended service of the ship and adequate strength and redundancy of the associated securing devices of hull openings.

II.9 Design transparency

Ships should be designed under a reliable, controlled and transparent process made accessible to the extent necessary to confirm the safety of the new as-built ship, with due consideration to intellectual property rights. Readily available documentation should include the main goal-based parameters and all relevant design parameters that may limit the operation of the ship.

CONSTRUCTION

II.10 Construction quality procedures

Ships should be built in accordance with controlled and transparent quality production standards with due regard to intellectual property rights. The ship construction quality procedures should include, but not be limited to, specifications for material, manufacturing, alignment, assembling, joining and welding procedures, surface preparation and coating.

II.11 Survey

A survey plan should be developed for the construction phase of the ship, taking into account the type and design. The survey plan should contain a set of requirements to ensure compliance of construction with classification rules and goal-based standards. The survey plan should also identify areas that need special attention during surveys throughout the ship's life.

IN-SERVICE CONSIDERATIONS

II.12 Maintenance

Ships should be designed and constructed to facilitate ease of maintenance, in particular avoiding the creation of spaces too confined to allow for adequate maintenance activities.

II.13 Structural accessibility

The ship should be designed, constructed and equipped to provide adequate means of access to all internal structures to facilitate overall and close-up inspections and thickness measurements.

APPENDIX

DEFINITIONS

1 Unrestricted navigation

Unrestricted navigation means that the ship is not subject to any geographical restrictions (i.e. any oceans, any seasons) except as limited by the ship's capability for operation in ice.

2 Net scantlings

The net scantlings should provide the structural strength required to sustain the design loads, assuming the structure in intact condition and excluding any addition for corrosion.

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ANNEX 4

WORK PLAN FOR THE DEVELOPMENT OF GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

1 Consideration of the probabilistic risk-based methodology in the framework of GBS.

2 Completion of Tier II - Functional requirements, in particular the need to:

.1 expand to include all types of new ships; and

.2 expand to include ships engaged in restricted navigation.

3 Development of Tier III – Verification of compliance criteria, including consideration of:

.1 the need for the development of guidelines for verification; and

.2 how verification will be carried out and by whom, i.e. Administrations, IMO, any other bodies.

4 Implementation of GBS.

5 Incorporation of GBS into IMO instruments.

6 Development of a ship construction file and consideration of the need for the development of a ship inspection and maintenance file.

7 Consideration of the need to review consistency and adequacy of scope across the tiers.

INTERNATIONAL MARITIME ORGANIZATION

IMO

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MARITIME SAFETY COMMITTEE
81st session
Agenda item 6

MSC 81/6/1
3 February 2006
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GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Report of the Correspondence Group

Submitted by the United States

SUMMARY	
Executive summary:	This document reports the outcome of the Correspondence Group on goal-based new ship construction standards.
Action to be taken:	Paragraph 33
Related documents:	MSC 80/WP.8, MSC 80/24 and MSC 81/6

Introduction

1 The Committee, at its eightieth session, established a Correspondence Group, under the co-ordination of the United States, to progress work intersessionally on agenda item 6 regarding goal-based standards for new ship construction and agreed to the following terms of reference (MSC 80/24, paragraph 6.58):

.1 develop draft Tier III criteria for the verification of compliance, for consideration of the Committee; and

.2 submit a report to MSC 81.

2 The following Member States participated in the work of the group:

BAHAMAS
BRAZIL
CANADA
CHINA
CYPRUS
DENMARK
FINLAND
GERMANY
GREECE
INDIA
IRAN (ISLAMIC REPUBLIC OF)
IRELAND
ITALY
JAPAN
MARSHALL ISLANDS
NETHERLANDS
NORWAY
PANAMA
POLAND
REPUBLIC OF KOREA
ROMANIA
SINGAPORE
SPAIN
SWEDEN
UNITED KINGDOM
UNITED STATES

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the following Associate Member of IMO:

HONG KONG, CHINA

observers from the following intergovernmental organization:

EUROPEAN COMMISSION (EC)

and observers from the following non-governmental organizations:

BIMCO
INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)
INTERNATIONAL ASSOCIATION OF DRY CARGO SHIPOWNERS (INTERCARGO)
INTERNATIONAL ASSOCIATION OF INDEPENDENT TANKER OWNERS (INTERTANKO)
INTERNATIONAL CHAMBER OF SHIPPING (ICS)
THE INSTITUTE OF MARINE ENGINEERING, SCIENCE AND TECHNOLOGY (IMarEST)
OIL COMPANIES INTERNATIONAL MARINE FORUM (OCIMF)
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS (RINA)

Basic tenets of Tier III

3 In beginning their task, the group discussed certain basic tenets for Tier III as shown in annex 1 as a means to constructively focus the discussion in order to make progress. The elements shown in annex 1 were not new to the members; in general they were all discussed at some point either in the working group or in plenary at MSC 79 and MSC 80. A number of members noted that the basic tenets shown in annex 1 needed to be revisited and updated to reflect the outcome of the discussions of the group, however, the group did not do this.

4 The group was unable to complete a draft Tier III, however, progress was made in the following areas:

.1 the verification framework, which includes the overall verification process including the scope of the Tier IV standards subject to verification;

.2 the verification authority;

.3 the information and documentation requirements that classification societies must provide to the verification authority; and

.4 acceptance criteria and linkage to Tier II.

5 In considering the need for guidelines, there were comments noting that there probably would be a need for the future development of guidelines but it was premature to determine which guidelines would be needed. Comments were received concerning the need to develop a Ship Construction File and Japan recommended this as a task for the correspondence group but it was considered outside the terms of reference.

Scope of Tier IV standards

6 A comment was made within the group that Tier III not only has to verify Tier IV detailed requirements but also Tier V industry standards. However, there was broad agreement that the purpose of Tier III is to verify that the mandatory requirements in Tier IV and only those Tier V standards that are incorporated by Tier IV comply with the Tier I goals and Tier II functional requirements. It was noted that there are numerous Tier V standards and to verify that all of them comply with Tier I and Tier II would be a significant burden and consequently we should only be concerned with those that are incorporated in Tier IV as mandatory requirements.

7 Based on the comment by IACS that, in general, classification society rules do not have detailed requirements for the entire Tier I goals and Tier II functional requirements, the group considered whether or not it was necessary that the classification society rules need to address all Tier I goals and Tier II functional requirements. Overwhelmingly, the group agreed that this was not necessary as Tier IV can also include IMO requirements as well as national requirements. In addition, a majority of the group agreed that IMO will need to identify who is responsible for developing the detailed requirements for the Tier I goals and Tier II functional requirements.

8 Those advocating that class rules need to encompass all of Tier I and Tier II cited it is necessary because it is the classification societies that enforce these requirements when the ship is designed and constructed. However, classification societies enforce many detailed statutory requirements in fulfilling their obligations as a recognized organization (RO) without including the detailed statutory requirements in their rules. The same would apply here in that class societies would enforce a detailed Tier IV requirement in their role as an RO without that requirement being in their class rules.

9 One member made the comment that, while it is not necessary for classification society rules to include or repeat IMO statutory requirements relative to new ship construction, IACS members currently incorporate all IMO mandatory instruments in their rules. However, it was pointed out that this is not true in all cases. For example, it is known that IMO mandatory requirements on permanent means of access have not been incorporated into all IACS classification society rules but there are IACS unified interpretations that require IACS members to apply the IMO permanent means of access requirement when acting as an RO.

10 The agreement by the group that Tier IV may include more than classification society rules impacts the verification process. It means the verification process of Tier I and Tier II GBS requirements includes more than just classification society rules only; at minimum it will also involve IMO requirements.

11 Three members commented that in addition to classification society rules and IMO detailed requirements, Tier III also needs to verify national standards. However, from the other comments that were received, it was concluded that national standards do not require verification by IMO. It was noted that guidance for verifying compliance of national standards may be needed since not all administrations delegate verification of ship construction to classification societies, which is permitted under SOLAS II-1/3-1. One member of the group recommended voluntary verification of national standards.

12 Three members also commented that Tier III needs to verify shipyard standards. Tier II currently contains a functional requirement relative to shipyard construction quality, and consequently verification of compliance with this functional requirement is required. It was probably generally envisaged that detailed requirements (Tier IV) for this functional requirement would be included within classification society rules and therefore verification would be

addressed through verification of the classification society rules. However, IACS commented that their rules do not include shipyard construction quality standards. The issue of how IMO can verify shipyard construction quality standards through GBS was identified early on and is one that has not been previously addressed nor was it specifically addressed within the correspondence group. This reinforces the need for IMO to determine responsibility for developing the detailed requirements for each Tier II item. The issue of verifying shipyard standards requires further consideration.

13 It was noted that the "owner" of the specific Tier IV standards is the organization responsible for developing and maintaining the standards. For instance, for classification society rules, the owner is the classification society. The group agreed that it is the owner's responsibility for providing the required information and documentation to the verification authority in order that verification can be carried out. It was pointed out that for the IACS CSR, it would be appropriate to consider one submittal from the IACS members rather than a submittal from each member.

Right of appeal

14 The group clearly concluded that during the verification process there must be some recourse and opportunity for corrective action by the "owner" of the Tier IV standards when it is determined by the verification authority that their rules may not satisfactorily address the relevant Tier I and Tier II elements. The concept mentioned most prominently was that during the verification process the verification authority would need to provide the Tier IV "owner" with complete documentation on any non-conformities and the Tier IV owner would then have an opportunity to address them.

Maintaining verification

15 In general, the group concluded that IMO will need to establish criteria that would initiate a review of the verification due to changes to the Tier IV detailed rules. A number of suggestions were made as to the criteria and the common theme expressed by almost every one was that the changes needed to be "substantial". A definition of what constitutes a "substantial" change was not developed, however, as one member suggested, re-evaluation would be needed when the performance level or safety level of the regulation was changed. There were also responses that noted that re-evaluation of verification could perhaps be done on a periodic basis. There was agreement that the owner of Tier IV is responsible for notifying the verification authority when changes are made to the Tier IV standards.

Verification authority

16 A strong majority of the group expressed the view that the verification authority should be an IMO group, under the auspices of MSC. The terms most often expressed were either "expert panel" or "group of experts". In support of this choice, the reasons given were that the IMO group of experts would provide the level of expertise needed as well as consistency of verifications while providing for the necessary resources and infrastructure. It was also noted that an IMO group of experts would be in a the best position to verify compliance with Tier I and Tier II of both the class society rules and IMO requirements that are part of Tier IV.

17 In arriving at this decision, the group considered other alternatives, including Administrations or a non-governmental organization such as IACS. In considering Administrations it was noted that many lack the resources, expertise and infrastructure to carry out verification. It was also noted that this could lead to inconsistent verification and place a

burden on classification societies to submit individually to each Administration. In considering IACS, it was noted that they would have the expertise, however since classification society rules will be the subject of verification, it was considered inappropriate and possibly a conflict for IACS to be involved in the verification. There were no suggestions of other NGOs to be considered.

18 The group did not consider, in any detail, who should be considered for membership of the IMO group of experts nor did it consider the criteria and process for selecting the members. There were comments that the members need to have sufficient technical expertise and possess experience in the application of the standards being considered for verification. There were comments that members of IACS need to be considered because of their expertise and intimate knowledge in the application of the rules. There were also comments that they need to be independent of the company whose standards are being verified. This issue needs further consideration.

19 The group also considered the issue of liability of IMO should verification be carried out by an IMO group of experts. A number of comments recommended checking with the IMO Legal Office.

20 There was also the suggestion by one member, which was supported by two others, that the verification process should be a two-step process. The first step would be a detailed review and assessment of the technical requirements and the second step would be an audit on whether the process followed for verification met pre-determined standards. They proposed that the first step would be carried out by a technical group including IACS representatives (as opposed to representatives of particular classification societies) in combination with experts delegated by flag Administrations that have the requisite technical knowledge. The second step would be carried out by the IMO group of experts. They were concerned that if verification is carried out only by the IMO group of experts, it would lack transparency and expertise and result in verification becoming a political process rather than a technical assessment.

Recognition and recognized organization

21 There was general agreement within the group that it was expected that individual Administrations would recognize the determination of the IMO group of experts with regard to verifying that classification society rules comply with GBS. However, it was also noted that this was entirely separate from and not to be taken as recognition of the classification society as an RO by an Administration.

22 However, there were a few members of the group who expressed the view that the decision of the IMO group of experts should be considered as advisory and that the final decision on verification should be left to the individual Administrations in the course of determining RO status of the classification society. There was consensus within the group that classification societies accepted by Administrations as an RO for new ship construction will need to have their rules verified as complying with GBS. However, it was also noted that the issue of recognition as and RO is much larger than compliance with GBS as there are ROs recognized for purposes other than new construction and therefore, the issue of recognition was beyond the scope of the group's work. The linkage between verifying a classification society rules as meeting GBS and recognition as an RO needs further consideration.

Verification framework

23 Based on the comments and agreements reached by the group on the points and issues noted above, the framework and process for verification were developed and are shown in annexes 2 through 4. There was not sufficient time to consider these processes in any detail within the group, however, comments from members indicated a recognition that these are generally accurate.

24 One member of the group commented that they did not see the need for two different processes, depending on whether the verification is for classification society rules or IMO standards. It was noted that there is not significant difference between the two processes; however, there are differences when it comes to requesting verification, which is an option for a classification society, and the interaction between the group of experts and a classification society or IMO during the verification process.

Tier III information and documentation requirements

25 The group considered the issue of what information and documentation a classification society would be required to provide to the verification authority in order to demonstrate that their rules complied with GBS. An initial draft was proposed by the co-ordinator as a means to generate comments and views from members in the group. There were comments of a general nature, which are discussed in the following paragraphs. In addition, there were quite a number of comments and recommendation on specific text. In general, the group was not able to come to an agreement on the text and consequently, the original proposal and all comments on specific text are presented in annex 5.

26 As agreed in the basic tenets of Tier III (annex 1), there needs to be clear linkage between these Tier III requirements and Tier II, similar to how Tier II is linked to Tier I.

27 A number of members noted that the information submitted in support of verification depends on finalization of Tier II. It was noted that some members who have supported a more holistic approach with goals and requirements based on safety standards do not support all of the elements shown in annex 5 as they do not support the corresponding Tier II functional requirements.

28 One member of the group recommended that instead of the requirements as presented, a more standard term for what is needed to be submitted is a rule commentary, which explains how the rules are derived and calibrated, detailing basic assumptions, scenarios covered, data sources and models used. They also recommended a standardized reporting format. In general, there was support for including a rule commentary, but as a supplement to the required information and not as a replacement. There was also support for developing a standardized reporting format.

29 In general, the majority of responses indicated that the level of detail provided in the co-ordinator's proposal was about right for this stage of the discussions. However, there was wide disparity among the comments received on this point. Some members strongly felt that the level of detail was insufficient and inconsistent to provide meaningful verification. Others expressed concern that it was too detailed and that it would place a burden on the classification societies in presenting the information to show their rules comply with Tier I and Tier II. They also noted that it could be a burden on the verification authority in carrying out the verification.

30 There were a number of comments concerning the level of detail of the review employed by the verification authority. Some advocated specific and detailed review to ensure the specific

acceptance criteria are satisfied. In addition there were references to "audits", which may mean something less than a 100% detailed review. A common theme to these comments is that IMO will need to address and provide guidance on the level of detail of the review that is expected of the verification authority.

31 A number of members commented that, at this stage, equivalent and novel designs were adequately addressed, although one member noted a concern if inappropriate numerical values are included. Others, while not commenting on the adequacy of the draft, noted it is the class rules that need to address novel and equivalent designs and Tier III needs to verify that they are appropriately considered by the class rules. There was a comment on the need to accommodate equivalence and innovation without weakening the rules. Others noted the difference between equivalent designs and truly innovative designs and that the latter may bear separate consideration.

Acceptance criteria

32 In considering the information and documentation requirements for the classification societies, the issue of acceptance criteria was also considered as it was noted that not all Tier II functional requirements contain acceptance criteria. In general, the response was that additional acceptance criteria were needed for the purpose of making verification clearer and also to augment Tier II. There was no clear consensus on whether or not Tier III should include acceptance criteria in those instances where Tier II does not include acceptance criteria. A number of members expressed the preference that Tier III should not include acceptance criteria and that instead the acceptance criteria needed to be in Tier II. This is entirely consistent with previous comments on this issue. There were also comments that Tier III needs to focus on the process and not include the acceptance criteria. However, there were some who supported including acceptance criteria in Tier III at this time and in future discussions and as a follow-on in the iterative process it would then be appropriate to determine if they should be placed in Tier II. There was also a comment that a checklist type of acceptance criteria should be avoided as it will only focus on the items in the checklist rather than fulfilling the intent of GBS.

Action requested of the Committee

33 The Committee is invited to approve the report of the Correspondence Group in general and consider the information presented in the report to further development of Tier III.

***

ANNEX 1

BASIC TENETS OF TIER III

1 Purpose: Tier III is to verify that a classification societies' detailed ship's hull structural requirements meet Tier I and Tier II. It is not for the purpose of verifying the ship meets Tier I and Tier II. The basic understanding is that if the ship complies with the classification society rules which have been verified as meeting Tiers I and II, the ship will therefore comply with Tier I and Tier II.

2 Applicability: For the purposes of this correspondence group, we will be developing Tier III criteria based on the Tier I – Goals and Tier II – Functional Requirements as agreed upon at MSC 80. Tier III applies to rules for ships, and based on the Tiers I and II from MSC 80, it is currently limited to the rules for bulk carriers and tankers in unrestricted navigation.

3 Content: Tier III needs to provide a process to verify the detailed structural requirements in classification societies' rules meet Tier I and Tier II. In its most basic form, Tier III will need to specify:

.1 the information that classification societies need to submit, and

.2 who will conduct the verification (verification authority).

4 Acceptance criteria: Tier III will need to address acceptance criteria. For some Tier II functional requirements, the acceptance criterion is specified; e.g. "design life" is specified to be 25 years. This is not true for all functional requirements, in which case a decision will be needed as to which of the following options should be pursued:

.1 include specific acceptance criteria in Tier III, or

.2 do not include specific acceptance criteria in Tier III. This would essentially mean that determination of acceptability will be left to the discretion of the verification authority.

5 Linkage: Tier III needs to link to Tier II much in the same manner as Tier II does to Tier I.

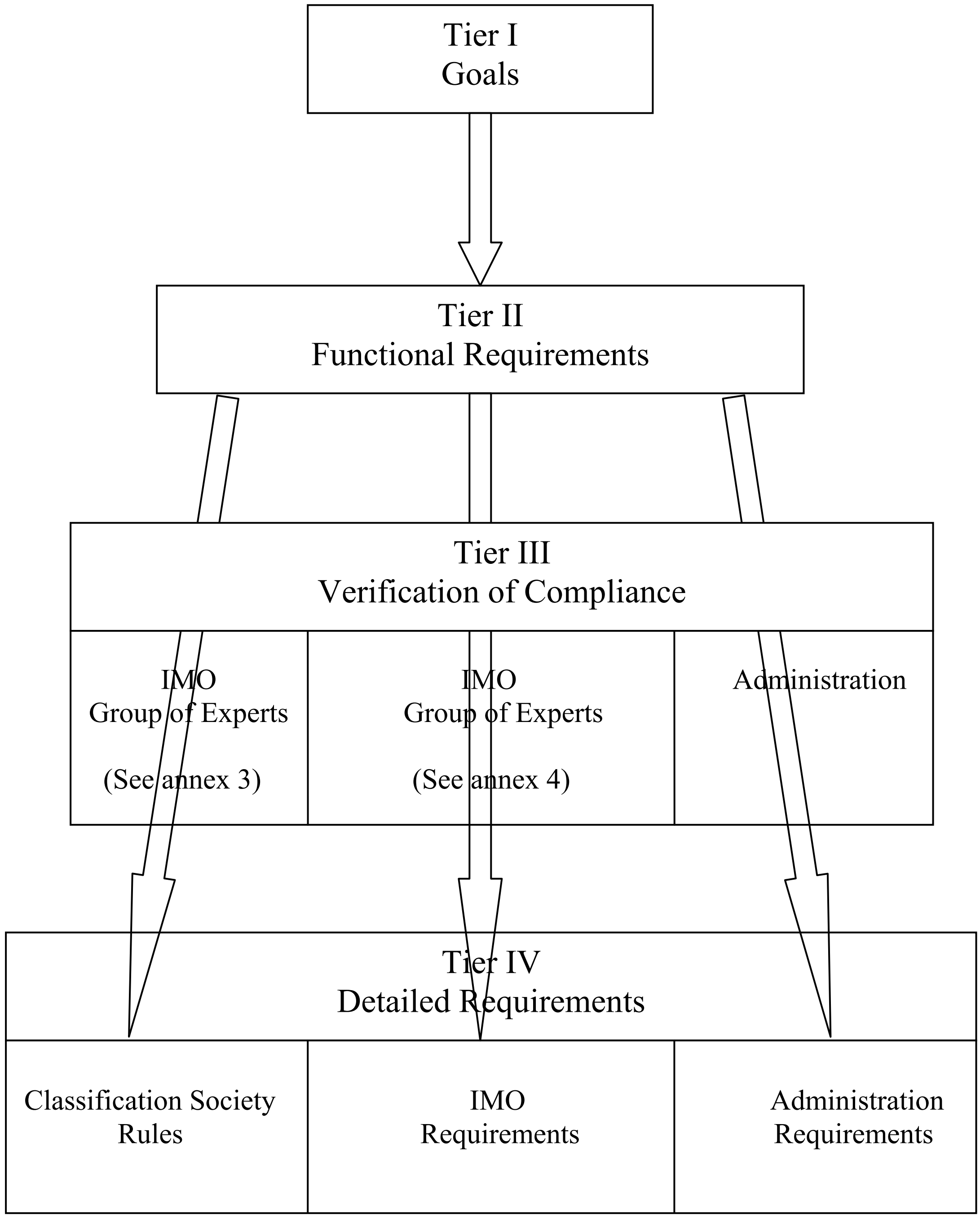
6 Guidelines: Need to determine if additional guidelines, to be developed by IMO, will be needed.

7 Overall, Tier III needs to be credible, transparent and auditable.

***

ANNEX 2

GOAL BASED STANDARD FOR NEW SHIP CONSTRUCTION – VERIFICATION FRAMEWORK



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ANNEX 3

VERIFICATION FRAMEWORK – CLASSIFICATION SOCIETY RULES

Standards of Verification

IMO Group of Experts criteria:

- Qualifications and selection
- Number of members, group leader
- Location/frequency of meetings
- etc.

Tier III verification criteria: *

- Information/documentation required to be provided by Classification Society
- Acceptance criteria
- Standard Format, Guidelines, Rules commentary
- etc.

* See annex 5

Initial Verification

Classification society submits request of verification to IMO [Group of Experts]

- Provides required information/documentation

↓

IMO Group of Experts conducts review/audit of classification society submission

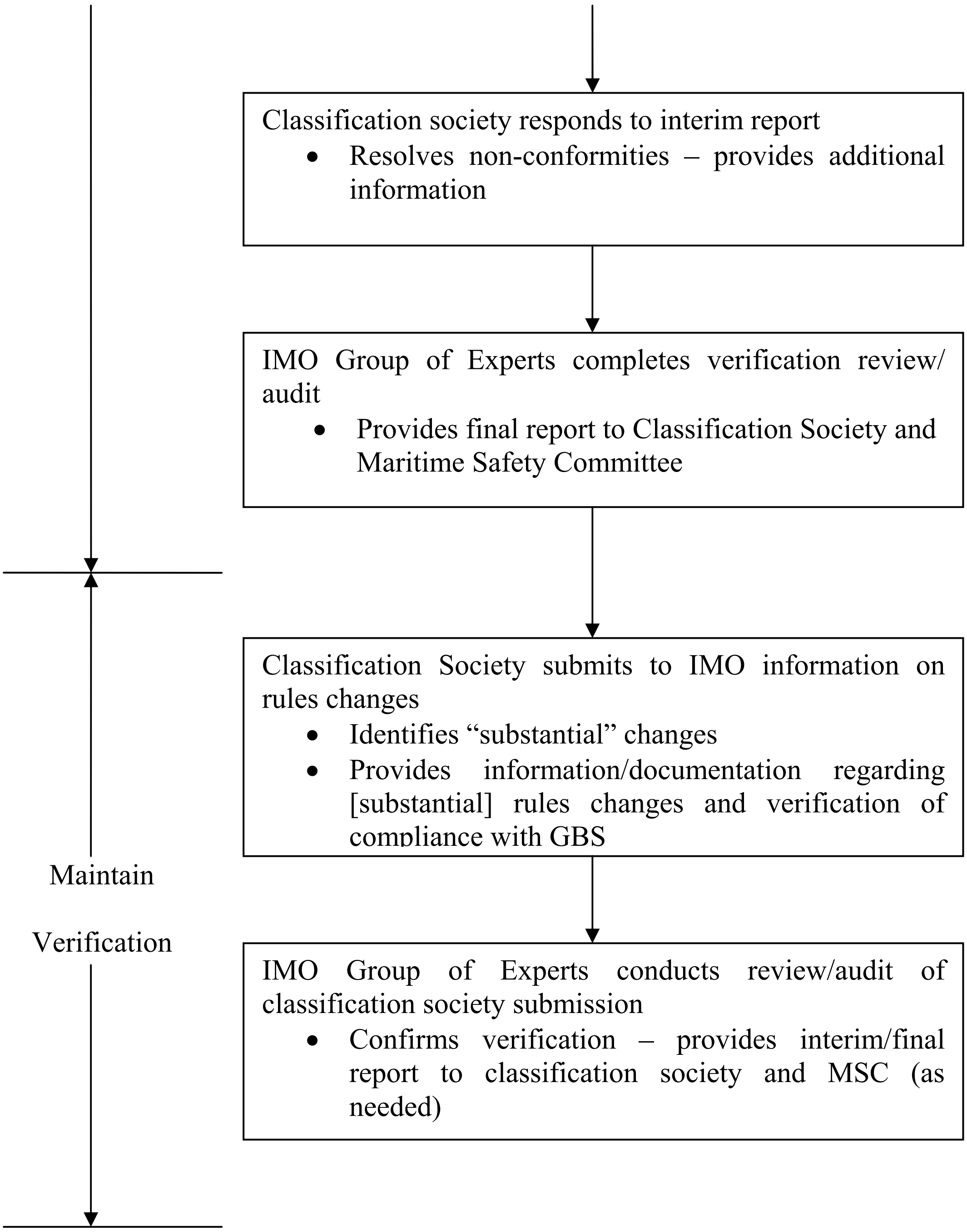
- Adhere to IMO established criteria regarding level of detail review/audit

↓

IMO Group of Experts provides interim report to Classification Society (if needed)

- Details results of review/audit – include request for additional information/documentation
- Provides full and complete details on any non-conformities

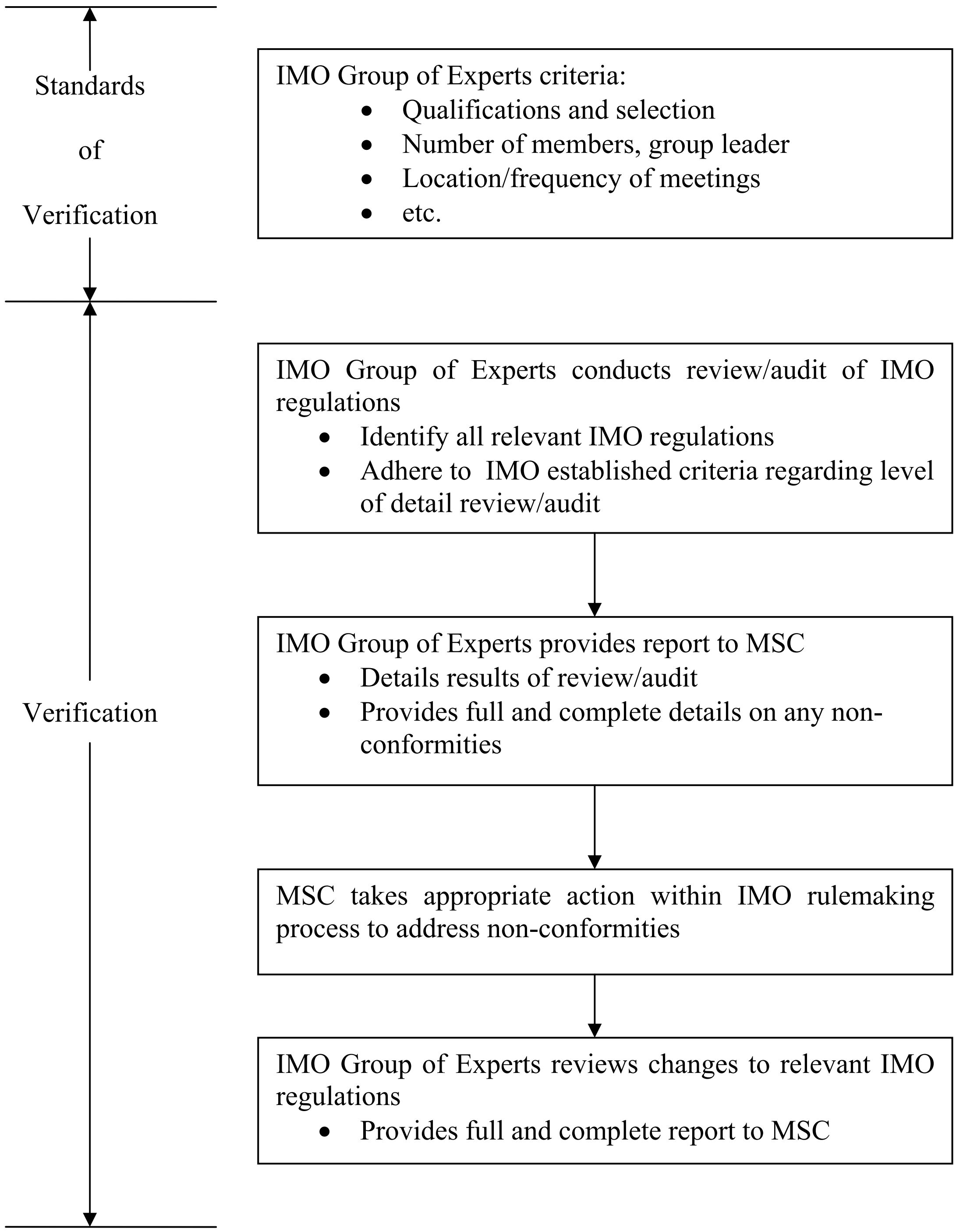
資料4


Classification society responds to interim report
• Resolves non-conformities – provides additional information
IMO Group of Experts completes verification review/ audit
• Provides final report to Classification Society and Maritime Safety Committee
Classification Society submits to IMO information on rules changes
• Identifies "substantial" changes
• Provides information/documentation regarding [substantial] rules changes and verification of compliance with GBS
IMO Group of Experts conducts review/audit of classification society submission
• Confirms verification – provides interim/final report to classification society and MSC (as needed)
Maintain
Verification

***

ANNEX 4

VERIFICATION FRAMEWORK – IMO REGULATIONS



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ANNEX 5

TIER III INFORMATION AND DOCUMENTATION REQUIREMENTS

Co-ordinator's original proposal (Note: as originally proposed it was titled "Draft Tier III"):

(Applicable to new oil tankers and bulk carriers in unrestricted service)

A classification society [recognized by an Administration in accordance with XI/1] shall have its rules verified as complying with the Tier I Goals and Tier II Functional requirements by submitting to the [verification authority], a copy of its rules and information to address the following items:

III.1. Design life and environmental conditions

1 Formulation and/or source of sea state data (scatter diagrams, etc.) including date of data and geographical location represented by the data;
2 Description of how the sea state data is used to develop the equations and scantling requirements for strength and fatigue;
3 Justification that sea state data represents 25 years and the North Atlantic;
4 All locations in the rules where design life and environmental conditions are cited.

Link: II.1 Design life, II.2 Environmental conditions

III.2. Structural strength

1 Evaluation to determine net scantlings are sufficient to withstand the following failure modes: excess deformation, yield, buckling and fatigue. Include the following:

.1 Data, including justification, on the acceptable limits of deformation, yield, buckling and fatigue;
.2 Safety factors, with justification why they are appropriate;
.3 Loading conditions, including: homogeneous, partial, alternate loads, multi-port, ballast conditions including ballast management, and loading and offloading are included in the evaluation;
.4 How workmanship and construction ("as built") design features are accounted for in the evaluation;
.5 Acceptable limits on continuity of structural members; and
.6 Structural members included in the evaluation

2 Evaluation to determine the main hull girder (plates and stiffeners) at net scantlings provides sufficient ultimate strength. Include the following:

.1 Data, including justification, on acceptable limits of ultimate strength;
.2 Safety factors, with justification why they are appropriate; and
.3 Structural elements included in the evaluation.

3 Evaluation to determine compatibility for cargo loading and offloading without unrealistic operating conditions, including criteria, with justification, to determine acceptability.

4 Evaluation to determine that failure of side shell, main longitudinal or transverse bulkhead, web frame or main longitudinal stiffener does not result in further structural failure.

5 Evaluation to determine that the structure can withstand, without further structural failure, the structural damage for those conditions from the damage stability analysis where the ship survives (s = 1.0). Include the following:

- .1 Limits, with justification, on the environmental conditions and period of exposure.
- .2 Acceptable limits of deformation, yield, buckling and if different than those in III.2.1.1, with justification.

Link: II.3 Structural strength, II.5 Residual strength, II.7 Structural redundancy

III.3. Fatigue life

1 Requirements verifying fatigue life is to be not less than design life;
2 Data, including the source, used to determine acceptable fatigue life; e.g. stress, number of cycles, confidence interval, etc.;
3 Structural elements, including identification of critical design details, required to be included in evaluation of ship's fatigue life.

Link: II.3 Fatigue life

III.4. Protection against corrosion

1 Mandatory use of coatings:

- .1 Locations and/or spaces where coatings are required to be used;
- .2 Types of coating including criteria for determining the type of coating to be used;
- .3 Required coating life and criteria used to determine required coating life;
- .4 Allowances where other corrosion prevention systems are also used.

2 Voluntary use of coatings:

- .1 Locations and/or spaces where permitted;
- .2 Criteria for selecting the type of coating;
- .3 Coating life and criteria used to determine the coating life.

3 Determination of the corrosion addition to develop "as built scantlings" in order that the ship structure scantlings do not fall below the net scantlings by the [design life] [2nd special survey]. Include the following:

- .1 Determination of corrosion rate based on ship type, location, cargo, loading, statistical data, etc.;
- .2 Time period;
- .3 Consideration of corrosion control measures.

Link: II.4 Coating life, II.5 Corrosion addition

III.5. Watertight and weathertight integrity

1 Evaluation to determine adequate watertight and weathertight integrity of the ship. Include the following:

.1 Criteria for determining which openings in ship's hull are required to be watertight or weathertight for a ship operating in the environment from III.1;
.2 Criteria for determining strength and redundancy requirements for the closures of the watertight and weathertight openings based on environment and design life from III.1.

Link: II.8 Watertight and weathertight integrity

III.6. Design transparency

1 Provisions that make "design" and "as built" drawings and information, sufficient to verify compliance with classification society rules, available to builder, owner, operator, and/or Administration, as appropriate. Include the following:

.1 Details for "Ship Construction File"; and
.2 Provisions for protection of intellectual property.

Link: II.9 Design transparency

III.7. Construction quality

1 Determination that a shipyard's construction procedures and practices meet a minimum level of quality. Include the following:

.1 Criteria used to determine the minimum level of quality, that includes but is not limited to:

.1 Selection of materials and specification for materials manufacturing;
.2 Assembly, including alignment, joining, welding, surface preparation, coating, castings, heat treatment, etc.;

.2 Actions taken when a shipyard is determined as not meeting the minimum level of quality construction.

2 Provisions when "as built" is different than "design". Include the following:

.1 Criteria for determining when review of the "as built" drawings is required;
.2 Criteria for determining when re-evaluation of net scantlings for strength and/or fatigue life is required.

Link: II.9 Construction quality procedures

III.8. Survey

1 Survey requirements, including the development of a Survey Plan, during ship construction sufficient to verify the ship is constructed in accordance with the classification rules, including:

.1 Types of surveys (visual, radiograph, etc) depending on location, materials, welding, casting, coatings, etc.;
.2 Frequency of surveys;
.3 Criteria for acceptance;
.4 Interaction with shipyard, including notification and documentation of survey results;
.5 Determination and documentation of areas that need special attention throughout ship's life, including criteria used in making the determination.

2 Provisions for providing shipowner representatives results of construction surveys.

Link: II.11 Survey

III.9. Accessibility

1 Evaluation to determine adequate access is provided for the internal structure for maintenance and to facilitate close-up inspections and thickness measurements. Include the following:

.1 Criteria for determining acceptability of access;
.2 Requirements for development of an Access Plan.

Link: II.12 Structural accessibility, II.13 Maintenance

COMMENTS RECEIVED IN RESPONSE TO CO-ORDINATOR'S ORIGINAL PROPOSAL

Greece and Japan

Note: Greece submitted comments based on the co-ordinator's original proposal, which follow the notation: **[Greece1]**. In their comments, Greece provided background and justification in *italic text*, additions are shown as highlighted and deletions as ~~strikeout~~. In response to Greece, Japan provided comments which follow the notation **[Japan]**. Greece then responded to Japan's comments and they are shown following the notation: **[Greece2]**. If additional comments from either Greece or Japan were received on a section, they are correspondingly noted **[Japan2]**, **[Greece3]**, **[Japan3]**, etc.

[Greece1]
III.1 DESIGN LIFE

[BACKGROUND INFORMATION - (From: MSC 80/6/5 , 4 March 2005)

II.1 Design life
13 Design shall primarily be related to "life expectancy" or design life as everything else flows from it (functional requirements): design methods, solutions, choice of materials, construction methods and quality, environment, maintenance/inspection strategies and regimes, etc. The notion of design life can be linked to various design philosophies, notably the following:
.1 "Infinite life" design: *this philosophy entails a rather theoretical notion in which structural components are expected to last for as long as specified without degradation of strength, which can only be achieved under controlled environments (**maintenance free!**)*
.2 "Safe life" design: *this philosophy entails the notion of fit for purpose or robust design, in which the structural components are expected to last for as long as specified, assuming nominal strength degradation, under a **normal (rational) maintenance** regime.*
.3 "Fail safe" design: *this philosophy entails a notion where **maintenance** is a key instrument in ensuring the specified life expectancy. Any failure of the nominal (assumed) maintenance regime would lead to shorter than expected life of structural components/system.]*

[Japan]
Following the disasters of the Comet in 1952-53, the concepts of "safe-life design" and "fail-safe design" were clearly introduced to the aircraft design. "Safe-life Design" aims not to cause damage for specified design life by ensuring enormous safety margin covering widely-scattered uncertainties. "Fail-safe Design" or "damage-tolerant design" tolerates controlled damages in normal operation which do not lead to fatal failure for the scheduled survey period under the normal maintenance regime by adopting "redundant structure", "double (segregated) structure", "back-up structure" and/or "load-dropping structure". At present, "fail-safe design" has come to prevail over the "safe-life design" due to technical difficulties and long-term economics of even the airline industry. "Safe-life design" is now limited to only the most critical areas such as landing gear. This may correspond to the hull girder ultimate bending capacity of ships against extreme load. As mentioned, Greece definition of "safe-life design" and "fail-safe design" deviates from the original. Please refer to the schematic plans attached. Ships, aircrafts and all vehicles are different from fixed offshore structures which cannot usually avoid rough weather and be well-inspected, well-maintained. We are of the opinion that GBS should also be realized by original "fail-safe design" approach under "normal" survey and maintenance regime, otherwise extensive "safe-life design" should finally result in unnecessary impact on the environment and economics against other industries. It is to be noted that "normal" survey and maintenance do not mean too frequent and/or excessive ones in the case of ships, too. It is also to be noted that any failure of normal survey and maintenance regime should not necessarily lead to structural failure, however, this should not endorse any relaxation of normal survey and maintenance regime. Needless to say, "safe-life design" can be adopted as an option by specific owners who prefer reduced maintenance load below "normal" level. Please see figures in the annex as attached.

[Greece2]
The definitions given by Greece come from the offshore industry. Those definitions deviate from those used in aircraft industry in that the aircraft industry's definitions are much more strict and severe. But this is not so relevant here. At any rate, it should be clarified that the "fail-safe design" has not come to prevail in the aircraft industry as stated. Instead, aircraft structure is

designed based on "safe life design"(*) with the objective of zero cracks with 94% confidence for 20 years and augmented with the "fail-safe design" (i.e. inspections). Furthermore, recurring problems weather "tolerant" or not are eliminated from the design. Greece does not propose zero cracks with 94% confidence for 20 years and we propose not to deviate or complicate the discussion. Our objective should be to adopt a rational approach to ship design, which eliminates known hot spot area cracks, and prevents other weaknesses and defects with a reasonable degree of certainty for the design life. On this front, it seems the difference between Greece and Japan is that we believe an upgrade over the present status quo is required, while Japan believes what we are presently doing is sufficient. Maintenance and inspection have a crucial role to play during the lifetime of the ship and thus in the Greek definition of "safe life design", these words are in bold. But it is not reasonable to need exhaustive inspections to discover and then repair cracks and deformations appearing from the first 5 years of life. And we agree with Japan that any failure of normal survey and maintenance regime should NOT lead to serious structural failure. We hope we can reach agreement with Japan on what the objective is and the need to upgrade present design and construction methods. We also have to agree on what is normal (rational) maintenance, but this is another subject not strictly related with design and construction standards.

(*) if interested kindly see Stanford University's, Aircraft Aerodynamics Design Group, http://adg.stanford.edu/aa241/structures/structuraldesign.html

[Greece1]
III.1 REQUIREMENTS:

1. Information, elaboration and references in the rules indicating that the concept of "Safe Life" design is being followed. Include estimated steel renewal amounts and locations to age 22 (for guidance not to exceed [2%] of original lightship).
2. All locations in the rules where design life is cited
3. To be developed…

III.2 ENVIRONMENTAL CONDITIONS

[*BACKGROUND INFORMATION - (From: MSC 80/6/5, 4 March 2005)*

II.2 Environmental conditions

19 Current ship design practice considers design environments with return periods (an ***average*** *time notion) equivalent to the ship's expected life (currently 20 years), which means that there is a rather large probability (P=64%) that the design (extreme) environment may be encountered more than once in the lifetime. For this reason, relevant design environments should have significantly low probabilities of being exceeded in any condition, but commensurate and consistent with other safety factors implicit in the design criteria.*

20 In terms of extreme wave events (He) in a random Gaussian process (like ocean waves), levels of probability of being exceeded of the order of 1-5% correspond to wave heights of the order of {2.2-2.4}Hs. Currently however, design wave heights of the order of 1.8 Hs only are being used, which relate to probability levels of being exceeded as high as 63.2%. In other words, the ship has a 63% chance of encountering waves that exceed her maximum design wave.

21 Needless to say, wave statistics, the basis of the formulation of the design environment and consequently the design loads, shall be updated to include the most recent advances in observation/measurements/analysis techniques. It is to be noted that current IACS wave statistics date back to 1986 (revised 1995)[2] and include unrealistic assumptions of zero speed and equal probability for all directions of wave headings which further reduce the design requirements.

2 IACS (2001), No.34 Standard Wave Data.]

III.2 REQUIREMENTS:

5 Formulation and/or source of sea state data (scatter diagrams, etc) including method of collection, date of data collection and geographical location represented by the data.

6 Verification that the data collected reflects up-to-date information comparable and benchmarked with different sources of data collection (satellite images, weather modelling etc.) Elaboration and justification of data in case they come from automatic/buoy source or crew observations. (NOTE: There is an argument that the observed data are less reliable since in general ships try to avoid bad weather).

[Japan]
Being different from fixed offshore structures, ships can avoid rough weather. The results of recent research pointed out that actual waves encountered by ships in the North Atlantic are more moderate than those estimated by currently available wave scatter diagrams. (e.g., Encountered Wave Height Distributions for Ships in the North Atlantic" Olsen A. et al, 2004, Influence of Weather Routing on Encountered Wave Heights" Sternsson M. et al, 2002). The primary reason may be the common use of weather routing technique, which has been extensively adopted in order to avoid excessive speed down, propeller racing and cargo damage as well as damage to the hull and equipments in rough weather. In addition, wave breaking of too steep waves are also to be considered in the statistical (linear) estimation of extreme wave heights. Our position is that ships should be designed based on actual wave data encountered by ships, not by fixed buoy, etc., in principle.

[Greece2]
Although satellite technology and communications (weather routing) has helped to provide advanced warning and planning, unfortunately ships cannot always avoid bad weather. In cases of sudden storms and weather changes they are not fast enough, and even for cases were course is changed to avoid the centers of storms, the outskirts prove to be many times a lot more severe than the weather routing advice. Greece's preliminary investigation with several Oceanographic Institutes show clearly more severe actual sea states than previously believed. The above concern the question of what the appropriate maximum design wave should be. The other question is what should be the acceptable chance of exceeding such maximum wave during the ship's lifetime. Obviously, based on the updated sea spectra information and the casualty/defect record, Greece feels that there should be both an increase in maximum design wave and a reduction in the probability of exceedance. This also is being supported by direct hydrodynamic analyses showing a serious deficiency of the presently used longitudinal strength formulae for tankers and bulk carriers. As for fatigue, the poor record speaks for itself. Furthermore, initial assessments indicate that the effect of these enhanced requirements on total ship steel weight should not be large.

[Greece1]

7 Include effect of steep waves. Assess the possibility that the ship might encounter a very steep (rogue wave). What safety factors/provisions do exist to tackle this type of waves (high height to length ratio).

[Japan]
Recently, rogue wave mechanism has been studying but has not been solved yet. It was presented that rogue wave was observed by satellite; however, it is not presented that ships encountered rogue wave. It is often said that observed wave height data by satellite, in particular

for large wave height, should be discussed to evaluate accuracy of the data. The collection method of wave data for ship design should be considered taking into account of accuracy of observed data. Ships can avoid rough weather; ships might not encounter rogue wave. Therefore sea scatter diagram for ship design should be applied based on the observed data ships encountered.

[Greece2]
Attaching folder "rogue" with two sample articles (of many recently published in the news - even QE II has been hit by rogue wave). Also containing some interesting photos.

[Greece1]

8 Description of how the sea state data is used to develop the equations and scantling requirements for strength and fatigue. (NOTE This topic needs to be elaborated more and developed in a more scientific way. Emphasis on the generation of load data due to waves. Loads are in general three forces and three moments. Typically the vertical and horizontal bending moments as well as the vertical shear force are of interest for all vessels with torsion being important in containers and bulk carriers (or it should be!). There are two types of loads high and low frequency. Also formulation is needed to generate sloshing and slamming loads due to waves. Furthermore, experimental verification of the above is necessary.)

9 Rules to specify when sea-keeping analysis (with realistic speed) is expected to yield higher results than the standard formulae. The sea-keeping results then need to be taken into account.

10 Justification that sea state data represents 25 years and the North Atlantic.

11 All locations in the rules where environmental conditions are cited.

12 To be developed…

Link: II.1 Design life, II.2 Environmental conditions

III.3 STRUCTURAL STRENGTH

[*BACKGROUND INFORMATION*

- JAPAN response to circular 1:
- Acceptance Criteria (4 of annex1)
In order to ensure the transparency of IMO GBS scheme, several quantitative acceptance criteria should be specified in Tier III, e.g.; A quantitative criterion should be given to the hull girder ultimate strength as the most fundamental issue that is critical to maritime safety and environmental protection. It is also considered necessary to specify acceptance criteria for significant structural members within vital compartments.

- INDIA response to circular 1:
Traditionally, the verification in shipping industry has been limited by examination of the 'technical equivalency'. In case this approach is followed, then acceptance criteria in the form of scantling requirements will be required for:

a) Longitudinal Strength & Watertight integrity of the hull girder.
b) Local Strengths & integrity of each main structural boundary, e.g. deck, sides, bottom, bulkheads.

c) Local strengths of primary members like girders, pillars etc., as well as those of the various secondary structural components.

d) Corrosion margins for all the components.

Also, all these would also need to be verified for the loads & the failure modes decided under Tier II. It would be very difficult later to incorporate this criteria under a 'Risk based approach' the IMO has agreed to follow in future. As an alternative, in case the verification is carried out under 'safety equivalency' approach, acceptance criteria will only need to be developed for the over-all safety factors under various loads and failure modes. This may be technically a bit more challenging, but can be easily integrated with the risk based approach. While sympathizing with the opinions of some of the distinguished members, India would support the second alternative of 'safety equivalency' approach through prescription of 'safety factors'.

- SINGAPORE response to circular 1:
II.3 Structural strength
The safety margins mentioned in this functional requirement should be specified. As of now, although each classification societies have incorporated various levels of safety margins in their structural rules. The manner in which safety margins is applied and the quantum should be specified.]

III.3 REQUIREMENTS:

6 Evaluation to determine net scantlings are sufficient to withstand the following failure modes: excess deformation, yield, buckling and fatigue. Include the following:

.7 Data, including justification, on the acceptable limits of deformation, yield, buckling and fatigue,

.8 Safety factors, with justification why they are appropriate,

.9 Loading conditions, including: homogeneous, partial, alternate loads, multi-port, ballast conditions including ballast management, and loading and offloading are included in the evaluation.
(Guidance: The rules should allow and consider: any transverse combination of cargo tanks across to be empty at or near design draft; asymmetric cargo loading conditions; flexibility in ballast tank utilization without severe increases of global bending moments.
The load/ weight distribution of the lightship should be also defined in the rules (avoid move of lightship weights towards the middle of the vessel in order to decrease the still water hogging moment)

.4 How workmanship and construction ("as built") design features are accounted for in the evaluation,(GUIDANCE: like for example initial deformations or initial curvature (out of plane deflection) of shafts.)

.5 Welding parameters to be defined on the basis of first principle equations and not by semi-empirical formulations. Margins for manufacturing induced variability to be included. Rules to be specific and accurate with respect to preheat and post-heat requirements. Welding sequences to be also defined. Effect of reduced strength in HAZ (heat affected zone).

[Japan]
These issues depend on the complicated combination of thickness and chemical composition of steel, and specific welding procedures, etc., which are intellectual properties of each shipbuilder. Therefore, our opinion is that these issues should be left to the approval by the classification society in charge.

[Greece2]
We refer to typical shipbuilding grades of steel, specific welding procedures, combination of thicknesses etc which have been specified in the rules for years (but unfortunately less so for new CSR) and cannot constitute "intellectual property". In case of a brand new material it would be a different approval process.

[Greece1]

.6 Acceptable limits on continuity of structural members. Continuity requirements to be specifically defined (Guidance: for example stringers to continue for x frames forward).

.7 Structural members included in the evaluation.

.8 Rules to include a table with stress concentration factors of details typical in ship geometry (misalignment, thickness transition, hard corners, doubler plates etc.) (NOTE: to remind the designers that stress is not simply Force over area.)

[Japan]
Stress concentration factors depend on the configuration and arrangement of structures around the subject point. Therefore, simplified list cannot be practical.

[Greece2]
Such stress concentration factors already exist (see DnV guide for fatigue analysis). This system is also used in other industries. A conservative simplified list will help tremendously in the elimination of cracks as a result of super-optimization (in the case of advanced designers) or bad design detail (in the case of developing designers). It is very practical in that it helps designers avoid advanced FEM, which is time consuming and resisted by designers, and which developing designers may not be too proficient in.

[Greece1]

.9 Effect of deflection on strength to be included. (NOTE: Direct/FEA models cannot account for this effect. Only the relative deflection can be estimated. Consequently the limits should be placed on relative rather than absolute deflections. Consider effect of hull deflection during turns to port and starboard on the integrity of the shafting system and the stern tube bearing.)

[Japan]
As for tankers and bulk carriers of normal proportion at least, global deflection has never been a critical issue even in the extensive use of HTS390.
Alignment can be affected by various factors such as initial designed gap, fabrication tolerance, rigidity of the shaftings and hull, spacing of bearings as well as changes in draft, temperature and wave height, etc. The global and local deflection during turns should be considered in conjunction with these factors, however, there has been no theoretical or rational acceptance criterion actually. Our opinion is that this issue is too premature.

[Greece2]
The vessels are not checked by FEM over their whole length (only middle portion) and thus cannot obtain accurate deflection results. Deflections cannot be left unchecked. Relative secondary deflection is a particular problem as for example between transverse bulkheads and neighboring brackets (see "Structural Defect Experience" discussed later on). In case of high relative deflection, such areas should be further analyzed. On this front we are happy to report that, after some resistance, IACS included in CSR the check of secondary deflection but not tertiary (between web frames) or secondary tertiary (between stiffeners).

[Greece1]

7 Evaluation to determine the main hull girder (plates and stiffeners) at net scantlings provides sufficient ultimate strength. Include the following:

.1 Data, including justification, on acceptable limits of ultimate strength
.2 Safety factors, with justification why they are appropriate, and
.3 Structural elements included in the evaluation.

8 Evaluation to determine compatibility for cargo loading and offloading without unrealistic operating conditions, including criteria, with justification, to determine acceptability. Define acceptable speed of loading and off-loading.

9 Evaluation to determine that failure of side shell, main longitudinal or transverse bulkhead, web frame or main longitudinal stiffener does not result in further structural failure or “domino effect”.

10 Evaluation to determine that the structure can withstand, without further structural failure, the structural damage for those conditions from the damage stability analysis where the ship survives (s = 1.0). Include the following:

.1 Limits, with justification, on the environmental conditions and period of exposure.
.2 Acceptable limits of deformation, yield, buckling and if different than those in III.2.1.1, with justification.
.3 To be developed… (Expand on which [specified] [foreseeable] damage/ flooding conditions are required to be checked).

Link: II.3 Structural strength, II.5 Residual strength, II.7 Structural redundancy

III.4 FATIGUE LIFE

[*BACKGROUND INFORMATION - (From: MSC 79/6/8, 23 September 2004)*
***.1** “ Fatigue life”(II-1): The design fatigue life shall be substantially longer than the ship’s design life depending on the acceptable level of risk set by the Organization. The actual fatigue life may be longer or shorter than the design fatigue life depending on the actual conditions and maintenance of the ship. The design fatigue life of structural details shall be calculated in accordance with a fatigue damage calculation procedure based, unless otherwise specifically stated, on design life and environmental conditions. The fatigue model shall include the whole ship, and not only “representative” details, and the calculations shall take due account of slamming and dynamic effects, induced vibrations, sloshing, secondary and tertiary stresses and all pertinent operational parameters. The structural fatigue assessment shall eliminate to the extent possible fatigue prone details.*

[Japan]
As recorded in the report of the WG on GBS at MSC80, the majority agreed that the fatigue life need not be longer than the specified design life since the assumed environmental condition of the North Atlantic provides suitable safety margin. Actual trading business in the North Atlantic is more or less 5% of the total, and besides, most of the ships are needless to be exclusively operated in the North Atlantic for the trading business of more or less 5%. In addition, the actual wave heights encountered recently by ships in the North Atlantic are more moderate than

traditional wave scatter diagrams (Please refer to our previous comments). On the other hand, the definition of fatigue life or critical size of fatigue damage is vague and varied widely. Therefore, risk cannot be quantified easily. In principle, fatigue damage, like paint damage, propagates gradually in the long term and doses not lead to immediate fatal loss of the hull integrity. The controlled fatigue damage within the critical size is one of the typical "tolerant" damages, which are to be detected practically and repaired under the normal survey and maintenance regime (Please refer to our previous comment on "Fail-safe Design"). It is to be emphasized that this has been widely adopted into the various industries and never means negative/unsafe approach.

[Greece2]
We restate below in brackets some previous comments (from Greece's response to Circular 4). Obviously it is impossible to design and construct ships that can guarantee zero defects. But it is not acceptable to allow the same defects ("tolerant" or not) appear in design after design, again and again in the same known areas of ships, while the technical solution to end this problem is known and not that expensive. Our point is that recurring damages showing in the defect record should be corrected by proper design and construction. Reliance on inspections should be left only for the totally unpredictable damages. It should be noted that in the vast areas of ship tanks and holds it is not always possible to detect cracks before they become severe. Importantly, also we should not forget that the public demands and perceptions have changed. The public demands a policy of "zero tolerance" and it is our duty to comply. Secondly, we should be aware of the common effort in the industry, headed by IMO, to improve the image of our industry, or rather stress the good record of our industry. These concepts of zero tolerance and safeguarding the image of shipping, are not too compatible with the concepts of "controlled fatigue damage" and "tolerant damages" to the extent that such damages are easily and very cost effectively preventable.

[(*) see "Structural Defect Experience", 16 August 2005, available from JTP site, dealing with the so far defect experience of Double Hull tankers. The average age of the world fleet is reported to be 7 years old. 50% of the world fleet is less than 5 years old and 80% is less than 10 years old (page 6). The shocking findings are as follows :

Quoting from page 12: **"One in four ships in the sample are reporting defects in the first five years of life. Two out of three ships with defects, are reported before their tenth anniversary."**

These above stated defects are in their majority fatigue cracks (two out of three -and thus something drastic should be done in the fatigue front of the new CSR - but it didn't) but also one in 10 defects are **deformations** not related to wastage. The above defect record is just one confirmation of the urgency and importance of our work. If things were A-ok in ship construction, we would not need to be here. By the same token, it is not appropriate to try to keep the status quo of ship construction and resist strengthening and quality improvements. It is also disappointing to see that, the new CSR, although stating that they take this defect record into account, do not actually introduce measures to correct these fatigue deficiencies and have resisted proposals by Greece to that effect. All of the above ships were designed basis North Atlantic. It has been claimed many times that this alone is sufficient margin and no improvements in strength and fatigue are needed. If that was the case, why one in four ships develop structural fractures and buckling before age 5? Obviously "N.Atlantic" has not helped. As Greece has pointed out, North Atlantic would be a good design basis if it was applied properly. However when it is diluted seriously by the time it finds itself into the design formulae, it is no more "North Atlantic". And before worrying about maintenance (whose lack of, will produce defects at older ages-of the design life) we should worry more about fixing problems evident from day one of a ship's life.]

[Greece1]

Reasoning: Fatigue life assessment is not an exact science and therefore fatigue life specifications for structural members must be higher than design life if they are to be used with confidence in ultimate strength assessment. In that connection is stressed that members not possessing a fatigue life of more than 150% of the design life should not be assumed fully effective in the ultimate strength calculations. Moreover, the use only of fatigue assessments of "representative" structural details is a dangerous oversimplification, as they are used for a variety of actual structural details, and should be avoided.

(From: MSC 80/6/5, 4 March 2005)

II.3 Fatigue life

22 In principle, the actual fatigue life of a structure should, as a minimum, be the same as the specified design life (fatigue design factor of 1). However, given the significance of construction, inspection and maintenance regimes in the actual fatigue life, and the uncertainty in fatigue damage predictions, the fatigue life shall be defined with due consideration of factors which fundamentally influence fatigue failure risk, namely: the consequences of failure, and the degree of accessibility for inspection, maintenance, and necessary repairs. This approach is established in the offshore industry[3], where fatigue design factors range from 1 (low risk)[4] to 10 (high risk)[5] .

23 Using prescription in linking fatigue life to design life with, for example, a fatigue design factor of 2, would necessitate focus on design against fatigue. In this respect, this would provide a target for the designer to meet and hence it would be treated as a primary objective or goal. The various factors that influence or determine fatigue life would be unavoidably influenced by this but so long as cost-effectiveness is made the basis for decision making, the implicit iteration in the rule development would help reach standards that reflect a balance of all things considered through rational decision-making. This view point advances the notion that prescription could be used at various levels of GBS development (sub- goals) to serve as target and to provide a focus for the designer without conflicting with the idea of goal-setting within a risk-based framework.

[3] ISO/CD 19904 (2001) – page 62.

*[4] For fatigue-sensitive locations where the possibility of close-up inspection in dry and clean conditions exists and the consequences of an eventual failure are deemed non-substantial hence of **low risk**.*

*[5] For fatigue-sensitive locations which are not-accessible and for which the consequences of failure are considered substantial, hence of **high risk]**.*

III.4 REQUIREMENTS:

4 Requirements verifying fatigue life is to be not less than design life.

5 Effect of uncertainties/assumptions on fatigue life. A criticality factor to be introduced in the requirements. The computed damage ratio to be multiplied by the criticality factor. Areas known not to have a fatigue problem will have a criticality factor of one. Areas prone to fatigue and areas critical for the survival of the vessel to have a criticality factor above one (to account for uncertainties).

[Japan]
First, as we pointed out previously, the assumed environmental condition of the North Atlantic involves suitable safety margin. Second, because of the nature, fatigue damages propagate in various time spans, not uniformly, and those exceeding critical size (small number) can be detected and repaired under the normal survey and maintenance regime (Fail-safe Design). Therefore, from survival of the ship point of view, there is no critical area insofar as fatigue is concerned.

[Greece2]
We have addressed above the North Atlantic and remain that recurring damages in – by now – well known areas should be eliminated. It is not appropriate to allow in the design cracks to develop within the first 5 years of life (or for that matter during the ships design life provided the structure has not corroded below net scantlings) and then have the operator or surveyor inspect/locate and repair them. Expected and predictable defects should be eliminated at design and construction so that the ship operator can deal with unexpected defects. A continuous virtuous circle (learning curve) should be established so even the originally unexpected defects are eliminated in future designs. As previously said we cannot rely on the possible detection. A crack is not always detectable since the structural areas are vast. A rapid crack propagation and Domino Effect may take place well before the initial crack is identified. Again the concepts of "zero tolerance" and safeguarding the image of our industry should be guiding.

[Greece1]

6 Data, including the source, used to determine acceptable fatigue life; e.g. stress, number of cycles, level of confidence, etc. (NOTE: Please note that even though the probability of occurrence of the loads is 10-8 according to the rules the probability of occurrence of the stress is much higher than that (stress being the ratio between moment and section modulus; both the moment and the section modulus through the corrosion process are random variables with different probability distributions). As steel corrodes the section modulus changes according to the corrosion rates etc. Presently rules do not consider this deterioration and they take the distribution of moment/load and stress to be the same (other than a factor). In reality this is not true and the stress has a higher probability of occurrence than 10-8. The stress has a probability of a few orders of magnitude higher than 10-8.)

[Japan]
As for IACS CSR adopted on 14 December 2005, global and local stress increases due to corrosion is taken into consideration explicitly.

[Greece2]
Unfortunately not in a realistic manner. For example the rules assess global strength basis net scantling plus half of the lifetime corrosion margin (despite different advise from our current wording of GBS Tier II, paragraph II.3.1 "Structural Strength") while for fatigue assessment in tankers 3/4ths of the lifetime corrosion margin is added to net scantlings for the fatigue assessment. For the fatigue assessment of details (with the only rule-required detail to be checked in Tankers being the hopper knuckle connection) it is assumed in the rules that the connection remains coated for 20 years and uncoated for only the last 5 years. And this without any coating specification being part of the rules. Furthermore, if the designer specifies grinding, he can increase the fatigue life produced by the assessment by a factor of up to 2. With the above allowances, it seems it will be challenging for any designer to come up with a design detail that will not pass fatigue assessment. We cannot see, under these circumstances, how anyone can hope for an improvement of the present fatigue crack defect record.

[Greece1]

7 Structural elements, including identification of critical design details, required to be included in evaluation of ship's fatigue life.

8 Evaluation and modelling to include the whole ship and take into account slamming, dynamic, vibratory, sloshing effects, secondary and tertiary stresses.

[Japan]

As for the slamming and vibration, there is neither reasonable method to assume the number of encounter nor recognized method to estimate the level of impact load and its distribution, and working stress level. Considering the level of state-of-the-art technology, these effects are to be incorporated into total safety margin.

[Greece2]

We feel uncomfortable to be put in a position to have to indicate to Japan (with its huge respectable research in ship design) that the above stated problems are either solved or extremely progressed and can be immediately applied.

- Slamming: all major classes include in their formulations, expressions for slamming loads and their distribution. This work was pioneered by the Japanese Dr. Ochi.
- Wave Induced vibrations: can be critical for bulk carriers and it has been found that they can contribute as much as 50% on fatigue damage. Methods for their estimation are well established. Yet, this crucial component, potentially producing half of the fatigue damage, is totally ignored.
- Sloshing: Developments in experimental and analytical techniques have enhanced the state of the art in sloshing predictions.

As for secondary/tertiary stresses, this is a long solved problem. All these effects could be incorporated into a total safety margin, but this cannot be done without checking and estimating the individual effect of each one of them. And certainly it cannot be done if we insist that fatigue life need not be more than design life, or that North Atlantic (as actually is applied) is enough margin.

[Greece1]

Link: II.3 Fatigue life

II.6 PROTECTION AGAINST CORROSION

[BACKGROUND INFORMATION - (From: work by Greece during evaluation of IACS new common structural rules)

TABLE 1 INDICATIVE COMPARISON TABLE OF YEARLY CORROSION WASTAGE mean values (mm/year) - see notes below

CORROSION ADDITION – BALLAST TANKS	DNV[1] ProjectD mm / 10 years	DNV[1] ProjectD mm / year	Corrba[2] (reduced for 5 years to coating breakdown)	Safety at Sea Ltd[3] (submitted data)	TSCF[4] (reduced for 5 yrs to coating breakdown)	Present class rule ABS (cape)	Present class rule ABS VLCC	Present class rule ABS Pmax BC	IACS NEW 1ST Draft	Indicative Average of data	Proposed rate	Proposed mm for 25 year life w/ maint. Excluding 0.5 mm
Location												
Deck plating	2	0.20	0.23		0.24	0.36	0.20	0.21	0.12	0.22	**0.22**	5.5
Deck Long.Web	1.8	0.18	0.23	0.40	0.50	0.38	0.25	0.25	0.12	0.28	**0.28**	7
Side Plate, upper.2m	3.5	0.35	0.26			0.24	0.20	0.20	0.09	0.24	**0.22**	5.5
Side Plate, rest	2	0.20	0.15	0.15	0.13	0.23	0.28	0.20	0.07	0.22	**0.20**	5
Side Long. Web	2.4	0.24	0.23	0.27	0.48	0.25	0.20	0.15	0.076	0.24	**0.24**	6
Bottom Plating	1.5	0.15	0.15	0.25	0.12 one side	0.19	0.25	0.19	0.07	0.19	**0.19**	4.75
Bottom Long. Flange	0.8	0.08				0.15	0.25	0.15	0.076	0.16	**0.20**	5
Bottom Long. Web	1.4	0.14		0.25		0.15	0.16	0.15		0.15	**0.22**	5.5
Lon. Bkh. Plate, upper 2 m	2.3	0.23	0.19	0.38 (heated)		0.20	0.23	0.16	0.076	0.23	**0.23**	5.75
Lon. Bkh. Plate, remaining areas	2	0.20	0.19	0.25	0.16	0.20	0.23	0.16	0.06	0.23	**0.23**	5.75
Longit. Bkh. Longit. Web, upper 2 m	3	0.30	0.30	0.25	0.56	0.15	0.16	0.16		0.30	**0.28**	7
Longit. Bkh. Longit. Web, remaining areas	2.3	0.23	0.23	0.25		0.15	0.16	0.16		0.23	**0.23**	5.75
Longit. Bkh. Longit. Flange	1.6	0.16	0.15		0.32		0.23			0.22	**0.22**	5.5
Deck and Side Transv. Web Plating, up. 2 m	3.5	0.35	0.30	0.28	0.30(avg. deck/sides)					0.30	**0.30**	7.5

Transv. Web Plating, other categories	*2.1*	*0.21*	*0.23*	*0.25*	*0.34*	*0.18*	*0.18*	*0.14*	*0.076*	*0.22*	***0.22***	*5.5*
Trans. Bkh. Plate	*1.9*	*0.19*	*0.19*	*0.25*	*0.32*	*0.20*	*0.22*	*0.31*	*0.076*	*0.25*	***0.25***	*6.25*

(1) CORROSION, IMPACT ON MODERN SHIP DESIGN, DNV, PAPER SERIES No. 2000 – P008, June 2000, (2) CORRBA Project: DNV, Marintek, Norges forskningsrad,1998, (3) Safety at Sea Ltd, Glasgow, IMO submission MSC 78/INF.6, Appendix A4, (4) Guidance Manual for Tanker Structures, Issued by TSCF in co-operation with IACS, Witherby & Co. Ltd, 1997

NOTES regarding data of Table 1.

1. *Above data refers only to uniform wastage and excludes localized pitting/grooving which proceeds at much higher rates.*
2. *The original higher Corrba and TSCF values could be used instead of the above reduced values due to coating since, for a typical specification ship, coating breakdown at edges, welds etc develops within 1 – 2 years. However to be very conservative, since Corrba and TSCF reported rates of corrosion for uncoated (after coating breakdown), a 5 year "no corrosion period" was added and values were reduced accordingly. (Wang et al, ABS, OMAE 2003 advise that ABS study data is at the high end of the original TSCF data.)*
3. *It must be pointed out that corrosion proceeds a lot faster in damaged areas of coating rather than in a totally non-coated tank. This is an additional reason that the above Corrba and TSCF rates of table 1 should be regarded as very conservative (low).*
4. *It is noteworthy that the empirical data from the shipping industry (Safety at Sea Ltd), based on class required renewals, closely agrees with Corrba and DNV projects and is more conservative than the TSCF data. Furthermore the data is in agreement with reasonable probabilistic models such as Paik's, when a reasonable COV (coefficient of variation) is chosen or when the exponential nature of corrosion rate is taken into account.*
5. *Corrosion wastage rates increase exponentially with the age of ship (to mean values of 0.50 – 0.60 mm/year from ages 20 to 25). This is not reflected in the above projects due to limited data for ships over 20 years old. Therefore for an adjustment of corrosion margin from ships of 20 year design life to 25 year design life, it is not sufficient to simply multiply the above average mean rates by 25 years (since they are mean rates of 20 year life ships). For proper corrosion additions to 25 year design life ships, the mean rates should be increased to account for the large end life increase and subsequently multiplied by 25. This was not done above in arriving at the proposed rates.*
6. *Considering all the conservative reductions and assumptions as per notes 1,2,3,5 above, the proposed rates should be considered as very conservative (low) resulting only if good maintenance of steel is performed throughout the ship's life.*

BULK CARRIER HOLDS		***DNV mm / yr Ref. 1***		***Safety at Sea Ltd (submitted data)***		***Present class rule (cape)***			***IACS NEW***		***Proposed rate mm/year***	***Proposed mm for 25 year life with maint. Excluding 0.5 mm***
Frames		*0.30*		*0.27*		*0.16*			*0.10*		***0.28***	*7.0*
Tanktop				*0.25*		*0.38*			*0.16*		***0.30***	*7.5*
Top hoppers				*0.27*		*0.21*			*0.10*		***0.28***	*7.0*
Bottom hoppers				*0.27*		*0.28*			*0.16*		***0.28***	*7.0*
Trans. Bulkheads mid				*0.27*		*0.28*			*0.16*		***0.28***	*7.0*

II.6 REQUIREMENTS

III.5. PROTECTION AGAINST CORROSION

3 Mandatory use of coatings:

.5 Locations and/or spaces where coatings are required to be used,
.6 Types of coating including criteria for determining the type of coating to be used,
.7 Required coating life (GUIDANCE: 15 years) and criteria used to determine required coating life (e.g. secondary surface preparation, number and DFT of coats, number of stripe coats and locations of their application etc.) (NOTE: present DE work is relevant).
.8 Allowances where other corrosion prevention systems are also used.

[Japan]
The target coating life for the spaces other than ballast and void spaces should be agreed by IMO.

[Greece2]
Agree

[Greece1]

4 Voluntary use of coatings:
.4 Locations and/or spaces where permitted
.5 Criteria for selecting the type of coating
.6 Coating life and criteria used to determine the coating life.

4 Determination of the corrosion addition to develop "as built scantlings" in order that the ship structure scantlings do not fall below the net scantlings by the ~~[~~design life~~] [2nd special survey~~]. (comment: do not understand where the 2nd special survey came from; inserting such notions abolishes the already agreed concept of a 25-year "design life" functional requirement – ii.6.2 discussed extensively- already specifies "design life", since it was agreed lets keep it that way.) Include the following:
.4 Determination of corrosion rate based on ship type, location, cargo, loading, statistical data, etc. (GUIDANCE : almost all widely accepted studies show lifetime averages of minimum about 0.20 mm/year for coated ballast tanks, minimum 0.25 mm per year for dry cargo holds, based on normal/prudent maintenance)
.5 Time period, (comment: Is this needed? ii.6.2 already states "adequate for design life")
.6 Consideration of corrosion control measures.

Link: II.4 Coating life, II.5 Corrosion addition

[Japan]
These data have not been accepted by the majority including IACS.

[Greece2]
Please read the references of Table 1. The data is IACS data (DNV, present ABS rules, TSCF in co-operation with IACS, ABS studies – OMAE 2003 – reporting higher wastages than TSCF etc.). Even previous NK studies show 0.30 mean yearly wastage rates for bulk carrier frames. Why this data is not used in the new CSR is another story. Greece has done a detailed evaluation on the (improper) way that the original IACS-supported NKK study handled the (limited) data to arrive at miniscule corrosion margin requirements. On that subject, Greece will not accept the new CSR reduced corrosion margins (which throw away all respected previous class and industry

studies and experience) and which in reality will lead to increased steel replacements and early scrapping of vessels. Among other problems, this constitutes a misrepresentation of the stated design life of 25 years. It is hoped that this item, along with few other crucial items, will be corrected before application of the new CSR, despite the recent IACS Council approval of the rules.

[Japan2]
Japan would like to make a supplemental explanation to its previous comment in order to avoid misunderstanding. In the proposed text, the rate of corrosion such as 0.20 mm/year is described as guidance in page 17, and its supporting data are shown on pages 15 and 16. Those data are based on several reports which have made by some IACS members previously. However, on evaluating the actual data about the rate of corrosion, we should care about the actual corrosion environment of the subject ships. For example, MARPOL has revised several times and new ships cannot be suffered the same corrosion environment as pre-MARPOL vessels. It should be noted that the extreme rate of corrosion mentioned above was obtained without distinguishing pre-MARPOL ships and post-MARPOL ships. To our understanding, IACS has therefore excluded such extreme and too unrealistic rate of corrosion from new CSR developed for the next generation ships.

[Greece 3]
The rate of 0.20 mm/year refers to coated ballast tanks of both tankers and bulk carriers. Existing studies converge to 0.20 – 0.30 mm/year for mean/average rates of coated ballast tanks (meaning that the first years when coating is intact the rate is nil, and after coating breakdown, the rate is higher than these values). Such data is also confirmed by the actual industry experience based on steel renewals due to wear. Thus 0.20 is not "extreme" as Japan states but the lowest limit of what the studies found. For the present rule ships this means 4 mm corrosion margin (0.20x20 years) which is just about what the current rules offer (in general being 25% of original plate thickness). For ships of 25 years design life the margin should be set in ballast tanks as 5 mm (0.20x25years). The problem is that the new IACS (25 years) CSR specify only 3 mm margin in ballast tanks, i.e. less than current 20 year rules. Why? Well, because they are based on a new NKK study which, among many other data exclusions, excludes all data from pre-MARPOL ships, as Japan correctly states.

However, there is no valid reason to exclude pre-MARPOL ships since MARPOL did not alter any coating requirements. The permanent ballast tanks of most pre-MARPOL ships were coated with hard epoxy coatings and thus the information derived from such data is crucial in evaluating coated wear rates. Excluding pre-MARPOL ships means that we examine data only from very young ships and thus the results of such analysis cannot be correct. This is exactly what happened. The picture (from an IACS presentation of the new study) shown at annex clearly shows this. All valuable pre-MARPOL tanker data (left) has been excluded, resulting in examining data of only few new ships (right), built mostly after 1992. Only one tanker in the remaining data is more than 12 years old. One could argue that only data from tanks alternatively loaded with ballast and oil cargo could be excluded, but what is the logic to exclude data from pure cargo tanks, permanent ballast tanks or external deck, bottom and side shell (other than to reduce the age of your sample?) Similarly data of all bulk carriers not having been originally built with epoxy hold paints has been dropped out, also eliminating most pre-1992 bulk carriers.

The above was just one of the methods used for huge deletion of data. Many other data exclusions were applied, under various "justifications", with several standard deviations being dropped, before fitting a probability curve. The remaining data obviously has no relation to reality and of course explains why only this latest "study" gives miniscule results when compared to all previous class studies. Thus, the recent statements by some of 90 or 95% confidence levels in the CSR corrosion margins are meaningless. As one example, the above pre-MARPOL diagram for COT bottom plate shows that the 95% confidence level requires a 6 mm corrosion addition to the bottom plate and the 85% level requires 4.2 mm. Even the reduced data of post-MARPOL diagram requires 5 mm margin for 95% (red line). The CSR apply only 3 mm margin to the bottom and keel plates. The issue of corrosion additions and some other crucial CSR subjects will need to be corrected before starting to apply these CSR for the next generation ships. Greece in co-operation with Greek shipping industry will soon publish a list of items requiring correction in the new CSR with appropriate technical justification. Such issues at present refer to the new CSR but will soon be very relevant in the context of Goal Based Standards. Would the setting of corrosion margins according to the above described CSR methods, for ships of 25 year design life, be acceptable to the Verification Authority?

[Japan3]
Japan firmly believes that the requirements on corrosion addition shall be decided based on the corrosion environment which new ships are expected to be encountered. In this regard, it is not appropriate to take into account all the data of pre-MARPOL ships to make requirements on corrosion addition for new ships.

[Greece1]
III.6. WATERTIGHT AND WEATHERTIGHT INTEGRITY

2 Evaluation to determine adequate watertight and weathertight integrity of the ship. Include the following:
- .1 Criteria for determining which openings in ship's hull are required to be watertight or weathertight for a ship operating in the environment from III.1.
- .2 Criteria for determining strength and redundancy requirements for the closures of the watertight and weathertight openings based on environment and design life from III.1.

Link: II.8 Watertight and weathertight integrity

III.7. DESIGN TRANSPARENCY

2 Provisions that make "design" and "as built" drawings and information, sufficient to verify compliance with classification society rules, available to builder, owner, operator, and/or Administration, as appropriate. Include the following:
- .3 Details for "Ship Construction File" to include:
  - a) Areas requiring special attention throughout ship's life
  - b) All Design parameters limiting the operation of ship
  - c) All areas or structural details for which alternate methods to rule standard wording have been used in the design and construction.

[Japan]
The definition of "rule standard wording" is vague. There is no need to specify structural details other than "rule standard wording" provided that those satisfy the rule of alternatives, which complies with GBS, too.

[Greece2]
By rule standard wording we mean the exact wording of the rule. In some cases, this wording is followed by the statement "other methods may be acceptable and will be examined on a case by case basis". Once an alternate calculation/method is done, there is no record on the ship final

plans. Our request has to do with transparency, and also easy monitoring of whether the "alternate to rule method" was as successful and reliable. Did it produce cracks? In such case immediate feedback could be passed to the class society that initially approved it, to cease allowing the particular alternate method.

[Greece1]

d) To be developed…

.4 Provisions for protection of intellectual property.

.5 Where rules allow alternate methods, set clear and scientific direct stress criteria and techniques. If these alternate methods were used in design, same to be clearly indicated with detailed calculations demonstrating equivalency to rule standard wording.

Link: II.9 Design transparency

III.8. CONSTRUCTION QUALITY

3 Determination that a shipyard's construction procedures and practices meet a minimum level of quality. Include the following:

.3 Criteria used to determine the minimum level of quality, that includes but is not limited to:

.1 Selection of materials and specification for materials manufacturing,

.2 Assembly, including alignment, joining, welding, surface preparation, coating, castings, heat treatment, etc.

.3 IACS Shipbuilding and repair quality standards

.4 Approval of welding shop by class.

.4 Actions taken when a shipyard is determined as not meeting the minimum level of quality construction

4 Provisions when "as built" is different than "design." Include the following:

.1 Criteria for determining when review of the "as built" drawings is required.

.2 Criteria for determining when re-evaluation of net scantlings for strength and/or fatigue life is required

Link: II.9 Construction quality procedures

III.9. SURVEY

2 Survey requirements, including the development of a Survey Plan, during ship construction sufficient to verify the ship is constructed in accordance with the classification rules, including:

.1 Types of surveys (visual, radiograph, etc.) depending on location, materials, welding, casting, coatings, etc.

.2 Provision of construction schedule for major parts before keel laying describing major construction phases to delivery

.3 Provision of rough next monthly schedule of inspections at each end of month.

.4 Provision of detailed weekly schedule of inspections

.5 Frequency of surveys

.6 Criteria for acceptance

.7 Interaction with shipyard, including notification and documentation of survey results

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.8 Determination and documentation of areas that need special attention throughout ship's life, including criteria used in making the determination.

3 Provisions for providing shipowner representatives results of construction surveys. Technical Correspondence between yard and class relating to vessel to be advised and made available to the owner. Similarly technical correspondence between yard and equipment makers to be advised and made available to class and owner.

[Japan]
Design transparency is deemed to be necessary; however, above draft 3.9.2 proposed by Greece contains technical matters in relation to intellectual property rights and price negotiation. Therefore draft 3.9.2 proposed by Greece is not adequate for provision as Tier III.

[Greece2]
We respectfully disagree. Such wordings are quite usual for many years in shipbuilding agreements worldwide and such intellectual property problems have not surfaced.

[Greece1]
Link: II.11 Survey

III.10. ACCESSIBILITY

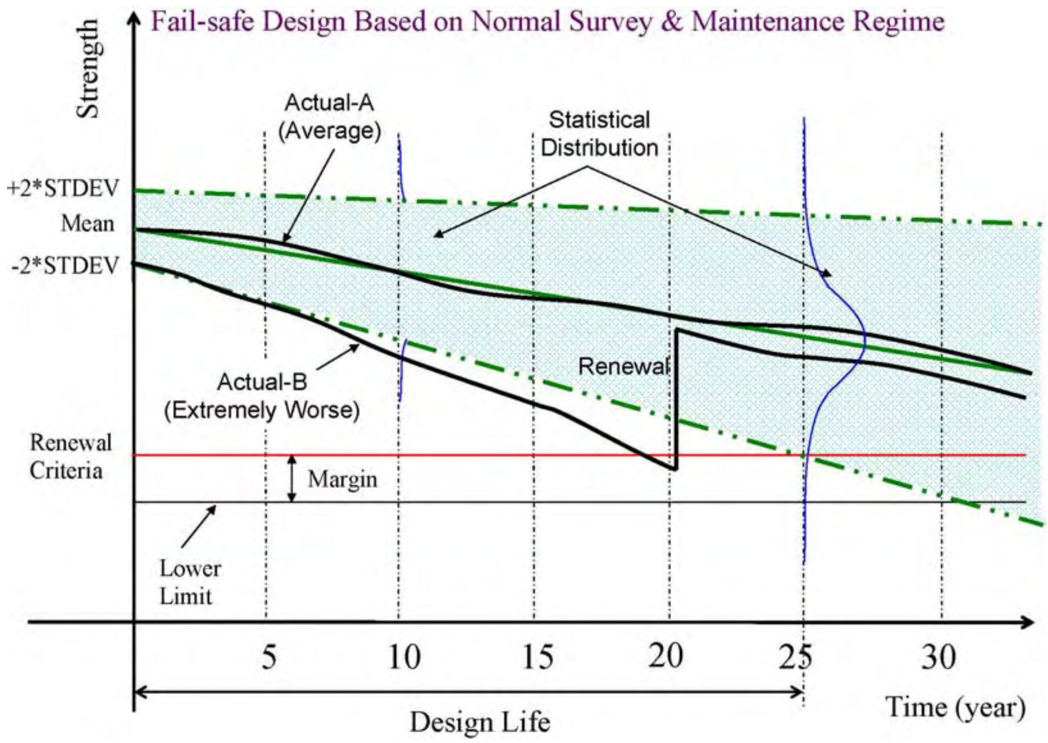
2 Evaluation to determine adequate access is provided for the internal structure for maintenance and to facilitate close-up inspections and thickness measurements. Include the following:

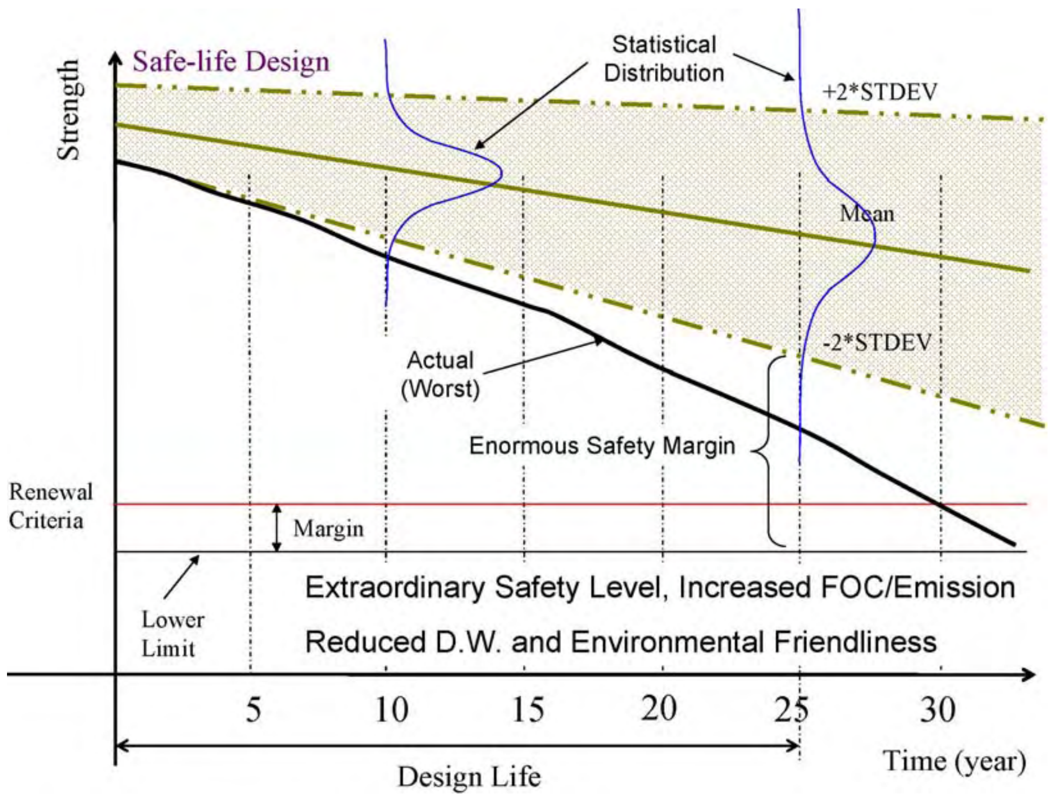
.3 Criteria for determining acceptability of access
.4 Requirements for development of an Access Plan.

Link: II.12 Structural accessibility, II.13 Maintenance

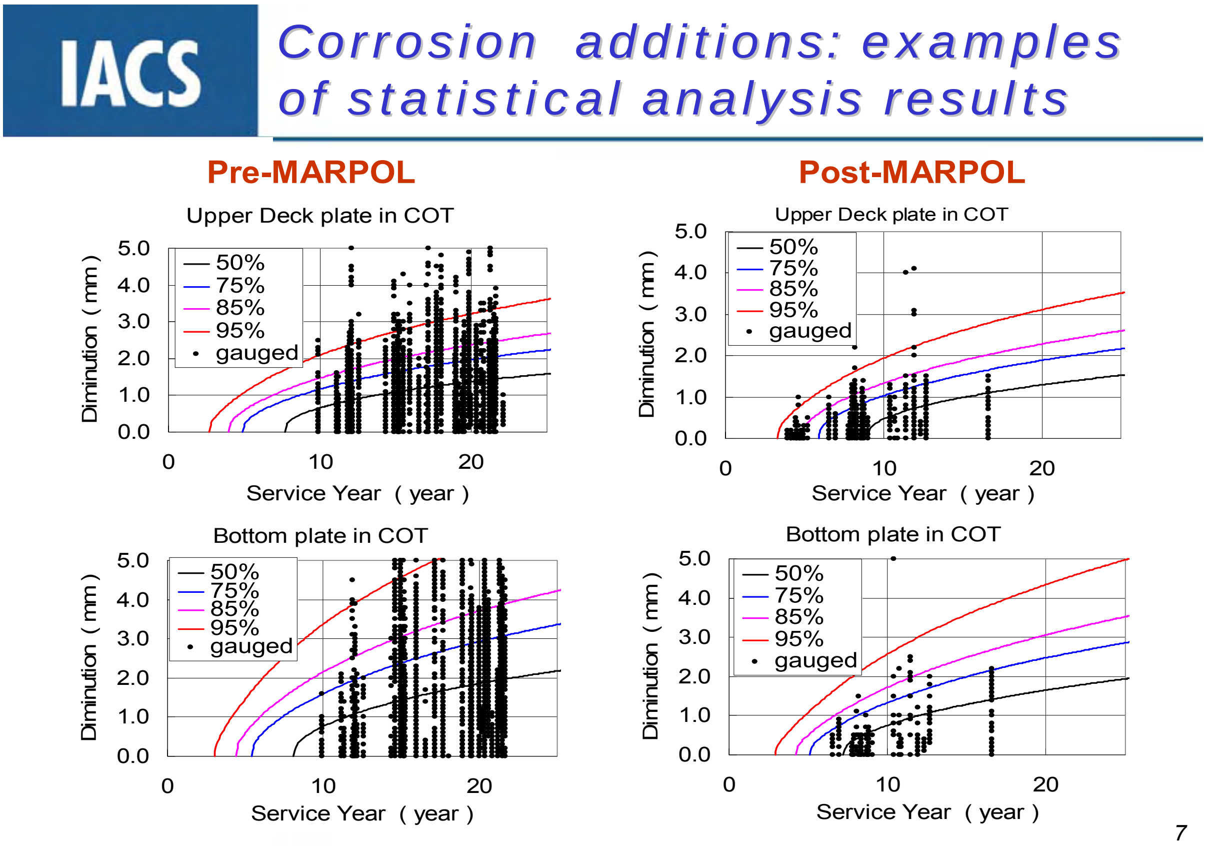
Annex

[Japan]


Fail-safe Design Based on Normal Survey & Maintenance Regime
Strength
Actual-A
(Average)
Statistical
Distribution
+2*STDEV
Mean
-2*STDEV
Renewal
Actual-B
(Extremely Worse)
Renewal
Criteria
Margin
Lower
Limit
5
10
15
20
25
30
Design Life
Time (year)


Safe-life Design
Strength
Statistical
Distribution
+2*STDEV
Mean
-2*STDEV
Actual
(Worst)
Enormous Safety Margin
Renewal
Criteria
Margin
Lower
Limit
Extraordinary Safety Level, Increased FOC/Emission
Reduced D.W. and Environmental Friendliness
5
10
15
20
25
30
Design Life
Time (year)

[Greece]



Japan and Greece

Note: Japan also provided comments on the text in the co-ordinator's original proposa, which follows the notation:** [Japan]**. Japan used the following to identify proposed revisions: Strike through (~~strike through~~) to show text to deleted, underlined indicates additional text or revision, { } shows examples specific to new oil tankers and bulk carriers in unrestricted navigation, and highlighted text indicates proposed acceptance criteria. Greece responded to Japan's proposal and Greece's comments are indicated as** [Greece]**.

[Greece]
General Comment: We find the Japanese proposals constructive and substantive. Without going into details, we found ourselves to agree with the majority of the proposals even if found somewhat general (noting our comments above for more specifics for which Japan, with its huge newbuilding research and experience, could contribute significantly). Many of these agreeable comments (in areas not previously addressed by Greece) could be included in the draft text, and other comments could be included in addition to our already proposed comments.

[Japan]
Draft Tier III – Verification of Compliance
(Applicable to new oil tankers and bulk carriers in unrestricted ~~service~~ navigation)

Reason:
Above term was agreed at MSC 80.

A classification society [recognized by an Administration in accordance with XI/1] shall have its rules verified as complying with the Tier I Goals and Tier II Functional requirements by submitting to the [verification authority], a copy of its rules and information to address the following items:

III.1. Design life and environmental conditions

1 Formulation and/or source of sea state data (scatter diagrams, etc) including date of data and geographical location represented by the data,

2 Descriptions of how the design life, environmental conditions and sea state data ~~is~~ are used to develop the equations and scantling requirements for strength and fatigue,

Reason:
Information related to "design life" and "environmental conditions" should also be addressed.

3 Justification that sea state data represents design life {25 years} and environmental condition {the North Atlantic},

Reason:
Generalized description considering future expansion of Tier III applicable to all types of ship.

~~4 All locations in the rules where design life and environmental conditions are cited.~~

Reason:
It is obvious that almost all of rules are related to design life and environmental conditions including sea state data implicitly or explicitly.

[Greece]
The point is understood, however we feel that the more clarity and transparency, the better even if it leads sometimes to redundancy. In this case such a list of the foundations of design will be useful from many aspects.

[Japan]
Link: II.1 Design life, II.2 Environmental conditions

III.2. Structural Strength

1 Evaluation to determine net scantlings are sufficient to withstand the following failure modes: excess deformation, yield, buckling and fatigue. Include the following:

.1 Data, including justification, on the acceptable limits of ~~deformation,~~ yield, buckling and fatigue,

Reason:
General precaution against excessive deformation is already stated in II.3 and III.2.1. On the other hand, actual effect of relative deformation on any structural member can only be counted as secondary strain/stress added to primary strain/stress caused by direct loads. Primary and secondary strain/stress can be assessed inseparably against yield and fatigue criteria. In addition, acceptable limits of the deformation of any structural member depend on the deformation of adjacent structural members, member properties and span of the structure(s) passing through those structural members, and connection details. Therefore, it is too much complicated to

specify the rational deformation criteria for the various cases. The independent criteria for deformation could be found in the old-fashioned rules, however, have almost disappeared from modern rules after employing detailed strength calculation by FEM.

[Greece]
We would not delete the limits on deformation. It may be not easy to compute the deformation (/deflections), but this should not be reason to delete the limit. Especially since FEM alone as presently applied in bulker and tanker design cannot replace in itself the requirement. Previous rules used very successful rule-of-thumb (practice-tested methods) such as maximum floor distance should not exceed x meters. Today some classes have implicit deformation criteria by specifying for example minimum depth of a deep member. In essence they specify a minimum inertia (i.e. limit on deformation). Such rules cannot be abolished unless new reliable methods are applied. The present defect record (*) calls for immediate corrective actions, and it is sad that the new CSR do not address the subject (of relative deflections). All engineering sciences incorporate limits on deformation. See for example deformation limits in the civil engineering discipline. It would be very instructive to study what other sciences have done on this subject.

(*) see “Structural Defect Experience”, 16 August 2005, available from JTP site, dealing with the so far defect experience of Double Hull tankers. The average age of the world fleet is reported to be 7 years old. 50% of the world fleet is less than 5 years old and 80% is less than 10 years old (page 6). The shocking findings are as follows :

Quoting from page 12: **“One in four ships in the sample are reporting defects in the first five years of life. Two out of three ships with defects, are reported before their tenth anniversary.”** These above stated defects are in their majority fatigue cracks (two out of three - and thus something drastic should be done in the fatigue front of the new CSR - but it didn’t) but also one in 10 defects are **deformations** not related to wastage.

The above defect record, is just one confirmation of the urgency and importance of our work. If things were A-ok in ship construction, we would not need to be here. By the same token, it is not appropriate to try to keep the status quo of ship construction and resist strengthening and quality improvements. It is also disappointing to see that, the new CSR, although stating that they take this defect record into account, do not actually introduce measures to correct these fatigue deficiencies and have resisted proposals by Greece to that effect. All of the above ships were designed basis North Atlantic. It has been claimed many times that this alone is sufficient margin and no improvements in strength and fatigue are needed. If that was the case why one in four ships develop structural fractures and buckling before age 5? Obviously “N.Atlantic” has not helped. As Greece has pointed out, North Atlantic would be a good design basis if it was applied properly. However when it is diluted seriously by the time it finds itself into the design formulae, it is no more North Atlantic. And before worrying about maintenance (whose lack of, will produce defects at older ages) we should worry more about fixing problems evident from day one of a ship’s life.

[Japan]

.2 Safety factors in conjunction with assumed design load(s) and calculation procedure including structural modelling, with justification why they are appropriate,

Reason:
Adequacy of safety factors can be meaningful and verified only in combination with both the level of assumed loads and strength calculation procedure.

.3 Loading conditions, including: homogeneous, partial, alternate loads, multi-port, ballast conditions including ballast management, and loading and offloading are included in the evaluation,

.4 How workmanship and construction ("as built") design features are accounted for in the evaluation,

~~.5 Acceptable limits on continuity of structural members, and~~

Reason:
Continuity of structural members can be quantified only based on yield and fatigue criteria, being similar to the effect of deformation as mentioned above.

[Greece]
Continuity is very important to be defined by specific criteria. See for example the previous ABS rules for stringers in the forepeak. They require to be "extended" by brackets for 3 frames aft of the stringers. If there are no specific requirements each builder will do what is most convenient. Again the defect record does not support the relaxing of this, very simple and easy to comply with, requirement (which unfortunately the new CSR do abolish).

[Japan]

.6 ~~Structural members included in the evaluation~~

Reason:
Almost all of structural members are, to begin with, subject to the evaluation.

Addition of (Draft) Acceptance Criteria

Reason:
See Appendix of this paper

Acceptance Criteria for yield, buckling and fatigue strength

Yield, buckling and fatigue strength criteria should be clearly provided for global hull girder strength, local strength of significant structural members within vital compartments and fatigue strength taking into account the following provisions.

.1 Hull girder longitudinal bending and shear strength

.1 Any structural members constituting hull girder should be required not to yield or buckle against maximum hull girder bending moment and shear force expected within the design life, except for, in principle, limited local area such as edge of openings, with suitable safety margins. Minimum acceptable section moduli of both deck and bottom to be maintained throughout the service life should be specified in Tier IV.

.2 Hull girder longitudinal bending moment and shear force at specified transverse section in both sagging and hogging conditions should be considered. Assumed still water bending moment and shear force should cover all loading conditions specified in the standard loading manual. Wave bending moment and vertical shear force should be defined by using statistical prediction based on the long-term sea state scatter diagrams in the design environmental conditions.

.2 Strength of primary structure

.1 Primary structure, which might lead directly to total breaking of hull girder, for instance double bottom structure and bulkhead structure (within cargo block), should be required not to yield or buckle against design loads, except, in principle, limited local area such as edge of openings.
.2 Assumed wave load should be defined by using statistical prediction based on the long-term sea state scatter diagrams in the environmental conditions.

.3 Fatigue strength

.1 For the typical members at high risk of fatigue damage which might lead to marine pollution by cargo outflow (oil outflow from the cargo tank) or seawater ingress into large compartment, fatigue life evaluation should be required.
.2 Assumed loading conditions should represent the most frequent conditions throughout the design life.

2 Evaluation to determine the main hull girder (plates and stiffeners) at net scantlings provides sufficient ultimate strength. Include the following:
.1 Data, including justification, on acceptable limits of ultimate strength
.2 Safety factors, with justification why they are appropriate, and
.3 Structural elements included in the evaluation.

Acceptance Criteria for ultimate strength
Requirement of hull girder longitudinal ultimate strength should be clearly provided from the view point of bending strength, taking into account the following provisions.

.1 Hull girder longitudinal ultimate strength

.1 Hull girder longitudinal ultimate bending capacity should be required to survive against the extreme hull girder longitudinal bending moment.
.2 Hull girder longitudinal bending moment should be assumed for sagging condition and/or hogging condition as the case may be. Still water bending moments in typical loading conditions should be covered. Extreme wave bending moment should be defined reasonably by using statistical prediction based on the long-term sea state scatter diagrams in the design environmental conditions.

3 Evaluation to determine compatibility for cargo loading and offloading without unrealistic operating conditions, including criteria, with justification, to determine acceptability.

4 Evaluation to determine that ~~failure~~ localized damage of any one stiffening member ~~of side shell, main longitudinal or transverse bulkhead, web frame or main longitudinal stiffener does~~ will not ~~result in~~ lead to ~~further structural failure~~ immediate consequential failure of other significant structural members.

Reason:
This is to follow the discussion results of MSC 80 in principle.

[Greece]
The new SOLAS XII, regulation 6.5.3, intended and narrowed for operational damages has little connection with our present effort to develop proper and all-encompassing GBS requirements.

[Japan]

5 Evaluation to determine that the structure can withstand, without further structural failure, the structural damage for those conditions from the damage stability analysis where the ship survives (s = 1.0). Include the following:

.1 ~~Limits, with justification, on the environmental conditions and period of exposure.~~ Assumed actual foreseeable scenarios, with justification why they are appropriate.

Reason:
Even if "environmental conditions" and "exposed period" are submitted, it is very difficult to verify them in accordance with Tiers I and II.

[Greece]
Hopefully when Tier II and III are finalized they will be specific enough to allow such verification.

[Japan]
~~.2 Acceptable limits of deformation, yield, buckling ultimate strength and if different than those in III.2.1.1, with justification.~~

{Acceptance Criteria for residual strength in flooded condition

.1 Residual strength of hull girder in flooded condition
.1 Hull girder longitudinal ultimate bending capacity of bulk carrier designed for the carriage of solid bulk cargoes should be required to survive in one hold flooded condition.
.2 Both still water bending moment in one hold flooded condition, and statistical wave bending moment of reasonable level of occurrence should be considered.

.2 Residual strength of significant structural members
.1 Significant structural members of bulk carrier designed for the carriage of solid bulk cargoes should survive in one hold flooded condition not to lead to immediate collapse of other significant structural members.

.3 No requirement is given to oil tanker.}

Link: II.3 Structural strength, II.5 Residual strength, II.7 Structural redundancy

III.3. Fatigue life

1 Requirements verifying fatigue life is to be not less than design life,
2 Data, including the source, used to determine acceptable fatigue life; e.g. stress, number of cycles, confidence ~~interval~~ level, etc.,
3 Structural elements, including identification of critical design details, required to be included in evaluation of ship's fatigue life.

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Link: II.3 Fatigue life

III.4. Protection against corrosion

1 Mandatory use of coatings:

.1 Locations and/or spaces where coatings are required to be used,
.2 Types of coating including criteria for determining the type of coating to be used,
.3 Required coating life and criteria used to determine required coating life,
.4 Allowances where other corrosion prevention systems are also used.

~~2 Voluntary use of coatings:~~

~~.1 Locations and/or spaces where permitted~~
~~.2 Criteria for selecting the type of coating~~
~~.3 Coating life and criteria used to determine the coating life~~

Reason:
It is unnecessary to specify any requirement for voluntary measures.

3 Determination of the corrosion addition to develop "as built scantlings" in order that the ship structure scantlings do not normally fall below the net scantlings by the ~~[~~design life~~]~~ ~~[2nd special survey]~~. Include the following:

Reason:
Extraordinary corrosion rate under the extremely corrosive environment and long-term poor maintenance cannot be covered by the initial corrosion margin. The periodical inspection and maintenance of sound level is the underlying premise of GBS.

.1 Determination of corrosion rate based on ship type, location, cargo, loading, statistical data, etc.,
.2 Time period,
.3 Consideration of corrosion control measures.

Link: II.4 Coating life, II.5 Corrosion addition

III.5. Watertight and weathertight integrity

1 Evaluation to determine adequate watertight and weathertight integrity of the ship. Include the following:

.1 Criteria for determining which openings in ship's hull are required to be watertight or weathertight for a ship operating in the environment from III.1.
.2 Criteria for determining strength and redundancy requirements for the closures of the watertight and weathertight openings based on environment and design life from III.1.

Link: II.8 Watertight and weathertight integrity

III.6. Design transparency

1 Provisions that make "design" and "as built" drawings and information, sufficient to verify compliance with classification society rules, available to builder, owner, operator, and/or Administration, as appropriate. Include the following:

.1 Details for "Ship Construction File", and
.2 Provisions for protection of intellectual property.

Link: II.9 Design transparency

III.7. Construction quality

1 Determination that a shipyard's construction procedures and practices meet a minimum level of quality. Include the following:

.1 Criteria used to determine the minimum level of quality, that includes but is not limited to:

.1 Selection of materials and specification for materials manufacturing,
.2 Assembly, including alignment, joining, welding, surface preparation, coating, castings, heat treatment, etc.
.3 Approval scheme of welding procedure
.4 Qualification scheme of welders

Reason:
It is very important for the selection of appropriate welding procedure and excursion of welding works carried out by the qualified and skilled welders to ensure the construction quality.

.5 Actions taken when a shipyard is determined as not meeting the minimum level of quality construction

2 Provisions when "as built" is different than "design." Include the following:

.1 Criteria for determining when review of the "as built" drawings is required.
.2 Criteria for determining when re-evaluation of net scantlings for strength and/or fatigue life is required

Link: II.9 Construction quality procedures

III.8. Survey

1 Survey requirements, including the development of a Survey Plan, during ship construction sufficient to verify the ship is constructed in accordance with the ~~classification rules~~ appropriate rules or standards, including:

Reason:
Other relevant rules, such as IMO and national requirements should also be addressed.

.1 Types of surveys (visual~~, radiograph~~, non-destructive examination, etc) depending on location, materials, welding, casting, coatings, etc.

Reason:
Generalized description is preferable.

.2 Frequency of surveys
.3 Criteria for acceptance
.4 Interaction with shipyard, including notification and documentation of survey results
.5 Determination and documentation of areas that need special attention throughout ship's life, including criteria used in making the determination.

~~2 Provisions for providing shipowner representatives results of construction surveys.~~

Reason:
It is considered necessary that results of construction surveys should be kept onboard throughout of ship's life from the viewpoint of "design transparency". Japan is of the opinion that the results of construction surveys are to be recorded in the Ship Construction File developed by the Organization. Japan believes that the details of "Ship Construction File" should be agreed by the Organization.

[Greece]
Do not agree with this deletion, and the above reasoning (which otherwise is agreeable) does not contradict with the notion of the owner representatives being advised during the construction.

[Japan]
Link: II.11 Survey

III.9. Maintenance

Proposal:
Japan is of the opinion that this draft provision of "accessibility" is preferable to be separated into two issues as we propose below, referring to the draft of "maintenance" and "accessibility" prescribed in Tier II.

1 Evaluation to determine adequate design and construction to facilitate ease of maintenance

Link: II.12 Maintenance,

III.10. Structural accessibility

1 Evaluation to determine adequate design and construction ~~access is provided for the internal structure for maintenance and~~ to facilitate overall and close-up inspections and thickness measurements of the internal structure. Include the following:

.1 Criteria for determining acceptability of access
.2 Requirements for development of an Access Plan.

Link: II.13 Structural accessibility

[Greece]
Do not really see the reason to separate into two items. Determining “adequate” design and construction is a vague term, bound to be problematic and subjective for the verification authority. The original clearer wording is preferred.

[Japan]
Appendix

Basic concept of acceptance criteria in Tier III
Applicable to new oil tankers and bulk carriers in unrestricted navigation
The purpose of Tier III provides procedures and acceptance criteria to verify that the rules, guidelines and codes given by classification societies and industries in Tier IV meet Tiers I and II provided taking into account safety of life at sea, protection of property and marine environment, and maritime security by the Organization. Acceptance criteria in Tier III should be provided to verify technical procedures and guidelines, classification rules and industry standards from the prevention view point of fatal structural collapse and consequent loss of life, property and marine pollution. Fatal structural collapse is such as total breaking (collapse) of hull girder and collapse of significant structure leading directly to total breaking of hull girder or equivalent. In order to verify whether the rules, guidelines and codes given by classification societies and industries in Tier IV can minimize the risk of such fatal structural collapse or not, following structural strength requirements should be submitted.

i. Hull girder strength, such as hull girder bending strength, hull girder shear strength and hull girder ultimate strength,
ii. Strength of significant structure within vital compartments, such as double bottom structure and bulkhead structure, which might lead to total breaking of hull girder directly,
iii. In addition, in order to verify whether the rules, guidelines and codes given by classification societies and industries in Tier IV can minimize the risk of massive water ingress into the vital compartments and cargo outflow into the sea, requirements of fatigue strength of significant structure within vital compartments should be submitted.

The following are comments received from other countries throughout the course of the correspondence group’s work.

Bahamas
It is suggested that the introductory paragraph is modified to read:
‘All Classification Societies, classifying ships covered by these standards, shall have their rules verified as complying with the Tier I Goals and Tier II Functional Requirements by submitting to the IMO: a copy of their rules for new ship construction dealing with the ships covered by these standards; and a document or documents demonstrating that their rules meet the Tier I and Tier II requirements. This demonstration shall include, at least, the following:’

In III.4.3 there are square brackets around design life and 2nd special survey. The aim must surely be that the ship should not fall below the net scantlings during its design life. To say that the scantlings should not fall below the net scantlings before the 2nd special survey is to say that at that 2nd survey, if the ship has deteriorated to the extent estimated in the original design calculations, the entire ship will need to be replaced. What we are trying to achieve is a ship which, if it deteriorates at the rate estimated at the design stage, will last for its design life without requiring steel to be replaced. In practice, because deterioration takes place at varying rates throughout the ship, certain parts may need replacement during the ship’s life, but we should not plan for that need for replacement at the design stage. Every effort should be made to minimize the need for steel replacement during the ship's design life.

Korea
Korea feels that the following items as drafted by the Chairman are in general appropriate, but with the following comments:

III.2. Structural strength

1 How do we control the workmanship? It seems to be quite a difficult job to make a regulation to evaluate the quality of the workmanship in the ship yards.

2 More clear definition for the ultimate strength is needed between the hull girder ultimate strength and the buckling strength of local plate with stiffeners.

3 This item for the loading and offloading has been already mentioned in III.2.1.3.

III.4. Protection against corrosion

2 The non-mandatory rules such as the voluntary use of coatings is not under control of the Authority.

3 The square bracket, [design life][2nd special survey] should not be removed from the CG's draft for the Committee's discussion because technical confirmation will be needed.

Norway
Draft Tier III – Verification of compliance
As Tier III is about verification of a document we do not think the mentioning of Tankers and Bulkers is relevant.

III.1. Design life and environmental condition

It seems as the term 'design life' is confused with the term 'return period'. We think the design life has so far not been defined. The impression is that most members of the WG think of this as 'expected time to scrapping'. However, the age of a ship at the time of scrapping is largely based on commercial consideration rather than safety and environmental protection considerations. (If repairing the ship is commercially attractive the ship will be repaired. If the market does not make repairing the ship attractive the ship will be scrapped). In any case, whatever definition is agreed this must not be confused with the term return period (the 25 year NA extreme Hs). As a general comment: The characteristic environmental loads will depend on the limit state. 25 year NA extreme applies to ULS.

III.2. Structural Strength

1. This should list limit states, and the order of the subparagraphs should be organized in a more logical sequence:
   i. Your 6
   ii. Definition of limit state criteria
   iii. Accident scenarios covered

iv. Environmental loading condition per limit state
v. Your 3
vi. Your 4
vii. Your 5
viii. Target safety level per limit state (should be in Tier I)
ix. Documentation of variabilities and uncertainties
x. Resulting partial safety factors

As state above we think a standard reporting format could be developed.

2. This is the same as 1 for ULS (hull girder) and should not be repeated. Subparagraph 4 refers to PLS and need not be repeated. Subparagraph 5 is also referring to PLS, and we can agree that what is included should be included, but ship collision is not the only accident scenario. (We think the paragraph is stating that a ship that survives a collision from a damage stability point of view should also have sufficient strength in damaged condition to survive – up to some yet undefined environmental load. This is a good point, but not the whole story).

In summary we think III.2 should be written as more high level principles, rather that some details, leaving other more important issues out.

III.3. Fatigue life

We are of the opinion that 'fatigue life' is not properly defined. With normal definitions fatigue life should be much longer than 'design life'. However, so far these terms are not properly defined. We do not think the fatigue limit state should be treated differently than other limit sates. The summary under III.2 applies.

III.4. Protection against corrosion

We agree that corrosion additions must be estimated by statistical analysis under the various conditions of actual protection. It is already clear from Tier II that scantlings should not fall below the net scantlings during the 'design life' with some yet undefined probability. For safety it is, however, more relevant to specify a probability for a survey period, as there is no independent verification in between. The 'design life' criterion is therefore also here mainly a commercial issue.

III.6. Design Transparency

We suggest that state of practice is described prior to discussing this, as we are unsure if the 'Ship Construction File' is a sufficiently well defined concept.

III.7. and III.8.

See comments on relation between Tier IV and V.

Panama

Regarding opening paragraph, receiving set of rule applied by class society may be a big task but one that administrations can cope with. Nevertheless, if is to be limited, at least general rules regarding tier II items need to be provided in order to carry out verification programme on behalf of the administration. Although most of the sections can be applicable to new designs, some mention of different design life criteria can be mentioned in III.1. It may be different depending on the novelty of the design. It has been noticed that under III.6 there is reference on ship construction file but the concept has yet to be decided and most importantly the entity in charge of its development. When discussing III.7 the subject of actions to be taken with a shipyard is determined as not meeting the minimum requirements is a difficult one. Towards whom are these actions directed. If is the shipyard then we would have a problem as they are not regulated by IMO. Also, only administrations where the yard is located have jurisdiction to act upon.

Poland

Comments referring to safety factors

The safety factors for specific modes of failure can be developed basing on the probabilistic approach and on the ship structures, which according to statistics have satisfactory safety records. The safety factors included in Tier II would precisely define the safety level for ship structure and they would influence the scope of information which is to be submitted for verification.

Spain

In order to enable the evaluators to assess whether or not the classification Rules, standards, etc., meet the criteria of Tiers I and II it is absolutely necessary that the "owner" of these standards submit together with the standards themselves, the data base used to calibrate their formulae, coefficients and safety factors used therein. It is obvious that every coefficient and particular safety factor has to be directly related to the present knowledge about the behaviour of the corresponding item of the structure. Therefore no matter how sophisticated a model of the item or structural detail may be, it will only be a model. To say only that a specific value has been used as a particular safety factor may be absolutely meaningless unless all the other assumptions used to evaluate the structural response are also known. On the other hand it must also be realized that any presently used modelling is subject to improvements on the basis of future enhanced scientific approaches and more comprehensive performance data are more accurately reported and interpreted. Indeed it well may be that the approach or the model being currently used by the "owner" of the standards might not be the most up-to-date available one. In principle we agree with the idea of Greece regarding the re-arrangement of the numbering system for the section, subsection, paragraphs, etc., in order to follow that of Tier II. However it appears that the word processor has modified the numbers and therefore we would use those which we understand are the right ones of Greece proposal, adding between brackets that in the Co-ordinator's original proposal when necessary. The proposed text is written with *our additions in italic* of the same font and the proposed deletions as strikeout.

Text:

III.1 DESIGN LIFE

4. Information, elaboration and references in the rules indicating that the concept of "Safe Life" design is being followed. Include estimated steel renewal amounts and locations to age *20* ~~22~~ (for guidance not to exceed [2%] of original lightship *provided it is not mostly concentrated in a specific zone*).
5. All locations in the rules where design life is cited. [First part of III.1.4 in C's O P]
6. To be developed…

Comments: Having studied the arguments raised by Greece and Japan we would like to state that we would agree with both on that "any failure of normal survey and maintenance regime should NOT lead to serious structural failure". We fully support the comment from Greece regarding the problems appearing on the first 5 years of life which in our opinion are clearly due in most cases to defective designing. We propose to indicate the 20^{th} anniversary (4^{th} Special Survey), rather than the 22^{nd} which comes around the subsequent Intermediate Survey and wish also to warn about the guidance limit on steel renewal proposed by Greece since a 2% of the original lightship concentrated in a tank or around some ship's girths may be indicative of the presence of very serious corrosion problems in that area. In summary we support Greece's proposal with minor modifications.

Text:

III.2 ENVIRONMENTAL CONDITIONS

13 Formulation and/or source of sea state data (scatter diagrams, etc) including *method and* date of data *collection* and geographical location represented by the data. [III.1.1 in C's O P]

14 Verification that the data collected reflects up-to-date information comparable and benchmarked with different sources of data collection (satellite images, weather modelling etc.) Elaboration and justification of data in case they come from automatic/buoy source or crew observations. (NOTE: There is an argument that the observed data are less reliable since in general ships try to avoid bad weather).

Comments: Upon review of the reasons provided by Greece ad Japan we feel that further research using real time data collection on several vessels is necessary to clarify the discrepancies between the presently controversial data. We adhere to Greece's proposal with a minor change in the wording of III.2.1.

Text:

15 Include effect of steep waves. Assess the possibility that the ship might encounter a very steep (rogue wave). What safety factors/provisions do exist to tackle this type of waves (high height to length ratio)

Comment: Just the proposal from Greece.

Text:

16 Descriptions of how the design life, environmental conditions and sea state data ~~is~~ are used to develop the equations and scantling requirements for strength and fatigue, [III.1.2 in C's O P]

Comment: Just the proposal from Japan.

Text:

17 Rules to specify when sea-keeping analysis (with realistic speed) is expected to yield higher results than the standard formulae. The sea-keeping results then need to be taken into account.

Comment: Just the proposal from Greece.

Text:

18 Justification that sea state data represents design life {25 years} and environmental condition {the North Atlantic}. [III.1.3 in C' O P]

Comment: We agree in principle with the proposal from Japan but subject to the comments raised by UK, which may lead to some additional clarifications.

Text:

19 All locations in the rules where environmental conditions are cited.[second part of III.1.4 in C's OP]

20 To be developed…

Comment: We agree with comments from Greece. We also feel that redundancy is beneficial.

資料4

Text:

III.3 STRUCTURAL STRENGTH

11 ~~Evaluation~~ *Information about the criteria used in the Rules* to determine *that the* net scantlings are sufficient to withstand the following failure modes: excess deformation, yield, buckling and fatigue. Include the following: [III.2.1 in C's O P]

Comment: We agree with IACS' interpretation about the intent of the requirement and propose the above text. We also concur with the re-arranging proposal from Norway but since it would be confusing to adapt our specific comments into Norway´ s scheme at this moment, we are keeping the original order.

Text:

.10 Data, including justification, on the acceptable limits of deformation, yield, buckling and fatigue. [III.2.1.1 in C's O P]

Comment: We basically agree with Greece in that we would not delete the limits on deformation. There are many elements and failure modes for which the design is not governed by the strength (stress), but by the stiffness (strain or deformation). We may refer as examples, the primary supporting members, which must provide adequate support to the secondary stiffeners as well as to contribute to the overall rigidity of the hull girder in order that it works as a girder (acting as tripping elements to keep the deck, bottom, shell and longitudinal bulkheads to work as the flanges and the webs of such girder). We would also refer to the racking as another problem which can be avoided by the presence of primary supporting members effectively connected or partial bulkheads. None of this cases is governed by the stress levels on the primary members. We furthermore would point out to the vibrations and to the operational limitations for machinery and equipment, which can be avoided by providing adequate stiffness. It is now frequent to find people who just rely on the stress output of FEM analyses without paying attention to the effects of the deformations, which indeed may affect to the way in which the loads are acting on the structure. This is a big risk and may lead to face again the same situation which arose in the late 70's after the extensive use of high strength steel on ship structures, when new buckling and fatigue problems (some not yet completely resolved) plagued most of the new-built vessels.

Text:

.2 Safety factors in conjunction with assumed design load(s) and calculation procedure including structural modeling, with justification why they are appropriate [III.2.1.2 in C's O P].

Comment: We agree with the proposal from Japan as we fully commented in our submittal of the past 18 January.

Text:

.3 Loading conditions, including: homogeneous, partial, alternate loads, multi-port, ballast conditions including ballast management, and loading and offloading are included in the evaluation. (Guidance: The rules should allow and consider: any transverse combination of cargo tanks across to be empty at or near design draft; asymmetric cargo loading conditions; flexibility in ballast tank utilization without severe increases of global bending moments. [III.2.1.3 in C's O P].

Comment: We feel that the original text is adequate. We also understand that the load combinations mentioned by Greece at the beginning of his Guidance are logical, however it is necessary to be specific – as in the "old Rules"- since this may lead to an infinite number of possibilities which would be impractical. Anyway the owner may request the yard to study and built a vessel suitable for those which he feels are necessary for a flexible operation of his vessel.

Text:

.4 How workmanship and construction ("as built") design features are accounted for in the evaluation,(GUIDANCE: like for example initial deformations or initial curvature (out of plane deflection) of shafts.) [III.2.1.4 in C's O P].

Comment: Regarding the way of taking into account workmanship and construction design features, we can only guess that it would mean how to modify the partial safety factors covering for the uncertainty on the resistance properties of the member, within the capability side of the equation. However we wonder how this could be done on a general basis. We feel that the comment from IACS suggesting to pass this matter under Tier II.9 points out in the proper direction.

Text:

.5 Welding parameters to be defined on the basis of first principle equations and not by semi-empirical formulations. Margins for manufacturing induced variability to be included. Rules to be specific and accurate with respect to preheat and post-heat requirements. Welding sequences to be also defined. Effect of reduced strength in HAZ (heat affected zone). [Included by Greece].

Comment: On this token we wish to comment that in most cases the weld sizes obtained by direct calculations are too small. The practical considerations are for these cases the governing criteria. Furthermore it must be considered that the corrosion additions used elsewhere in the area, are too small for the weldments and the HAZ due to the changes in the metallurgical properties and the roughness of the final surface. This makes it more vulnerable to the corrosion attack than the well coated flat areas of plates and stiffness. In summary we would not preclude the use of well-proven semi-empirical formulations as a complement to the first principles direct calculations. We agree with Greece regarding the inclusion of preheat and post-heat requirements, welding sequences and strength reductions in HAZ areas.

Text:

.6 Acceptable limits on continuity of structural members. Continuity requirements to be specifically defined (Guidance: for example stringers to continue for x frames forward).

Comment: We agree with the proposal from Greece. We do not share the reasons alleged by Japan on that the continuity can be quantified just based on the yield and fatigue criteria. The smooth transition of properties is paramount to achieve a good behaviour of the structure. By the way, the provision of smooth transitions has always been considered to form part of what was known as "good shipbuilding practices". Having into account that the fatigue problems around the secondary stiffeners end connections area not yet completely resolved, it does not seem wise to disregard the much more complicated details associated to transitions.

資料4

Text:

.7 ~~Structural members included in the evaluation~~

Comment: We agree with Japan that this may be deleted since practically all the structural members are subject to evaluation.

Text:

.7 Rules to include a table with stress concentration factors of details typical in ship geometry (misalignment, thickness transition, hard corners, doubler plates etc.) [Included by Greece].

Comment: We also support that the Rules should include such table as a guidance.

Text:

.8 Effect of deflection on strength to be included. [Included by Greece]

Comment: For the same reasons mentioned when commenting the requirements in III.3.1.1 [III.2.1.1 in C's O P], we feel this point is important and is to be included.

Text:

.9 Acceptance criteria for yield, buckling and fatigue strength……….(see whole text on sheet 26 of the draft of RPT Annex 5), [Included by Japan]

Comment: We welcome the text provided by Japan which we feel should be included completely. However in line with what we have maintained in previous comments some guidance is to be added to cover the aspect of the deformations.

Text:

2 Evaluation to determine the main hull girder (plates and stiffeners) at net scantlings provides sufficient ultimate strength. Include the following [III.2.2 in C's O P].

Comment: We agree with the comments from Norway and IACS. This matter is to be treated in the same manner as the other limit states.

Text:

.2 Acceptance criteria for Ultimate Strength……….(see whole text on sheets 26 and 27 of the draft of RPT Annex 5), [Included by Japan]

Comment: We agree with the inclusion of the whole text proposed by Japan.

Text:

3 Evaluation to determine compatibility for cargo loading and offloading without <u>unrealistic operating conditions</u> (?), including criteria, with justification, to determine acceptability. [III.2.3 in C's O P]

Comment: We do not see the intent of this requirement since as Korea mentioned it seems to have been addressed under II.3.1.3. We also see difficulties to define the term "unrealistic" as pointed out by IACS.

Text:

4 Evaluation to determine that ~~failure~~ localized damage of any one stiffening member~~ of side shell, main longitudinal or transverse bulkhead,~~ ~~web frame or main_longitudinal stiffener~~ ~~does~~ will not ~~result in~~ lead to ~~further structural failure~~ immediate consequential failure of other significant structural members. [III.2.4 in C's O P]

Comment: We feel that Japan really hit the point and support their proposal.

Text:

5 Evaluation to determine that the structure can withstand, without further structural failure, the structural damage for those conditions from the damage stability analysis where the ship survives (s = 1.0). Include the following:

.1 ~~Limits, with justification, on the environmental conditions and period of exposure.~~ Assumed actual foreseeable scenarios, with justification why they are appropriate.

.1 Acceptable limits of deformation, yield, buckling and if different than those in III.2.1.1, with justification.

.2 To be developed… (Expand on which [specified] [foreseeable] damage/flooding conditions are required to be checked).

Comment: We agree with the proposal of Japan for sub-paragraph .1, but do not agree with deleting the subparagraph .2, and feel reasonable to leave a third one to specify the conditions to be checked.

Text:

6 Acceptance Criteria for Residual Strength in flooded condition……….(see whole text on sheets 27 and 28 of the draft of RPT Annex 5), [Included by Japan]

Comment: We agree with the inclusion of the whole text proposed by Japan.

Text:

III.4. FATIGUE LIFE [III.3. in C's O P]

9 Requirements verifying fatigue life is to be not less than design life,

10 Effect of uncertainties/assumptions on fatigue life. A criticality factor to be introduced in the requirements. The computed damage ratio to be multiplied by the criticality factor. Areas known not to have a fatigue problem will have a criticality factor of one. Areas prone to fatigue and areas critical for the survival of the vessel to have a criticality factor above one (to account for uncertainties).[new paragraph proposed by Greece]

Comment: We agree with the comment from Norway regarding the un-proper definition of the term "fatigue life", but keep subparagraph .1 until getting a better wording. We also feel that the inclusion of the new subparagraph .2 proposed by Greece is correct.

Text:

3 Data, including the source, used to determine acceptable fatigue life; e.g. stress, number of cycles, level of confidence, etc., (NOTE: Please note that even though the probability of occurrence of the loads is 10-8 according to the rules the probability of occurrence of the stress is much higher than that (stress being the ratio between moment and section modulus; both the moment and the section modulus through the corrosion process are random variables with different probability distributions). As steel corrodes the section modulus changes according to the corrosion rates etc. Presently rules do not consider this

deterioration and they take the distribution of moment/load and stress to be the same (other than a factor). In reality this is not true and the stress has a higher probability of occurrence than 10-8. The stress has a probability of a few orders of magnitude higher than 10-8.

Comment: We agree in general with the rationale provided by Greece and have included their explanatory NOTE even though we feel that they will not appear in the final text, since we deem they are interesting for the purpose of clarifying what is looked for. However we would like to add, that in the case of unsymmetrical stiffeners, the maximum stress across the section in way of their attachments to the primary supporting members, is much bigger than the value obtained dividing the bending moment by the section modulus, since the stiffeners are also submitted to non-uniform torsion with their ends having restrictions to the free warping. This originates a direct stress component to be added to the conventional bending stress thus producing a total direct stress which for some geometries may be as large as twice the direct bending stress. We had offered for the consideration of IACS a method to evaluate the total direct stress at any point of the section much more comprehensive than that proposed by IACS in their JTP Rules, which only allows to find the total stress at two points of the section. Our results had been benchmarked successfully with the data of one CS, unfortunately IACS have not allowed the possibility of benchmarking our results against their data base and disregarded our proposal.

Text:

4 Structural elements, including identification of critical design details, required to be included in evaluation of ship's fatigue life.

5 Evaluation and modelling to include the whole ship and take into account slamming, dynamic, vibratory, sloshing effects, secondary and tertiary stresses. [new paragraph proposed by Greece]

Comment: We agree with the inclusion of the new paragraph proposed by Greece.

Text:

III.5. PROTECTION AGAINST CORROSION [III.4. in C's O P]

5 Mandatory use of coatings:

.9 Locations and/or spaces where coatings are required to be used,

.10 Types of coating including criteria for determining the type of coating to be used,

.11 Required coating life (GUIDANCE: 15 years) and criteria used to determine required coating life (e.g. secondary surface preparation, number and DFT of coats, number of stripe coats and locations of their application etc.),

.12 Allowances where other corrosion prevention systems are also used.

Comment: We agree with the inclusions proposed by Greece in sub-paragraph III.5.1.3.

Text:

~~6 Voluntary use of coatings:~~

~~.4 Locations and/or spaces where permitted~~

~~.5 Criteria for selecting the type of coating~~

~~.6 Coating life and criteria used to determine the coating life~~

Comment: We agree with Japan and Korea that this paragraph should be eliminated.

Text:

4 Determination of the ~~corrosion addition~~ *criteria used* to develop "as built *minimum acceptable gross* scantlings" in order that the ship structure scantlings do not normally fall below the net scantlings by the ~~[~~design life~~] [2nd special survey]~~. Include the following:

Comments: We concur with UK proposal of using "criteria used" in lieu of "corrosion addition". We feel the term "as built scantlings" is not correct here: once the "minimum net scantlings" have been calculated, if we add the tabular corrosion margins we will obtain the "minimum acceptable gross scantlings". Above that, the owners may wish to add something extra arriving to the actual "as built scantlings". It is important to distinguish between both concepts. We agree with several members of this CG regarding the deletion of the reference to the 2nd special survey.

Text:

3 Determination of corrosion rate based on ship type, location, cargo, loading, statistical data, etc. (GUIDANCE: almost all widely accepted studies show lifetime averages of minimum about 0.20 mm/year for coated ballast tanks, minimum 0.25 mm per year for dry cargo holds, based on normal/prudent maintenance).

4 Consideration of corrosion control measures.

Comment: We agree with Greece in their concerns and consider advisable to include the guidance. Furthermore we also agree with deleting the subparagraph referring to the time period.

Text:

III.7. DESIGN TRANSPARENCY

1 Provisions that make "design" and "as built" drawings and information, sufficient to verify compliance with classification society rules, available to builder, owner, operator, and/or Administration, as appropriate. Include the following:

.6 Details for "Ship Construction File" to include

a) Areas requiring special attention throughout ship's life

b) All Design parameters limiting the operation of ship

c) All areas or structural details for which *alternatives to the specific Rule requirements* have been used in the design and construction.

Comment: We are also concerned with the matters raised by Greece and support the addition of the three points for inclusion in the "Ship Construction File". Upon examination of the comments from Japan we propose rewording of point c) with the above text outlined in yellow. We certainly feel that the owners need to know clearly where and how such alternatives have been used, since due to the probable lack of service experience the affected elements will require a closer monitoring than those following the standard Rule requirements (assumed to be well proven).

Text:

.3 Where rules allow alternate methods, set clear and scientific direct stress criteria and techniques. If these alternate methods were used in design, same to be clearly indicated with detailed calculations demonstrating equivalency to *the specific Rule requirements*.

Comment: We agree with Greece in the inclusion of this new sub-paragraph since we understand that the Rules must request the designer to submit full data to demonstrate the assumed equivalence of the alternatives to the specific Rule criteria.

Text:

III.8. CONSTRUCTION QUALITY [III.7. in C's O P]

.3 IACS Shipbuilding and repair quality standards
.4 <u>Approval scheme of welding procedure</u>
.5 <u>Qualification scheme of welders</u>

Comment: We agree with the proposal of Greece to include sub-sub-paragraph III.8.1.1.3 but prefer for the subsequent the two sub-sub-paragraphs of Japan which enhance Greece's proposal.

Text:

III.8.2.2 Criteria for determining when re-evaluation for strength and/or fatigue life is required. This should include consideration of net scantlings where appropriate."

Comment: We have reproduced above the text proposed by UK for this subparagraph.

Text:

III.9. SURVEY [III.8 IN C'S O P]

3 Survey requirements, including the development of a Survey Plan, during ship construction sufficient to verify the ship is constructed in accordance with the ~~classification rules~~ <u>appropriate rules or standards</u>, including:

.1 Types of surveys (visual~~, radiograph~~<u>, non-destructive examination,</u> etc) depending on location, materials, welding, casting, coatings, etc.

Comment: We agree with the proposals from Japan.

Text:

.6 Provision of construction schedule for major parts before keel laying describing major construction phases to delivery.
.7 Provision of rough next monthly schedule of inspections at each end of month.
.8 Provision of detailed weekly schedule of inspections.

Comment: We agree with the inclusion of these new sub-paragraphs proposed by Greece.

Text:

4 Provisions for providing shipowner representatives results of construction surveys. Technical Correspondence between yard and class relating to vessel to be advised and made available to the owner. Similarly technical correspondence between yard and equipment makers to be advised and made available to class and owner.

Comment: We agree with the expanded text proposed by Greece in order that the owners may keep an accurate record of all the conditions and limitations that the vessel may have.

Text:

III.10 ***STRUCTURAL*** **ACCESSIBILITY** ***AND MAINTENANCE*** [III.9 in C's O P]

1 Evaluation to determine adequate design and construction ~~access is provided for the internal structure for maintenance and~~ to facilitate *ease of maintenance and* overall and close-up inspections and thickness measurements of the internal structure. Include the following:

.1 Criteria for determining acceptability of access

.2 Requirements for development of an Access Plan.

Comment: While we are in general in agreement with the wording of the proposal from Japan, we as Greece, do not see the need to separate the accessibility for the maintenance from that intended for the inspections. We agree with Greece that determining when "Adequate design and construction" has or not been provided may be problematic. We wonder if the idea is not to say "*Adequate access without needing additional staging*".

Final comment: We note the comments offered by Japan in their Appendix "Basic concept of acceptance criteria in Tier III" (pages 31 and 32), with which we are in full agreement.

United Kingdom

At this stage, the draft is about right. However, we would prefer it if reference to "safety factors" were replaced by reference to "safety criteria". Similarly, in III.4.3, we would prefer "corrosion addition" to be replaced with "criteria used" in the phrase "Determination of Corrosion addition to develop as built scantlings". Also in III.7.2.2 "of net scantlings" could perhaps be modified along the lines of: "Criteria for determining when re-evaluation for strength and/or fatigue life is required. This should include consideration of net scantlings where appropriate."

In general, if specific numerical factors are adopted without qualification, then that could lead to implicit mandating of a specific design methodology. For example, a single overall factor applied to the ultimate design strength of the hull girder of the vessel might not be appropriate when using a methodology which applies various factors to elements within both the demand and resistance sides of the equation based on the magnitude and uncertainty associated with the individual loadings and also the uncertainties on the resistance side.

III.1.3 Justification that sea state data represents 25 years and the North Atlantic

Presumably, this is relating to design global wave bending moment, design global max shear, etc. In order to be relevant and applicable in practical terms, "25 years" will need to be more closely defined. i.e., what is the maximum acceptable probability of the max global design figures being exceeded in 25 years? An absolute guarantee of never being exceeded in 25 years isn't scientifically possible. Also, we can't set a probability of exceedence so small that it isn't possible to build a commercially viable ship. On the other hand, the max probability of exceedence does need to be set, at such a level that it bears comparison with other comparable industries.

III.2.1.2 Safety factors, with justification why they are appropriate

Reference to "safety factors" implies a specific design methodology. This could reasonably be removed as it is already covered under III.2(1).

III.2.2.2 As for III.2.1.2

With regard to comments of Bahamas:

These comments raise issues which go to the core of the present debate. Bahamas very reasonably points out that our aim must be that the ship should not fall below the net scantlings during its design life, whilst at the same time acknowledging that in practice certain parts may need replacement during the ship's design life. As alluded to in our comments above on "25 years" it would seem that there are two related issues here. One is to ensure that the probability of global failure is at an acceptably low level. The other is to ensure that the probability for lower level deterioration, resulting in a need for localized structural renewal is set at a level which is extremely unlikely to lead to any significant loss of global capability.

With regard to Greece comments:

III.1. Requirements

The proposed requirement for steel renewal over the 1st 22 years of life is essentially a commercial one rather than a safety objective. The extracts from MSC 80/6/5 will need further discussion. They are relevant, however this rather neatly illustrates the danger of IMO discussing and redefining selected elements of the contents of (for example) class rules but not discussing them in enough depth to consider all of the implications. The fact that there is a 63.2% probability of the nominal design wave being exceeded may, or may not be significant depending on the various margins which are applied on both the demand and resistance sides of the strength formulation. Having said this, if IMO goes down the route of debating on this sort of detail, then before the goal based regime is implemented there will need to be very careful, detailed consideration of the points raised by Greece. At this time we remain concerned with the danger of arbitrarily modifying certain factors within the IACS formulations without fully considering all of the implications.

IACS

The following detailed comments refer to the first draft Tier III.

III.1. Design life and environmental conditions
No comment.

III.2. Structural strength
Item III.2.1 is not clear. As stated it appears to address the process of determining that the net scantlings of an individual design are sufficient to withstand the failure modes addressed in the Tier IV rules. In our view, the scope of this requirement is to request information about the criteria used in the rules for each structural strength limit state (e.g. hull girder strength, local strength yielding, buckling, fatigue, excess of deformation, ultimate strength). We agree with the comment made by Norway [ref. 4] about the logical sequence of bullet points. We do not understand the intended meaning of III.2.1.4 on workmanship and construction design features. In any case, as worded, this seems more relevant for inclusion under Tier II.9 – Construction quality procedures.

Regarding III.2.2, the ultimate strength should be treated like the other limit states.

Regarding III.2.3, we do not know how to define "unrealistic operating conditions", which is a vague expression. In any case, it seems a functional requirement to be considered for inclusion in Tier II.

Regarding III.2.4, it appears to specify particular requirements for residual strength after damage and/or structural redundancy which, to our understanding, are not appropriate for inclusion in Tier III. The text is also very vague and problematic since it does not specify the nature or scope of the "failure" to be considered or under what circumstances. We should seek to avoid repetition of cases such as are currently being addressed by IMO with respect to SOLAS XII/6.5.3. Tier III may request documentation/ demonstration as to how the structural redundancy requirements of Tier II are achieved.

Regarding III.2.5, the functional requirement II.2 – Residual strength , requests the definition of foreseeable damage scenarios and not all those conditions where the ship survives from damage stability analysis. This text would appear to require an incredible number of structural damage and load cases to be verified. Tier III should not contain additional functional requirements beyond those agreed for inclusion in Tier II. As previously pointed out, it is to be noted that the compatibility of structural residual strength and current damage stability requirements is not established and may require a major study and development effort to achieve. This relationship is currently only addressed in isolated cases (e.g. bulk carrier structural survivability after hold flooding under SOLAS XII and associated IACS requirements).

III.3. Fatigue life

No comment.

III.4. Protection against corrosion

III.4.2, on the voluntary use of coatings, should be deleted.

Regarding III.4.3, in our view the part in square brackets about the duration of corrosion additions – [design life][2nd special survey] – should be removed and addressed under Tier II, as it appears to define a functional requirement.

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MARITIME SAFETY COMMITTEE
81st session
Agenda item 6

MSC 81/6/[Japan2]
xx March 2006
Original: ENGLISH

GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Basic concept of a Ship Construction File (SCF)

Submitted by Japan

SUMMARY	
Executive summary:	This document provides a basic concept of a Ship Construction File (SCF) in order to facilitate the consideration of the Committee.
Action to be taken:	Paragraph 9
Related documents:	MSC 80/24; MSC 81/6; MSC 81/6/[Japan1]

Background

1. The Committee, at its eightieth session, discussed on the Goal-Based Standards for New Ship Construction. Through the discussion, the importance of design transparency was broadly recognized, and as a consequence, the draft text of Tier II (Functional requirements) mentioned about the readily available documentation which includes main goal-based parameters and all relevant design parameters that may limit the operation of the ship in the item II.9 Design transparency (see paragraphs 6.51 and 6.52 in MSC 80/24).

2 The Committee also noted that there had been considerable discussion in the working group on how the information should be made available. The working group had been in wide agreement that the issue of how this information was documented was very important and would need further consideration at a later time.

3 Moreover, the item II.11 Survey of the Tier II mentioned that the survey plan should be developed for the construction phase of the ship, and the plan should also identify areas that need special attention during surveys throughout the ship’s life.

Basic concept of a Ship Construction File (SCF)

4. Japan firmly believes that improvement of safety at sea and/or protection of the marine environment can be achieved not only by Goal-Based Standards at a design/construction stage but also by proper “survey and maintenance” throughout the ship’s life. It, therefore, shares the view that the information on goal-based parameters, all relevant design parameters and the survey plan specific to each ship should be kept throughout the ship’s life.

5. At MSC 80, there was considerable discussion on how the information should be made available. Japan thinks that the information should be included in a Ship Construction File (SCF) and it should be kept on-board throughout the ship’s life in order to provide guidance to persons concerned regarding operation and/or “survey and maintenance”. While some delegations pointed out that the information would be a large collection of documents, Japan is of the opinion that an SCF should be as simple as possible and limited to items vital to operation and/or the survey plan.

6 While detail requirements for an SCF should be included at a lower level than Tier III, Japan is

preparing a sample list of items in an SCF, as shown in the Annex, in order to facilitate the discussion at the Committee. Information for each Item in an SCF could vary depending on ship types or other situations, but the list would be helpful to grasp a picture of an SCF.

7. Because Tier I, II and III are not supposed to directly apply to individual ships, Tier IV rules (i.e. class rules) should be ensured to have a function for the information availability, and the function should be verified under the Tier III of the Goal-Based Standards. In this regard, matters on information availability are the issue which should be dealt with in the IMO. Japan is of the opinion that the concept how the information is made available should be incorporated at a level of Tier II, or Tier II should be drafted taking into account the concept of an SCF.

8. Japan is of the opinion that, in addition to information at a design/construction stage, it is necessary to gather information after placing a ship in service, such as survey records, maintenance records and suffered damages, in order to make it possible to be used for future operation and/or survey. In this regard, it should also be considered how such information is recorded and filed. A possible option is making a Ship Maintenance File separate from an SCF and another is adding such information to the SCF.

Action requested of the Committee

9. The committee is invited to consider the concept of an SCF taking into account the above comments.

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ANNEX

A sample list of items in a Ship Construction File (SCF)

Tier II items		Information to be recorded	Example of the concrete information
DESIGN			
1	Design life	Clear statement of assumed design life	-
2	Environmental conditions	Clear statement of assumed environmental conditions	-
3	Structural strength	Clear statement of calculating conditions and results	Assumed loading conditions Scantling (net) Scantling (gross)
4	Fatigue life	Clear statement of calculating conditions and results	Assumed loading conditions Calculated results (fatigue life and areas to be marked for survey)
5	Residual strength	Clear statement of assumed conditions	-
6	Protection against corrosion	Clear statement of coated areas and other measures for corrosion protection	Coated areas and applied coating specification Selected anti corrosion measures Any other measures for corrosion protection
6.1	Coating life	Clear statement of target coating life	-
6.2	Corrosion addition	Clear statement of corrosion addition and wastage allowance	-
7	Structural redundancy	Clear statement of assumed conditions	Assumed damage conditions Assumed load conditions
8	Watertight and weathertight integrity	Clear statement of key factors for watertight and weathertight integrity	-
CONSTRUCTION			
10	Construction quality procedures	Clear statement of applied construction quality standard	-
11	Survey	Clear statement of areas where higher attention to structural fatigue and corrosion are called	-
IN-SERVICE CONSIDERATIONS			
12	Maintenance	Clear statement of maintenance plans specific to the ship inclusive of those supplementary to generalized normal maintenance regime, which should be defined by IMO	-
13	Structural accessibility	Extended Ship Structure Access Manual (SOLAS II-1/3-6) covering both cargo and other areas	-

INTERNATIONAL MARITIME ORGANIZATION

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MARITIME SAFETY COMMITTEE
81st session
Agenda item 6

MSC 81/6/4
7 March 2006
Original: ENGLISH

GOAL-BASED NEW SHIP CONSTRUCTION STANDARDS

Japan's position on goal-based new ship construction standards

Submitted by Japan

SUMMARY	
Executive summary:	This document provides Japan's basic position on goal-based new ship construction standards, which includes the following: 1. GBS should be developed so as to achieve the optimum combination of sufficient hull strength, minimum environmental burden and acceptable social costs; 2. It seems to be worthy of using the safety-level approach in developing GBS; 3. In the case that GBS will go along with prescriptive approach, Tier III should have minimal verification criteria which need to be thoroughly discussed in the Committee based on technical and scientific knowledge; 4. GBS shall be consistent with the framework of the SOLAS Convention. Tier III should be developed taking into account that Tier IV must have two types of mandatory requirements: i) legally binding ones and ii) ones that are mandatory under the responsibility of the Administration; The guidelines for the authorization of organizations acting on behalf of the Administration (resolution A.739(18)) should be amended so that Administrations can entrust only the organizations which have structural rules in conformity with GBS.
Action to be taken:	Paragraph 26
Related documents:	MSC 80/24; MSC 81/6; MSC 81/6/1 and MSC 81/6/5

For reasons of economy, this document is printed in a limited number. Delegates are kindly asked to bring their copies to meetings and not to request additional copies.

Background

1 Based on the idea that IMO should have basic requirements on hull strength in order for securing and promoting safety of ships and preventing environmental pollution from ships, the Committee has been discussing structural requirements along with the concept of goal-based standards. The concept is that goals are set at first, and basic functional requirements to achieve the goals are then developed, and finally concrete measures by which functional requirements are applying to ships are developed. The Committee has agreed that goal-based new ship construction standards (GBS) have five-tier system. It has so far developed draft Tier I goals for all ship types and draft Tier II functional requirements for bulk carriers and tankers of unrestricted service.

2 Furthermore, the Committee, at its eightieth session, discussed basic principles of goal-based standards including the utilization of risk-based approach. The Committee thought that further consideration on the risk-based approach was necessary and invited Member Governments and international organizations to submit comments to MSC 81 (MSC 80/24, paragraph 6.10).

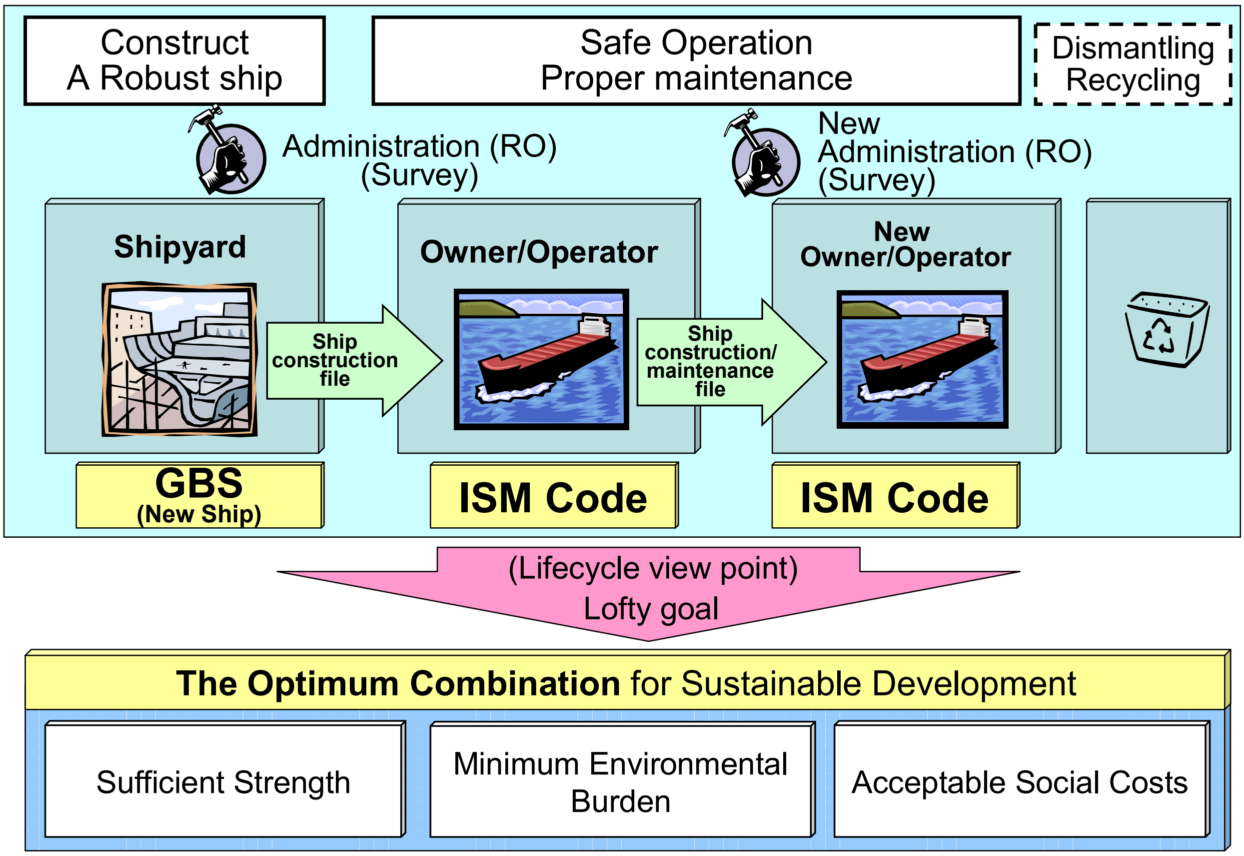
High quality regulations

3 Japan firmly believes that hull strength should be secured throughout the ship's life by safety culture among all stakeholders concerning design/construction and maintenance/operation.

4 Japan further believes that new regulations should be developed so as to achieve the optimum combination of high level of safety, minimum environmental burden and acceptable social costs induced by the regulations. For example, measures which greatly raise the safety level but impose massive burden on the environment, such as fire-extinguisher equipments using halon gases, should not be allowed, and other measures which raise the safety level very little but cost one million dollars per ship are inadequate. On the contrary, if measures are worthwhile to spend one million dollars per ship, they should be introduced as a mandatory requirement even if the world economy bears the costs. Japan has no doubt that all Member Countries and international organizations participating in the Committee share the above mentioned view and think that developing such "***high quality regulations***" is one of the fundamental activities of IMO.

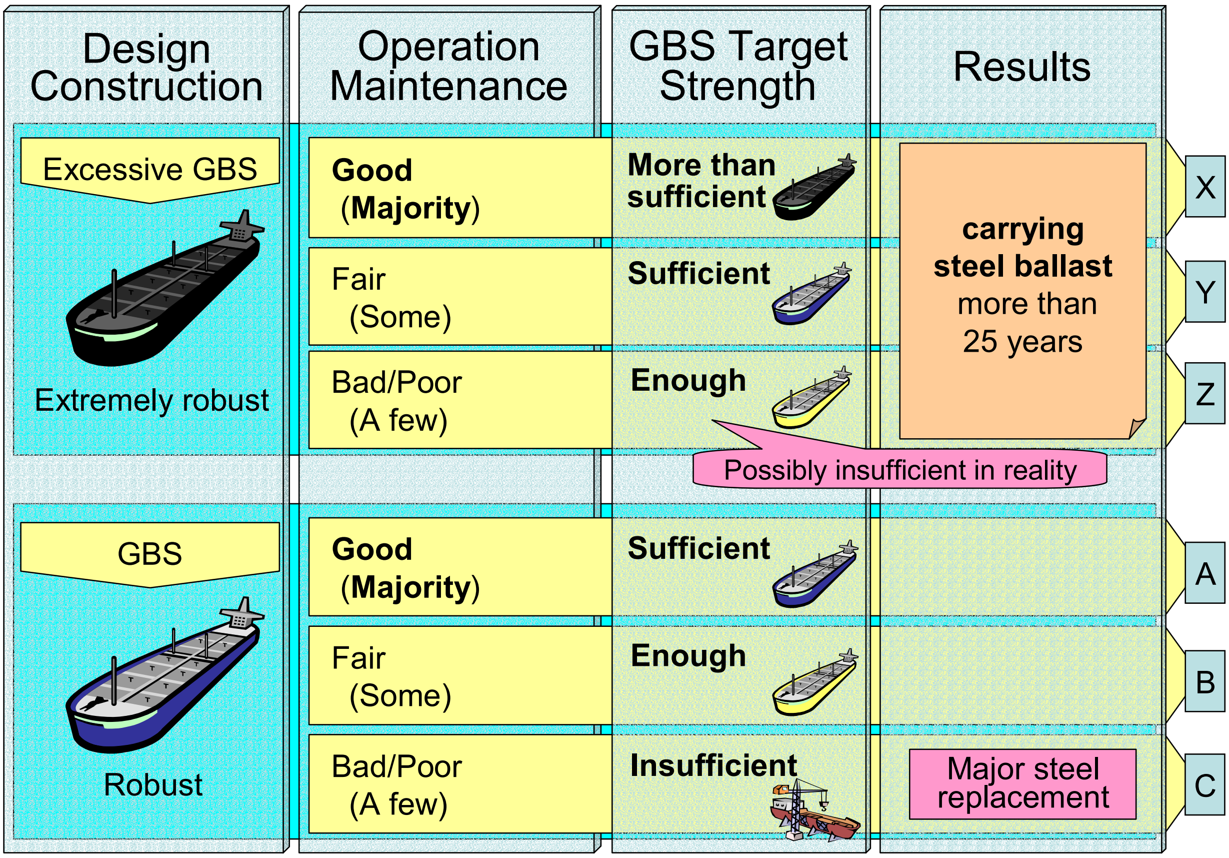
5 Japan is of the opinion that, in line with the idea of "*high quality regulation*", the goal-based new ship construction standards should be developed so as to achieve the optimum combination of sufficient strength, minimum environmental burden including CO_2 emissions due to steel ballast, and acceptable social costs induced by increase of fuel consumption from the viewpoint of life-cycle (Fig. 1). In seeking the optimum combination, all the measures including those relating to operation and maintenance should be taken into account. If problems come from bad operation or poor maintenance, it seems reasonable to enhance the practice of companies rather than to make all ships carrying steel ballast (Fig. 2).

Fig. 1 Securing sufficient strength throughout the life of a ship



6 A Ship Construction File is one example of the measures to keep good operation/maintenance, which includes operational/maintenance conditions being supposed in the design stage. The File should be kept on-board in order to make it possible for persons concerned to refer the File whenever they want. The information contained in the File should be conveyed to the new owner/operator always when the owner/operator is changed. Japan submitted this idea in another submission to MSC 81.

Fig. 2 Options for Goal-based Standards



Safety-level approach

7 It seems to be worthy of using the safety-level approach, which is also called the risk-based approach, in developing the goal-based new ship construction standards.

8 The way of developing standards in IMO is changing from 're-active', which means that measures are taken responding to lessons learnt from accidents, to 'pro-active' which means that measures are developed in advance by setting an appropriate safety level to prevent accidents. Japan supports this trend.

9 In the pro-active approach, a safety goal to be achieved has to be set taking into account the fact that it is impossible to provide 100% safety or zero risk. This means that it is necessary to set an acceptable safety level for the society. In case the safety level approach is taken in developing the goal-based standards, a safety level would be incorporated into Tier I goals. Functional requirements in Tier II can be derived from brain storming methods and/or from analytical methods by which their contribution to the safety level in Tier I can be determined.

10 In order to set appropriate Tier II functional requirements for Tier I goals, it is necessary to develop not only a method to analyse the contribution of functional requirements to goals but also a method to verify the adequacy of functional requirements against goals. In order to make it possible to do so, goals can be recognized as a safety level and functional requirements can also be considered as factors for improving the safety level. In short, setting safety levels and their analysis are essential for the safety level approach.

11 Some functional requirements may be independent but others may be interrelated. Consequently, the relationship among each functional requirement and the level of interrelationship should be identified.

12 If the safety-level approach was used in developing the goal-based standards, the contents of Tier I and Tier II would somehow be influenced, and the Committee should therefore decide how we should proceed as soon as possible.

Criteria for verification

13 In case that the safety-level approach would not be taken and the goal-based standards are developed in the same manner as the current, Japan believes that Tier III should be developed so as to verify the compliance of Tier IV requirements against the draft Tier I and the draft Tier II both of which were already developed at MSC 80.

14 With regard to the verification criteria, Japan believes that it is necessary to set criteria, because there is still allowance in some functional requirements in Tier II and the judgement might be different depending on the person who verifies. For example, the functional requirement for residual strength needs "actual foreseeable scenarios" but it is not described what an actual foreseeable scenario is. It may lead to intolerable divergence in the safety level among Tier IV requirements. Japan firmly believes that such criteria need to be set based upon cautious consideration at the Committee because they have a major influence on Tier IV standards.

15 In setting verification criteria, we should bear in mind the idea of "*high quality regulations*". In other words, the criteria should be set to achieve the optimum combination of high level of safety, minimum environmental burden and acceptable social costs, as precisely described in paragraphs 3 to 6 of this document.

Framework and role of Tier III

16 In addition to the matters of acceptance criteria, it is important to share a common recognition on legal aspects of Tier III and its subject of verification, i.e. Tier IV, in order to create a proper framework for Tier III.

17 While the legal aspects of the goal-based standards have not been discussed in the Committee, Japan is of the opinion that the goal-based standards should be incorporated into the SOLAS Convention because of its tacit acceptance provisions, which make the standards come into effect earlier.

18 In incorporating the goal-based standards into the SOLAS framework, Japan recognizes that some discussions on legal aspects of Tier III and Tier IV are needed, whereas it seems to be not so difficult to incorporate basic elements of Tier I and Tier II into SOLAS after reaching an agreement on their contents in a similar way to regulation II-2/2 titled *Fire safety objectives and functional requirements*. And the common recognition on legal aspects of Tier III and Tier IV must be a basis for discussion on elements to be included in Tier III.

19 Japan supports the verification framework shown in annex 2 to the report of the Correspondence Group (MSC 81/6/1) in principle. As Tier IV requirements ought to be mandatory in order to ensure Tier II functional requirements, Tier III are procedures for verification whether or not a Tier IV requirement is appropriate to be mandatory. And, as in

annex 2, Tier IV requirements seem to be composed mainly of classification society rules, IMO requirements and Administration requirements[1].

20 The points that need to be discussed are:

.1 how classification society rules are to be made mandatory under the framework of the SOLAS Convention; and

.2 who is the verification authority from a legal view point.

Current SOLAS regulations II-1/3-1[2] and XI-1/1[3] regulates that requirements of a classification society become mandatory by recognition of the classification society by the Administration, and this implies that the Administration is the legal entity for recognition of the classification society and its rules.

21 Japan believes that the above mentioned legal framework should be unchanged in introducing the goal-based standards because legal responsibility of flag States is clear along with the *flag State doctrine*. Furthermore, classification society rules contain not only structural requirements for new ship construction but also those for engines, electronic equipment and statutory surveys delegated by flag States, and the classification society rules are so frequently revised. From this point, it seems difficult to treat classification society rules in the same manner as other legally binding IMO requirements that are developed and verified by IMO itself. In this regard, the current legal framework, in which Administrations recognize classification societies and, therefore, their requirements become mandatory, is suitable for the legal framework of the SOLAS Convention.

22 On the other hand, even under such a legal framework, it seems to be reasonable to make use of an expert group for verifying classification society rules that are commonly used in many countries in order to reduce the workload and to avoid inconsistent results among Administrations. However, in line with the said legal framework, the outcome from the expert group should be treated as "an experts' evaluation report on compliance of classification society rules against Tier II functional requirements," and the Committee (or the Assembly) will make a resolution which recommends that "Administrations should respect the outcome of the expert group and are encouraged to accept the result of the expert review under their responsibility".

23 In conclusion, there are two types of mandatory requirements in Tier IV, one is legally binding IMO instruments and the other is that requirements become mandatory under the

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[1] Some Tier IV requirements, including those on construction quality procedures in Tier II, are currently in industrial standards, and they can be made mandatory by being referred in classification society rules, IMO regulations or Administration rules.

[2] **Regulation II-1/3-1 –Structural, mechanical and electrical requirements for ships**
In addition to the requirements contained elsewhere in the present regulations, ships shall be designed, constructed and maintained in compliance with the structural, mechanical and electrical requirements of a classification society which is recognized by the Administration in accordance with the provisions of regulation XI/1, or with applicable national standards of the Administration which provide an equivalent level of safety.

[3] **Regulation XI-1/1 – Authorization of recognized organizations**
Organizations referred to in regulation I/6 shall comply with the guidelines adopted by the Organization by resolution A.739(18), as may be amended by the Organization, and the specifications adopted by the Organization by resolution A.789(19), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the annex other than chapter I.

responsibility of the Administration in accordance with provisions such as SOLAS regulation II-1/3-1. In any case, the role of Tier III is providing appropriate procedures and matters taken into consideration in verifying Tier IV requirements meet Tier I and Tier II by the Administration and/or IMO. The legal status of Tier III has not been discussed in the Committee yet, but only essential elements to be legally bound to the Administration should be regulated in the SOLAS Convention. From such view points, draft Tier III in the CG report may contain both procedures and matters that should be legally bound and those that are not necessary to be legally bound. It should be appropriate that procedures which are not legally bound to the Administration are included in an MSC resolution or Assembly resolution.

Recognition of RO and Tier IV standards developed by Administrations

24 Japan believes that, when the Administration entrust the inspections and surveys on new ship construction to the recognized organizations, the Administration should only select those classification societies with verified Tier IV requirements. In this regard, resolution A.739(18), Guidelines for the Administration of Organizations acting on behalf of the Administration, which is quoted in SOLAS regulation XI-1/1, should be amended as appropriate.

25 On the other hand, when the Administration develops the Tier IV requirements, the Administration itself can verify them in accordance with Tier III verification procedures. Such verification by the Administration should be audited in accordance with the framework and procedures for the voluntary IMO member state audit scheme (resolution A.974(24)). In addition, the Code for the Implementation of Mandatory IMO Instruments (resolution A.973(24)), will be amended to include the obligation of the flag State Administration.

Action requested of the Committee

26 The Committee is invited to consider the above comments and take action as appropriate.

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新世代船体構造強度基準の作成に関する調査研究（**MP1**）

リスクベースワーキング・グループ（WG2）

リスクベースワーキング・グループ（WG2）委員名簿（敬称略、順不同）

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リスクベースワーキング・グループ（**WG2**）

目　　　次

1．はじめに

国際海事機関（IMO）の海上安全委員会（MSC）では、老朽船（バラ積み貨物船、タンカーなど）の船体構造崩壊事故の頻発に鑑み、船体構造安全性の最終目標を掲げて、その下で船体構造基本性能基準を組み立て、さらに詳細詳構造基準を導く5階層からなるゴールベース新船構造基準（Goal-Based Standard for New Ship Construction：GBS-NSC）の作成審議を開始した。

MP1-WG2では、このGBS－NSCにおいて、欧州各国と協力してリスクベース・アプローチの検討を進める作業を行い、その成果をIMO MSC81へ提出した。

２．調査研究の目的及び背景

国際海事機関（IMO）の海上安全委員会（MSC）では、老朽船（バラ積み貨物船、タンカーなど）の船体構造崩壊事故の頻発に鑑み、船体構造安全性の最終目標を掲げて、その下で船体構造基本性能基準を組み立て、さらに詳細詳構造基準を導く 5 階層からなるゴールベース新船構造基準（Goal-Based Standard for New Ship Construction：GBS-NSC）の作成審議を開始した。

MSC80（2005 年 5 月）では、GBS-NSC の作成を進める一方、ドイツをはじめとする欧州各国がリスクベース・アプローチ及びリスクレベルの検討も推進することを主張した。我が国はリスクベース・アプローチも併行して行うとした GBS 新船構造基準に関する作業部会（WG）の合意に賛成して、そのような作業を推進する意向を表明した。MSC80 は審議の結果、GBS 新船皇后基準に関してリスクベース・アプローチも併行して検討することに合意した。我が国、ドイツ、デンマーク、スウェーデン、ノルウェー及び英国は協力してリスクベース・アプローチの検討を推進するリスクベース・アプローチ国際共同グループ（International Collaboration Group on Risk-based Approach on GBS：GBS-ICG）を設立し、MSC81 及びそれ以降の会議に共同して提案文書を提出することとなった。また、2005 年 10 月に釜山で開催された GBS 新船構造基準に関するアジア・ワークショップにおいて「IMO・GBS 構造基準におけるアジア・イニシアチブの構築」が、我が国、韓国及びシンガポールの間で合意され、急用で出席できなかった中国も参加する模様である。

目標：

IMO・MSC で検討しているゴールベース新船構造基準に関して、リスクベース・アプローチによる基準を欧州各国と協力して作成し、IMO における制定を目指す。

欧州で進められているリスクベース・アプローチによる船舶安全基準調査研究（SAFEDOR）の動向を調査し、これと協調して我が国からの貢献を提供し、EU＋我が国が IMO における安全性基準作成をリードする。

当調査研究報告書は、以上の作業における 2005 年度の成果を示すものである。

３．MP1WG2の活動状況

3.1　第１回会合（2005年10月4日）

（1）MP1-WG2 の趣旨

WG2 の背景と趣旨が説明された

（2）GBS リスクベース・アプローチに関する国際共同グループ

7 月 5、6 日にコペンハーゲンにて開催された本会合の報告をもとに審議が行われた。

（3）GBS リスクベース・アプローチの課題

過去に日本海事協会で行われた「Risk Management and Risk Assessment for Ships and Offshore Structure」に関する報告書の説明が行われた他、リスクベース・アプローチに関する下記の国際会合の予定が紹介された。

・International GBS Workshop in Korea: October 6 and 7 at Pusan

・International GBS Workshop in Crete: October 17

（4）2005 年度の作業予定

本年度の作業予定について検討を行い合意された。

3.2　第2回会合（2005年10月26日）

（1）韓国 GBS WS 関連

韓国 GBS WS の報告をもとに審議が行われた。

（2）ギリシャ GBS WS 関連

ギリシャ GBS WS の報告をもとに審議が行われた。

（3）SAFEDOR 関連

SAFEDOR 関連の報告があり、「SAFEDOR の真の目標」について検討が行われた。

3.3　第3回会合（2005年12月12日）

（1）今年度作業について

今年度のプロジェクト実施内容全般について報告が行われた。

（2）来年度作業について

（1）の進捗状況をもとに次年度の作業計画について検討を行われた。

3.4　第4回会合（2006年2月8日）

（1）IMO GBSセミナーについて

2006年5月9日に欧州と共同して開催予定の本会合について紹介が行われた。

（2）今年作業について

今年度のプロジェクトで実施された各調査項目について報告が行われた。

（3）2005年度調査研究報告書のまとめ方について

報告書のまとめ方について説明があり、作業分担が決められた。

（4）MSC81の対応

提案文書をもとにMSC81の対応について検討が行われた。

４．IMO での審議状況

国際海事機関（IMO）の海上安全委員会（MSC）では、老朽船（バラ積み貨物船、タンカーなど）の船体構造崩壊事故の頻発に鑑み、船体構造安全性の最終目標を掲げて、その下で船体構造基本性能基準を組み立て、さらに詳細詳構造基準を導く 5 階層からなるゴールベース新船構造基準（Goal-Based Standard for New Ship Construction：GBS-NSC）の作成審議を 2004 年から開始した。

4.1 発端

エリカ号事故、プレスティッジ号事故と、欧州海域で引き続いて重大海洋汚染事故が発生した。これらのタンカーはいずれも、船齢が 25 年を越える老朽船であった。特に 2002 年 11 月にスペイン沖で発生したプレスティッジ号の事故は、老朽化したタンカーが荒天中に船体損傷を起こし、最終的には船体が折損して沈没した。

この事故では、船体損傷を起こした時点でプレスティッジ号が至近の港へ避難することを申し出たが、スペイン海事当局はむしろスペイン沿岸から同号を締め出して北大西洋の真ん中へ曳航させ、結果として沈没したという経緯がある。

この事故ではさらに、同号が適切に検査され修繕されたか、その船体強度の査定が甘かったのではないか、という指摘もある。船舶の安全及び船舶からの油の流出の防止は 一義的にはその船舶の旗国にある。SOLAS 条約で船体構造については、第 II-1 章第 3-1 規則に、「船体構造については、旗国が承認した船級協会の規則に従うこと」と記されているのみで、船舶の安全に責任を有する旗国が船体構造に関して評価する手段を持っていないことが指摘された。我が国は勿論、船舶構造規則を制定しており、このような事態にはなっていない。

旗国として多くの船舶を登録しているバハマ及びギリシャは、「主管庁には、実質的に船舶の船体及び構造強度について検査・監督する基準が無いことは問題である。IMO は新船建造に係わる基準の決定に重要な役割を担うべきであり、そのような基準を IMO が定めるべきである」と主張し、「北大西洋の荒天を 25 年間航海しても壊れない船体であるべきである」という目的指向の基準、すなわち **Goal Based Standard (GBS) for New Ship Construction** を制定すべきと IMO の理事会に提案した（2003 年）。この提案は、技術的検討というよりも「IMO が船体及び構造強度の基準を定めるか」という IMO のポリシーの問題と認識され、IMO 理事会はそのような方向の是非を検討するよう MSC に要請した。

4.2 MSC77

2003 年春の MSC 第 77 回会議では、新造船の船体構造に関する GBS を制定していくことが合意された。

4.3 MSC78

GBS の実質的な議論は 2004 年 5 月の MSC 第 78 回会議から開始された。GBS は、

・達成すべきゴール(第１階層: Tier I)、
・ゴールを達成するために、各国あるいは船級教会の船舶構造規則が持つべき基本的機能要件(第２階層: Tier II)、
・船舶に対する実際の規則（各国政府及び船級協会の規則）が Tier II の基本的機能要件を具現していることを認証する方法(第３階層: Tier III)、
・船舶に対する実際の規則（船級規則・標準など）（第４階層: Tier IV）、
・実施細則（第５階層: Tier V）

からなる階層構造を持たせることに MSC78 は合意した。このうち、第３階層までを IMO で作成し、第４階層以下は船級協会などが適宜規則策定を行うことを想定している。

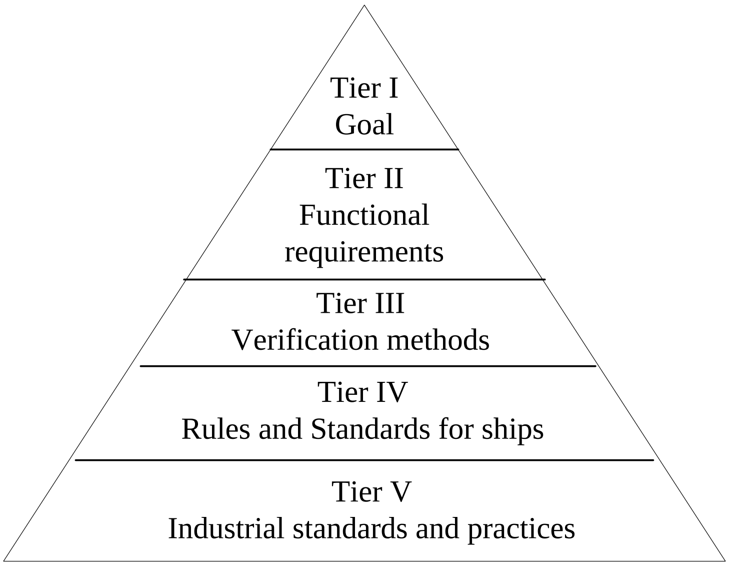


図３ GBS の階層構造

我が国は、船舶の安全性を確保するためには、構造要件だけではなく、船主のメンテナンスやオペレーションが重要であるとの立場から、構造基準の策定に当たっては、メンテナンス及びオペレーションの基準も策定すべきであると提案した。

4.4 MSC79

2004 年 12 月に開催された MSC 第 79 回会議では、GBS の基本について議論され、大筋以下の合意に達した。

(a) 国際的にそろったレベルを得るために、GBS の性能要件は、船級協会が世界的に同一に実行できるような均一の基準でなければならない。
(b) 船舶の建造、修繕及び運航において、その船舶が GBS に合致していることを評価し得るものでなければならない。
(c) 船舶の建造場所や建造者によって基準が変わらないことを確保できるものでなければならない。
(d) IMO が作成する GBS は、世界的に均一に理解されるものであって、不明瞭ではなく、これを実現するための仕様的基準が作成され得るものでなければならない。
(e) ゴールは長期間の目標として設定されるものであるが、許容基準は技術の進展にしたがって替え得るものでなければならない。

MSC79 では、基本的考え方とゴール（Tier I）について一応結論を出した。すなわち、

“Ships shall be designed and constructed for a specified design life to be safe and environmentally friendly, when properly operated and maintained under the envisaged operating and environmental conditions, intact and foreseeable damage conditions throughout their life.” 「船舶は、設定された使用期間に渡り、想定される運航及び環境海象条件のもとで適切に保守され運航される時、健全時及び想定される損傷時において、安

全を保持しかつ環境を汚染しないように運航されるよう、設計され建造されなければならない。」

なお、設定する船舶の使用期間の標準は 25 年とすること、想定する環境海象条件は北大西洋海域の海象とすることが提案され、多くの支持を得た。ギリシャは、最初はタンカーとバルクキャリアに関する Tier II を早急に作成するように主張した。これに対してドイツ、オランダ及び北欧諸国は、Tier I から Tier III までは仕様的な（presctiptive）要件であってはならないこと、ゴール及び基本性能要件はリスクベースで考えるべきであると主張した。

4.5 MSC 80

GBS の 5 階層のうち、第 1 階層から第 3 階層について今次会合で検討された。第 1 階層は基本原理の現行ドラフトが修正なく合意され、適用について、「全ての“新”船」であることが再確認された。第 2 階層は、適用対象を「航行に制限がないタンカー及びバルカー」の新船に絞ることが確認され、構成を、「設計」、「建造」、「就航中」に再分類した上で詳細事項が合意された。

また、第 3 階層は CG にて草案を作成することとなった。なお、リスクベース・アプローチとの協調（FSA WG）の必要性を認識し、当面、FSA と GBS の審議は、並行して行うこととなった。

今後、第 3 階層が、第 4 階層(IACS 規則等)の GBS 適合性の検証法を規定するのか、安全率等の具体的な数値規定を行うのか、等の基本路線論争が開始され、安全率等の具体的な数値規定を審議することになれば、我が国によるタイムリーな対応が重要となる。

前回会合（MSC 79）で合意した GBS の 5 階層システム（第 1 階層；ゴール、第 2 階層；機能要件、第 3 階層；適合性検証、第 4 階層；技術規則、第 5 階層；業界標準等コード）にしたがって、IMO は、第 1 階層から第 3 階層までの作業を進めていくことを、はじめに確認した。

下記のような本会議からの作業指示に基づき、前回作業部会（WG）のレポート(MSC80/6)をベースに、各国からの提案を WG で検討した。

8. GBS の基本原理をとりまとめること（リスクベース・アプローチの取扱いも含む）
9. 第 1 階層をとりまとめること
10. 第 2 階層を見直すこと

そして、時間が許せば、

11. 第 3 階層の草案を見直すこと
12. IMO 規則への GBS の取り込み法を検討すること
13. GBS の作業計画を見直すこと
14. 次回 MSC81 に向けて、GBS 検討作業を継続する CG の設置と CG で議論すべき課題を検討すること

（1）GBS の進め方について（リスクベース・アプローチとの関連）

本会議では、リスクベース・アプローチとの協調（FSA WG）の必要性を認識しているが、当面、FSA と GBS の審議は、並行して行うこととなった。WG では、リスクベース・アプローチを取り入れるべきか／当面は仕様的アプローチを採るべきか(リスクベース・アプローチの実用性)について相互に譲らぬ議論が続いた。妥協案として、リスクベース・アプローチの推進派が MSC81 に具体的な実用事例を提出すること、その結果を受けて以降の方針を決定することで合意した。

（2）基本原理、及び第 1 階層（ゴール）について

基本原理の現行ドラフト（MSC80/6 Annex1）は、修正なく合意された。第 1 階層の適用について、「全ての“新”船」であることが再確認された。

（３）第 2 階層（機能要件）

WG では適用対象を「航行に制限がないタンカー及びバルカー」の新船に絞ることが確認された。「その他の船種、及び航行に制限のあるタンカー及びバルカー」の新船については、次回以降検討することとなった。また、第２階層の構成を、設計、建造、就航中のカテゴリーに再分類し、各要件の順番を並べ替えることとなった。審議の経緯、及び結果概要は、次のとおり。

（イ）設計

Ⅱ.1　Design life

設計寿命について、ギリシャは「30 年」を強硬に主張したが、我が国を含め大勢が「25 年」を主張したため、25 年とすることでギリシャも同意した。合意した内容は、次のとおり。

「設計寿命は 25 年未満であってはならない」

Ⅱ.2　Environmental conditions

「北大西洋」の海域を想定して疲労を含めた強度設計を行うことに合意した。合意した規定は、次のとおり。

「船舶は、北大西洋の環境条件と関連する長期波浪データを基に、設計されなければならない」

Ⅱ.3　Structural strength

「構造の冗長性」に関わる規定については、新たな項目" Structural redundancy"を設けて規定することとなった。また、第２階層でネット寸法に対して「安全マージン」を要求することで合意したが、具体的な数値については複雑であり統一的な記載が不可能との認識の下、第 3 階層以下で規定することとなった。合意された規定は、次のとおり。

「船舶は、適切な安全マージンをもって設計されなければならない。以下、省略」

Ⅱ.4　Fatigue life

我が国と IACS は、疲労は強度設計の一側面であり、敢えて「疲労寿命」を独立項目とする必要性はないと主張したが、ギリシャ、ポーランドが「疲労寿命」の項目を残すことを主張し、項目が残った。合意された規定は、次のとおり。

「設計疲労寿命は、設計寿命(25 年)未満としてはならず、Ⅱ.2「環境条件」をベースにしなければならない。」

なお、ギリシャ・バハマ等の少数を除く WG の多数意見は、「北大西洋環境条件を想定するので、設計疲労寿命を設計寿命よりも長くする必要性は無い」であり、WG 議事録に明記された(上記規定は、対外的にポジティブな印象を与える表現としている)。

Ⅱ.5　Residual strength

合意された規定は、次のとおり。

「船舶は、規定された損傷状態（衝突、座礁または浸水）において、波浪と内圧に耐えるように、十分な強度をもつように設計されなければならない。以下、省略」

Ⅱ.6　Protection against corrosion

ギリシャ及びバハマを除く多数意見に従い、機能要件としての「防食 "Protection against corrosion"」を新設し、その下に「塗装寿命」と「腐食予備厚」を細目として記述することで合意した。また、ギリシャ及びバハマ等少数が塗装及び腐食予備厚確保をそれぞれ強制化することを主張したが、技術進歩を阻害しな

い様に自由度確保に配慮する大勢は、これを否決した。また、防食法として塗装を採用する場合には塗装寿命を指定すべきこととなったが、区画によらない一律な年数は規定できないとの認識の下、15 年とか 10 年とかの具体的数値規定は削除した。また、腐食速度の設定に関しては、ギリシャ及びインタータンコが加速モデル試験によるデータの否定除外を主張したが、技術進歩推進に配慮する大勢からは、支持を得られなかった。

Ⅱ.7　Structural redundancy

合意した規定は、次のとおり。

「船舶は、いかなるひとつの構造部材の「局部的な損傷」も、他の構造要素の瞬時な損傷を引き起こし、構造強度の喪失・水密性の喪失など重大な損傷に至ることが無いように、冗長性をもって設計され、建造されなければならない。」

バルカーの構造 Redundancy 規則騒動を基に慎重に立案された原文となっており、対外的には小骨のみならず大骨をも含む記述ながら IACS による「解釈」の自由度(影響を極限する)を十分に確保した内容となっている。

Ⅱ.8　Watertight and weather tight integrity

新たな項目として 追加することに合意した。合意された規定は、次のとおり。

「船舶は、就航中に十分な水密性と風雨密を保持するよう、設計され、船体開口の閉鎖装置は、十分な強度と冗長性を有するように設計されなければならない。」

Ⅱ.9　Design transparency

安全を確認するために必要な設計情報へのアクセスが要求されることとなったが、知的財産権について、配慮されることに合意した。また、“ship construction file”の内容を検討していくことも合意した。

（ロ）建造

Ⅱ.10　Construction quality procedures

工作品質標準の共通化・強制化要求は無くなった。本件についても、知的財産権について、配慮することに合意した。

Ⅱ.11　Survey

合意した規定は、次のとおり。

「検査プランは、船種、設計を考慮して、船の建造段階に対して作成されなければならない。また、検査プランには、就航中の検査において、特に強度を必要する場所を明示するものでなければならない。」

（ハ）就航中

Ⅱ.12　Maintenance

メインテナンスがしやすいように、設計建造しなければいけないことだけを規定した。また、メインテナンスファイルの必要性を、今後検討することとなった。

Ⅱ.13　Structural accessibility

合意した規定は、次のとおり。

「船舶は、概観検査、詳細検査及び板厚計測を容易にするために、すべての内部構造にアクセスできる適当な交通手段を提供するように、設計、建造、装備されなければならない。」

（4）作業計画

前回会合で合意された作業計画について見直した。内容は、以下のとおり。

10. リスクベース・アプローチを、GBS フレームワークの中で検討することを追加した。
11. GBS の基本原理に関する審議は(一応)終了した。
12. 第 1 階層（ゴール）に関する審議は(一応)終了した。
13. 第 2 階層（機能要件）に関し、①全ての船種に展開すること、②制限された航海に従事する船舶に展開すること
14. 第 3 階層（適合性検証）の作業を進めること、その際に、①検証のためのガイドラインを作成することの必要性、②検証は、どのように、誰が行うかを、検討すること
15. GBS の施行
16. GBS の IMO 規則への組み込み
17. “ship construction file”の作成、検査・メインテナンスファイルの必要性の検討
18. 階層をまたぐスコープの一貫性と妥当性を見直すこと

（5）コレスポンデンス・グループ（CG）の設置

CG の作業について、WG では、第 3 階層の草案作成に絞って、議論することに合意した。しかしながら、WG 終了後のプレナリーで、ドイツ等がリスクレベルの検討も CG の TOR に追加することを主張した。結果、CG の TOR は、第 3 階層の草案作成のみとなったが、我が国などリスクレベルの検討を行った経験のある国々で協力して、次回に提案文書を提出することとなった。CG のコーディネータは、WG 議長の Jeffrey G. Lantz（米国）になった。

（6）本会議における審議

本会議は WG の報告を受けて、以下のとおり議論し、合意した。

（ア） リスクベース・アプローチ

ドイツ等がリスクレベルの検討も CG の TOR に追加することを主張した。その結果、CG の TOR は、WG 案ととおり第 3 階層の草案作成のみとなったが、我が国はリスクベース・アプローチも併行して行うとした WG の合意に賛成して、そのような作業を推進する意向を表明し、ドイツ、デンマーク、スウェーデン、ノルウェー及び英国と協力して検討を推進し、次回に提案文書を提出することとなった。なお、ドイツが協力グループの幹事を務め、その第一回会議をコペンハーゲンで６月下旬に開催されることとなった。我が国からは吉田公一（海技研）が参加することとなった。

（イ） CG の設置

本会議は、(ア)の議論の上に立って、CG の設置とその TR を WG 提案どおり承認した。

（ウ） GBS の基本原理と GBS 新船構造基準

今回 WG が作成した GBS の基本には、maritime security への配慮が示されているのも係らず Tier I 以下にはこれらが示されていないという指摘が再三なされたが、これは「GBS の基本原理」は新船構造基準に限らず GBS に関する一般原理を示すものである一方、今議論している Tier I から Tie V は GBS 新船構造基準であることを混同していることが原因であることを、我が国は再三示唆した。

また、今次検討を進めている GBS 新船構造基準の Tier I から Tier III は、Tier IV 以下で作成される船級

協会の詳細構造基準を決めるための基準であることの認識の欠如も見受けられた。

（７）所感

今次検討を進めている GBS 新船構造基準の Tier I から Tier III は、Tier IV 以下で作成される船級協会の詳細構造基準を決めるための基準であることから、「規則作成のための基準」の作成のためには安全レベル（あるいはリスクレベル）を認識して目標を定める必要がある。これには、独及び北欧が主張するリスクベース・アプローチが不可欠である。我が国は、バルクキャリアの安全性に関する FSA を実施した際に、リスクを求める手法を調査の上定めて使用した経験があり、またその際に、バルクキャリアのみならず多くの船種のリスクも求めている。これらの蓄積した技術及び情報を活用して、リスクベース・アプローチを欧州と協力して推進する必要がある。

4.6 リスクベース・アプローチに関するコペンハーゲン会議

MSC の GBS において、リスクベース・アプローチを推進するカナダ、デンマーク、ドイツ、日本、オランダ、ノルウェー、スウェーデン、英国は、MSC への対応について協議する会議を、2005 年７月にコペンハーゲンで開催した。

(1). 日時：2005 年７月５日（10:30am～18:00pm）、６日（08:30am～16:00pm）
(2). 場所：デンマーク海運省（Danish Maritime Authority）Vermundsgade 38C, Copenhagen, Denmark
(3). 出席国：カナダ、デンマーク、ドイツ、日本、オランダ、ノルウェー、スウェーデン、英国

(4). 議事

デンマーク海運省局長 Mr. Christian Breinholt が参加者へ歓迎の意を表して、開会を宣言した。７月５日は Mr. Breinholt の議長の下に会議を進行し、６日は２つのグループに分かれて議論した。すなわち、
(a) Draft group for main lead document to MSC81
(b) Draft group on supporting documents

(4.1) 全体会議（７月５日）

(4.1.1) 基本的な議論

「リスク」の概念について、共通の理解を得るため、ブレーン・ストームを行った。
・MSC に出席する多くの人は、「リスク」についての理解が異なる。あるいは正しく理解していない。
・「リスク」を「危険」と解釈すると、「リスク･ベース」はネガティブなアプローチであるという間違った印象と理解を与える恐れがある。

IMO の GBS-新船構造規準の Tier I から Tier III は、「**standard for rule**」、つまり「新船構造規準を実際に定める classification societies の rule に対する規準」であることを確認した。

(4.1.2) 作業計画

当非公式グループから MSC81 へ、リスクベース・アプローチを紹介して、GBS-新船構造規準への適用を示す文書を提出する。この文書は、当グループに参加する国の共同提出とする（最終的な参加の合意は各国主管庁による）。さらに、co-sponsor を探す（by 日：韓及び中、by ノルウェー：インド、by デンマーク：露、ニュージーランド及びオーストラリア、by 独：ギリシャ及びリベリア

文書は以下のように、いくつかに分ける。

(a) 基本文書（Lead paper）：リスクベース・アプローチを紹介し、その可能性、リスクの現状等を示す。その内容は Draft group for main lead document で検討する。１０月までに draft し、１１月には IMO へ提出する。

(b) Safety level に関する文書は、吉田、Alex（蘭）、Mikael（Swe）及び victor（加）が draft する（今年中）。

(c) 用語に関する文書：

デンマークが「リスク」に関する用語をまとめた文書を用意する。MSC81 に提出するかは、その出来を見て、グループでさらに検討する。

(d) Global structure of Tier II 及び Tier III：

リスクベースに書き換える可能性を示す文書を作成する。Presctiptive Approach と Risk-based Approach を比較して、両者に大きな差異はないことも示したい。

(e) Possible structure of Tier III

英はリードして制作する。

(f) Risk-based Tier III

ノルウェーは draft する。

(4.2) Draft group for main lead document to MSC81

リスクベース・アプローチを紹介する Lead paper の内容を議論した。吉田は図 4.2.1 の内容を提案し、グループは基本的にこれに合意した。内容は Ms. Jost（独）が draft して、メンバーにメールする。

リスクベース・アプローチは新しいものではなく、すでに適用されている（海洋構造、他の産業など)。これを示す ISSC の報告書（吉田が議長をしてまとめたもの）がすでにあり、非常によい情報であるので、吉田が日本からこれを MSC81 へ INF paper として提出するよう要請された。

また、ISSC の Design Principle Committee の報告も提出するよう、その Committee の議長（Prof. Hansen: Denmark）に要請する。

Tier の組み立てには、日本が MSC79 へ提出した文書が適当であることにグループは合意した。これに risk/safety level を入れた図 4.2.2（日本作成）も活用することとなった。すなわち、メンテナンスと運航もリスクの算定に入れる必要がある。追加すべきこととしては、Tier III の役割を Tier II に明確に示す必要がある。あるいは、Tier 0 に各 Tier の役割を明確に示す必要がある。

現状のリスクレベルは、ISSC の report（吉田が提供する）及びデンマークの文献から引用する。

現状のリスクレベルについては、日本のバルクキャリア FSA（MSC75/INF.6）から転用する（吉田が提供する)。構造は、船舶のリスクの一部であるが全体ではないことに注意する必要がある。

リスクベース・アプローチの適用例は、曲げモーメントが適当であろう。

(5) 次回会議

このグループの会合は極めて有用であることをグループは認識した。

今年１０月に EU の会合があるため、来年１月（MSC81 への提出前）に次回会合を開く必要性を認識した。場所はロンドン（DNV 事務所）で、FP50 の後の１月１６日。

(6) 連絡方法

DMA が web-site を開設することも検討したが、e-mail で情報交換及び文書配布することに合意した。

Lead paper contents

- What is “risk” and “safe”.
- There is no 100 % safe or 0 % risk.
- Accountability of the Administration is to show the public the quantity/level of safety of ship,.
- Risk-based and/or safety level approach have been introduced and used for many years in offshore industries, land based industries.
- Probabilistic approach (as a part of safety level approach)
  – Sea environment is expressed by probabilistic method.
  – Strength of structure (buckling, ultimate, fatigue) is expressed bay probabilistic method.
  – Probabilistic approach for oil out-flow in MARPOL
- So, whatever you like or not, we must introduce safety level (or risk base) approach.
- Safety level approach is NOT difficult one.
  – [show examples]
  – [draft Tier II based on safety level approach]

図 4.2.1 Lead paper contents (1st draft by Yoshida)

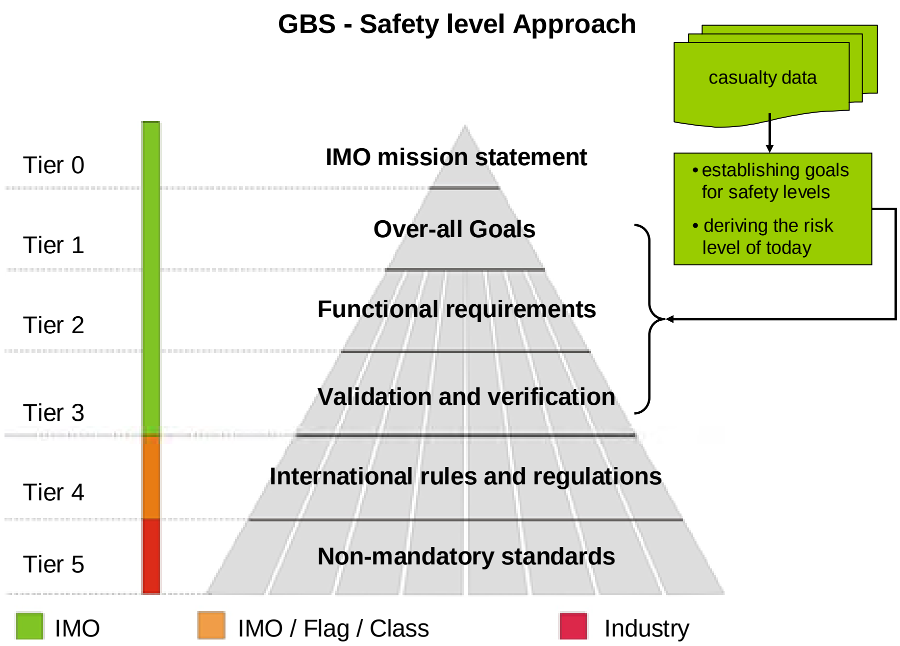


図 4.2.2 Safety Level Approach (Risk-based Approach)

4.7 リスクベース・アプローチに関するハンブルグ会議

MSC の GBS において、リスクベース・アプローチを推進するデンマーク、ドイツ、日本、オランダ、ノルウェー、英国は、前回のコペンハーゲン会議に続き、MSC(1 への対応について最終的に協議する会議を、2006 年３月にハンブルグで開催した。

(1) 日時：2006 年３月１日、２日、３日

(2) 場所：ジャーマニッシャー・ロイド本部、ハンブルグ、ドイツ

(3) 出席者：

デンマーク；C. Breinholt, J. Juhl

ドイツ：A. Jost, S. Asshauer, P Sames

オランダ：E.C.A. Bekke

ノルウェー：R. Skjong

英国：A. Hull

日本：吉田公一

(4) 議事内容

(4.1) コペンハーゲン会議の議事録の確認：確認した。

(4.2) MSC81 提出文書

MSC81 へ提出した文書及び提出予定文書について、意見交換及び議論した。

・グループの基本文書 MSC81/6/2、及び Seminar on GBS Risk-based Approach MSC81/INF.4 を確認した。セミナーに関しては、別の議題の下で検討する。

・吉田は、コペンハーゲン会議の合意に基づいて、ISSC（国際船舶海洋構造会議）のリスク・アセスメント委員会報告（2000 年報告及び 2003 年報告）を、MSC81/6/3 及び INF.7 として提出したことを報告し、その概要を説明した。これらの報告書は、リスクレベル（セーフティ・レベル）基準の設定の仕方及び設定例を示している。また、最近の船舶及び海洋構造物に関するリスク・アセスメントを概括している。

・Skjong は、IACS の提出文書 MSC81/INF.6 を説明した。この文書では GBS と FSA の関係、リスクベース・アプローチの事例を示している。

・Asshauer は、INF.6 の内容に基づいて、GBS と FSA の関連を明確にした文書の提出を IACS が準備中であることを報告した。すなわち、FSA の Step 1 から 3（HAZID、リスク・アセスメント、RCO）は、GBS の Tier I ゴール及び Tier II 基本性能要件を検討･作成するための資料を提供できる。FSA の Step 3 から 5（RCO、CBA、勧告）は、Tier IV 及び V の基準、規則作成に利用できる。

･吉田は、日本が提出予定の基本姿勢文書の案について、リスク・ベースアプローチのみのためはなく、日本の基本姿勢を示したものであることを断った上で説明し、支持を求めた。以下の議論があった。

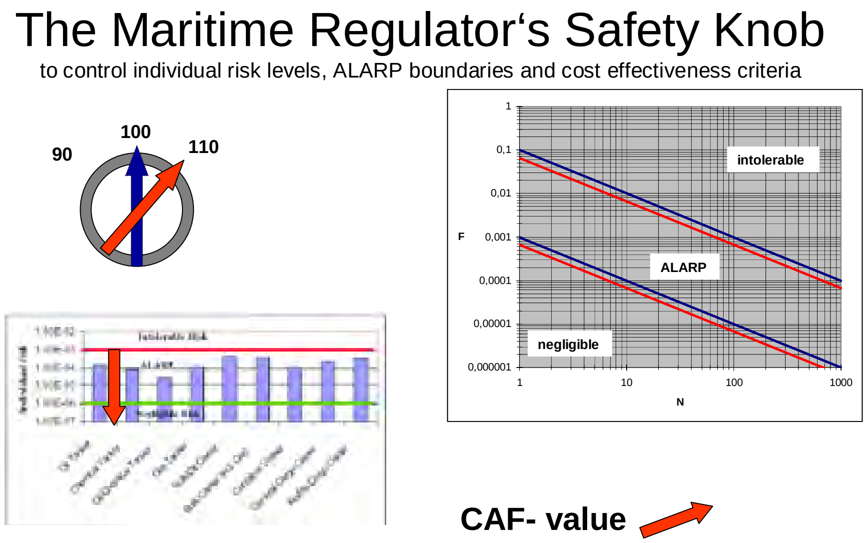
- Fig.2 の説明が足りない。メンテナンスが悪いと、GBS の下でも船はダメになることを言いたいと説明した。この説明が不足している。
- リスクベース・アプローチに関する項（７～11）は支持する（デンマーク、独、英、ノルウェー）。
- 判定用基準（Criteria for verification）については、IMOのGBSを利用して（理由にして）、IACSのCSRに変更を加えようというギリシャの目論見は周知の事実である。これに乗ってはいけない。つまり、prescriptiveなcriteria for evaluationをGBSの中、あるいは別のstandardとして決める（ギリシャの狙い）に手を貸してはならない。MSC80ではTier IIにそのようなspecific prescriptiveな基準を入

れることを阻止してきた。Risk-based Approach Tier I及びIIをrisk-baseで、quantitativeに記述すれば、それ自身がcriteriaとなるという吉田の考えに皆が賛成した。このことで日本の基本文書の当該部分（7～12）を支持する。さらにこれを明確にし、実現可能であることを示す文書を日本に書いてほしい。MSC81/6/3 Japanに資料があるため、これを利用した７週間文書を吉田が書くこととなった。

- ➢ Tier III については、evaluation/verification の手続きを書けばよい。最終的には各国の主管庁に verification の権限があることは、皆が理解した。Tier III の実際の evaluation/verification の作業の進め方も、大方基本と同様の意見であった。
- ➢ なお、Hull が、英文の修正を示唆した。

・Mull は英国提出予定文書について説明した。リスクベースがよいかどうかの問題ではなく、利用できる技術な利用すべきである。リスクベース・アプローチは新しいものではなく、信頼性構造設計・評価など、十分に使われてきた技術もある。

・Breinholt はデンマーク提出予定文書を示し、「safety knob」の考えを紹介した。すなわち、goal と基本性能要件をリスクベースで記述すれば、安全を向上したい時には、安全指標を上げればよいという考えである。これは、FN カーブで「ALARP」の閾値を変えることに対応する。



・日本を除く各国の提出予定文書に対するコメントは、３月６日（月）正午までにメールで送る。特に、GBS は「Standard for rules」であることを十分認識し、また IMO のメンバーに認識させるように努めることで合意した。

(4.3) 用語（Glossary）

デンマークが用意している文書は、未完成部分が多く混乱を招くため、提出しないことに合意した。

(4.4) Tier III について

Risk-based Approach Tier I 及び II を risk-base で、quantitative に記述すれば、それ自身が criteria となる。

従って、evaluation/verification の手続きを書けばよい。すなわち、Teir III を Risk-base で書く必要はない。最終的には各国の主管庁に verification の権限があることを確認した(ここの部分は日本の意見と同じ)。

(4.5) GBS Guidelines

吉田は、IMO の rule making tool として、FSA はその進め方・手法を IMO の Guidelines として定めた。GBS の内容は、MSC79 及び MSC80 で詰めて合意したが、その進め方・手法は文書にしていない。したがって、GBS についても guidelines を作成したほうが良いと提案した。これは大方の支持を得た。日本がそのような意見を文書で出せるかを考えるよう、要請された。

(4.6) GBS Seminar on Risk-based Approach

５月９日に IMO にて開催する GBS Seminar on Risk-based Approach について、打ち合わせた。

・MSC81 における GBS の議論で、Risk-based Approach への支持を得ることが、セミナーの目標である。
・レセプションは、日本が準備する。MEPC54 の時には、IMO と打ち合わせる必要がある。
・各プレゼンターが用意したプレゼンテーション概要を検討し、修正要請をまとめた。これらの修正を入れた概要をデンマークが取りまとめて、７週間文書として MSC81 へ提出する。
・発表内容文書及びスライド（Power Point)は 4 月 1 日までに作成して回章し、その後の２週間でメールにより意見交換してから仕上げる。
・EU へは、SAFEDOR から参加を呼びかける。
・MSC 会議で日本が通常行っているレセプションへの招待状を、当セミナーのレセプションへの招待状とし、それにセミナーのプログラムと登録用紙（MSC81/INF.4）及びセミナーの概要（各プレゼンターの発表概要：デンマークが準備する）を同封してほしいという要望があった。
・５月８日に、最終打ち合わせ会議を設ける（場所は未定。おそらく DNV の London 事務所）

(4.7) GBS Risk-based Approach Seminar

MSC 81（2006 年５月 10 日から 20 日に開催）の１日前に、GBS のリスクベース・アプローチを推進する国は、GBS のリスクベース・アプローチに関するセミナーを開催することに合意し、準備を進めている。セミナー開催案内は、MSC81 の公式文書 MSC81/INF.4(資料 1)として回章されている。

５．欧州の動向の調査

5.1 SAFEDOR

SAFEDORは、最新技術によって船舶の安全を費用対効果の上に立って向上させ、欧州の造船・舶用業界の競争力を高めようとする欧州連合（EU）のプロジェクトである。

このため、リスクベースの船舶の安全に係る規則体系を構築し、これに適合でき、かつ費用対効果のあるリスクベース・デザインの技術・手法を開発することを目標としている。ここで、リスクは、実行可能な範囲で出来るだけ低く抑えることを目指す。

SAFEDORは以下の作業項目から成る。

- 人的要因を含む通常の運航、極限状態、事故及び重大事故のシナリオを組立て評価する方法を開発し、これを設計に取り込む手法を確立する。
- 船舶の安全及び保安を維持しつつ、経済性のある技術的解決方法を開発する。
- リスクベースの規則体系を構築する。
- 以上を満足する船舶設計事例を開発する。

リスクベース･デザインは、通常の設計目的（船速、載荷量、乗船旅客数、等）に合致しつつ、リスク（人命喪失、環境汚染）の回避及び減少を設計の中で取り扱う総合的設計手法とする。このデザインの中では、リスク低減効果とそのための費用の対比を行い、経済的に可能かつ有利な設計を見出す手法も含む。これは、現状の「ルールに寄る設計」とは大きく異なり、設計者に相当の自由度を与えつつ、安全性の向上と経済性を両立させるものである。

SAFDORは、2005年から３年計画で開始された。

IMOに対しては、MSCで検討しているGBSの中で、リスクベースの規則体系を構築しようとしている。

5.2 日本とSAFEDORの協調会議

SAFEDOR と日本及び IMO の協調会議が、2005 年 10 月に、ギリシャのクレタ島で開催された。

(1) 日時：　２００５年　１０月１３日 午前０９：３０ ～ 午後１３：００
１０月１４日 午後１６：００ ～ 午後１８：３０

(2) 場所：　Knossos Royal Village Hotel, Crete, Greece

(3) 出席者：

日本側	吉田公一、井上 剛
IMO	Mr. Tom Allan
SAFEDOR	Prof. D. Vassalos, Mr. C. Breinholt, Dr. P. Sames, Dr. R. Skjong, Prof. A. Papanikolaou, その他４名

(4) 議事

(4.1) SAFEDOR の説明

Dr. Sames が SAFEDOR の目標、活動内容の概要を説明した。

- 今年から４年計画で開始する。
- 20mEuro の予算のうち、12mEuro は EU が支給し、残りの 8mEuro は参加団体（造船業、関連工業、

海運業などの業界団体も含む）が支出する。

・プロジェクトは大きく２つに分けられる。

(a) Safety/Risk-based Approach for rules for ships

(b) Safety/Risk-based design of ships

・(a)については、日本と情報及び意見を交換して、進める用意がある。

・(b)については、参加団体（特に業界団体）の利害が係るので、協調は困難であろう。

(4.2) 日本の MP1 の調査研究の紹介

・吉田が、次週の Workshop 用の資料に基づいて、船技協の MP1 の中の Risk-based Approach の活動予定を紹介した。

・日本の調査研究は、今年度から開始したところである。

・IMO における Risk-based Approach on GBS に対応することが今年度の主眼である。

・来年度には、個別の船体強度要件（縦強度、健全時強度、限界強度、疲労強度など）について、Risk-based Approach の可能性を検討することが考えられている。

・吉田はまた、今年 10 月６日に釜山にて開催された Asian International Workshop on IMO GBS の模様を紹介した。

・SAFEDOR 側としては、日本のみならず、韓国、中国及びシンガポールの IMO GBS における Risk-based Approach への参画を期待する。

(4.3) IMO MSC に対する対応

(a) IMO MSC80（2005 年５月）における GBS に関する議論、特に Risk-based Approach について欧州各国と日本が協調して MSC81 へ対処していくことを確認した。

(b) デンマーク海事局長の Mr. Breinsholt から、MSC81 の前の火曜日に、IMO にて GBS: Safety-based approach の one-day seminar を設けることが提案され、賛同を得た。

(d) MSC 議長の Mr. T. Allan は、その場で IMO へ連絡し、会議場（IMO の本会議場）を抑えた。

(e) この会議が国際的な色彩を持つために、デンマーク（＋欧州）と日本の共同開催（名義のみ）としたい旨提案があり、持ち帰って検討する旨、返答し置いた。ドイツの代表にも共同開催に参加することを呼びかける。

・Mr. T.Allan 氏から、日本がいつも開催している Day-before reception を、この One-day Seminar に絡めて IMO で開催することが可能か聞いてきたので、持ち帰り検討する旨、返答し置いた。

・セミナーのプログラムは、デンマーク（＋ドイツ）及び日本（共同開催が合意される場合）で考案する。内容は、Risk-based Approach の説明、例示とし、(1)のメンバーのプレゼンテーションとする。参加は、IMO の Circular letter で正式に周知する（MEPC53 のときの GHG one-day seminar に倣う）。

(4.4) SAFEDOR と日本の共同 workshop

・日本側はまだ、どのような調査研究となるか定まっていないこと、及び SAFEDOR 側も作業を開始したばかりであることから、このような共同 workshop は将来有意義であろうことは認識するものの、時期尚早であるという認識で一致した。

5.3 One-day Open Workshop on IMO GBS

(1) 日時：２００５年１０月１７日

(2) 場所：Knossos Royal Village Hotel, Crete, Greece

(3) 出席者

・吉田公一及び井上 剛（海上技術安全研究所）

・IMO MSC 議長 Mr. T. Allan

・IMO 関係者：Mr. J. Lantz（MSC GBS WG 議長：USA）、Mr. C. Breinholt（デンマーク）、Ms. A. Jost（ドイツ）、Mr. D.Bell（バハマ）、Mr. A. Hull（UK）Dr. R. Cazzulo（IACS）、Mr. D. Rauta（Intertanko）、Mr. G. Scapa（CESA）、

・SAFEDOR：Prof. D. Vassalos、Dr. P. Sames、Dr. R. Skjong, その他多数

・ギリシャ政府：Mr. M. Kefatogiannis

・ギリシャ関係者(Ship owners)：Mr. G. Gratsos, Mr. Panapoulos, Mr. Sakkarines, その他多数

・organizer：Prof. A. Papanikolaou,

(4) 発表と質疑応答

プログラムを添付資料１に示す。各プレゼンターが発表した後、質疑応答があった。主な議論は以下のとおり。

(a) IMO 事務局長 Mr. T. Mitropoulos に代わって、Mr. T. Allan が基調講演し、IMO における GBS の検討の起点とその後の流れを説明した。

(b) Lantz 氏は、MSC80 における GBS に関する議論を説明し、さらに CG の動向を説明した。

(c) G. Gratson 氏（ギリシャ：バルクキャリア船主連合）は、1980 年代に「船体スチールよりも積荷を運ぶ」発想で船体構造の薄いバルクキャリアが多く建造された（これにはギリシャ船主も加担したことを認めた）が、これがその後のバルクキャリアの船体損傷事故に関連していると述べた上で、ギリシャ（特にバルクキャリア船主）としては、スキャントリングを今よりも増す方向で安全性を向上する基準を早期に採用すべきと述べた。また、船主としては、スキャントリング増加に伴う船価の増加を分担することを認めるとともに、そのような船舶のほうが、ライフサイクルコストが良いことを主張した。

(d) Cazzulo 氏（伊:RINA）は、IACS におけるタンカー及びバルクキャリアの Common Structure Rule(CSR)の開発の現状を説明した。また、GBS の Tier III で、何をどのように誰が verify するかを論じ、IACS の CSR が IMO の Tier IV rule としての役割を果たすことの可能性を示唆した。どのように verify するかについては、Tier III が方法論の基本を示し、詳細はさらにガイドラインとして開発する必要があると述べた。verify するのは主管庁に責任があるが、各主管庁が独自に verify する時の整合性（consistency）が問題となるため、IACS が自主的に verify し（Self-Audit）、主管庁に最終判断を仰ぐことが現実的であると述べた。これに対しては、IACS が自主的に verify して主管庁が recognize するのでは、「主官庁が Classification society 任せ」という現状となんら変わらず、GBS 開発の意義に合致しないという意見が示された。

(e) 吉田は、添付資料２にしたがって、GBS の Risk-based Approach の可能性と必要性を述べた。

・Tier I Goal には Safety Level の目標値（年間死亡率：10^{-5} など）を指すことができる。

・Tire II の規則の有効性を、数値的に評価する必要がある。これは、FSA の STEP 3 で RCO を評価する手法で行うことができる。

・外部環境条件が確率論的に与えられるので（25 年間の海象等)、応答する船体強度も確率論的に与えることとなる。

(f) D. Rauta 氏（Intertanko）は、タンカーの事故自体は、年々減少していることを示した上で、塗装、溶接の不備による船体の損傷は引き続き起こっていると述べた。また、機器及び設備の不備（ウィンドラス、舵など）は、造船所が粗悪品を使用している例もあり、これが航行安全に対して危険要因となると述べた。GBS については、船体強度及び工作・施工（塗装も含む）に関してより高い基準を設けて、人命の損失及び環境汚染がない(zero）ことを目指すことが、Intertanko の基本的考えであると結論した。

(g) D. Scapa 氏（伊：Fincantieri）は CESA を代表してプレゼンテーションした。
・GBS は明確なゴールの下に基本性能要件を示すものであり、この要件を満足しつつゴールを達成することに関しては、船舶設計の自由度を認めるべきである。すなわち、基準は「Parfromance-based」であることを支持する。
・その一つの技告げん手段として Risk-based Approach を支持する。
・船舶が 25 年間安全に就航し続けることは、建造基準だけでは達成できず、適正な船体の保守と運航の保持が不可欠である。
・経済的なもくろみを規則作成に持ち込むことに反対する。

(4.5) パネルディスカッションにおける議論
パネルディスカッションでは、タンカーとバルカーに限定して MSC の WG で作成している GBS 新船構造基準と、Risk-based Approach GBS のどちらが良いか、どちらを進めるべきかということに議論が集中した。
(a) IMO MSC80 における Risk-based Approach の認識については、

(i) Allan 氏は、「Prescriptive approach for bulk carriers and tankers」と「Risk-based Approach」を Parallel に進めることに合意したのは、当分はどちらがよいかの決定を先にして、当面はそれぞれの draft を進めることを目指したものとの議長としての認識を示した。

(ii) ギリシャの ship owner たちは、「Prescriptive approach for bulk carriers and tankers」を先行し、「Risk-based Approach」の作業はそれを妨げないという合意であったという認識であると表明した。

(b) ギリシャの ship owner の認識では、shipyard が safety と利益を compromise していると述べたが、吉田は、船価競争と輸送の効率追求の中で、できるだけ軽い船を求めてきたのは船主であったことを指摘した。

(c) ギリシャ船主は、船体構造の要件が経験的によく確立しているタンカーとバルカーに関して MSC が進めている「Prescriptive approach for bulk carriers and tankers」の GBS の作成を妨げるべきではないと主

張した。

(d) Skjong 氏は、IACS の JTP の CSR においても、規定の根底には Risk-based Approach が存在していることを指摘した。

(e) 吉田がプレゼンテーションで述べたように、船舶の外的環境条件も確率論的に与えられることから、いずれにしろ Tier II の基本的性能要件は、Risk-based Approach に立脚しているという認識で大方合意した（ギリシャ船主以外）。

(f) 吉田はさらに、MSC で作成している GBS の Tier I の規定「２５年間、北大西洋の海象で運航可能」を Goal としても、現在の Tier II の規定は抽象的であり、Tier IV の規則（船級規則）を評価するには曖昧さが在ることを指摘し、Risk-based Approach は、Skjong 氏が指摘している基本性能要件の根底にある Risk-based の基礎を明らかにして、Tier III の verification に耐えるものにすることであると述べ、賛同を得た。

(g) Breinholt 氏は、主管庁の説明責任の上からも、目標（safety goal）を数値で示す必要があること、基本性能要件の back-ground にある Risk-based Approach の内容を明示する必要があることを述べ、大方の支持を得た。

(h) Bell 氏は、Risk-based Approach の GBS の中身が未だ明確に示されていないことを指摘した。GBS－ICG on Risk-based Approach としては、MSC81 でそれを明確にする文書を提出する必要があるという認識を確認した。

(i) パネル･ディスカッションの結論としては、Allan 氏の認識(1)(a)に合意し、MSC81 において、さらに議論すべきことに合意した。

(j) Breinholt 氏は、MSC81 の直前の日に、GBS-Safety level approach の one-dayworkshop を開催することを通知した。

(4.6) 全体的な印象

この Workshop は、Risk-based Approach を推進することを SAFEDOR 側がギリシャ船主に対して説得する意味合いが強く感じられた。Allan 氏も SAFEDOR 側に加担しているという印象を得た。

SAFEDOR 及び IMO の Risk-based Approach Group は、具体的な Tier I 及び II を MSC81 で示す必要があるという共通の認識を得た。

船体強度の規定に関することであり、日本として放置・傍観できない事項であろう。むしろ、実現可能な方途を示すことが必要であろう。

６．GBS におけるリスクベース・アプローチの検討

6.1　リスクベース・アプローチ手法の検討

6.1.1　リスクの定義

リスクとは，安全と危険とを包含したもので，リスクの低い側をより安全，リスクの高い側をより危険とする概念である。従来の製品設計では，絶対安全が求められることが多かったが，安全と危険の境界は不明瞭である。リスク管理の概念では，危険と安全の境界はリスクの許容値であり，許容値の決定に広い領域の人間が関与することにより，危険と安全についての広いコンセンサスを得ようとするものである。具体的には，次式の通り，リスクは「破損の起きる確率」と「破損による被害の大きさ」の積として表現される。

RISK(Consequence/Time)＝LIKELIHOOD(Event/Time)×IMPACT(Consequence/Event)

リスクを基にして構造設計を行うことを考えると，破損による結果の重大性を考慮して設定されるリスク許容値に対して，構造側の破損確率を一定レベル以下に抑えることが必要となる。

6.1.2 確率論に基づく構造設計 [1), 2)]

（1）構造信頼性評価手法

破損確率は次式で与えられる。

$$P_f = \int_0^{\infty} f_L(L)\cdot F_S(L)dL = \int_0^{\infty} f_S(S)\cdot(1-F_L(S)dS \qquad (1)$$

ここで，ｆ：確率密度関数，F：確率分布関数，S：強度，L：荷重

安全性指標 β は，安全率と破損確率の中間とでも言うべき安全性尺度で，基本的には強度と荷重の分布特性において平均値と標準偏差の２つの統計量のみで信頼性評価ができるため，計算も破損確率計算より簡便で，しかも破損確率との対応関係があるといった利点がある。

安全性指標（safety index）という概念は，Cornell によって初めて提案された。その定義は次式である。

$$\beta = \mu_Z / \sigma_Z \qquad (2)$$

ここで，Z：安全性の評価関数　（Z=0 が破壊面を表す）

μ_Z：Z の平均値，　σ_Z：Z の標準偏差

Cornell は，安全性の評価関数 Z として安全裕度（強度 S と荷重 L の差）M をとった。また，強度 S 並びに荷重 L は正規分布するものとした。この時，（2）式は次式となる。
この方法は，FOSM（First-Order Second-Moment）法と呼ばれる。

$$\beta = (\mu_S - \mu_L)/\left(\sigma_S{}^2 + \sigma_L{}^2\right)^{1/2} \qquad (3)$$

$$P_f = \Phi(-\beta)$$

ここで，　　σ_X：X の標準偏差

μ：平均値，Φ(X)：標準正規確率分布関数

Cornell の安全性指標の物理的意義を下図に示す。斜線部の面積が破損確率を表している。

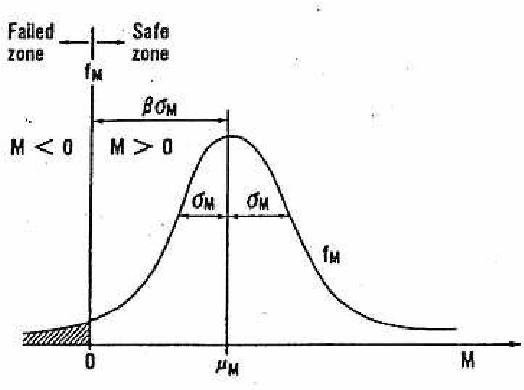


図 6.1　　Cornell の安全性指標

（2）式で定義される安全性指標の大きな問題点は，評価関数に対する不変性の欠如である。例えば，同一の問題（S＜L）に対して異なる評価関数を用いると，安全性指標は異なった結果を与える。そこで，Hasofer と Lind は安全性指標を次式で定義し直した。

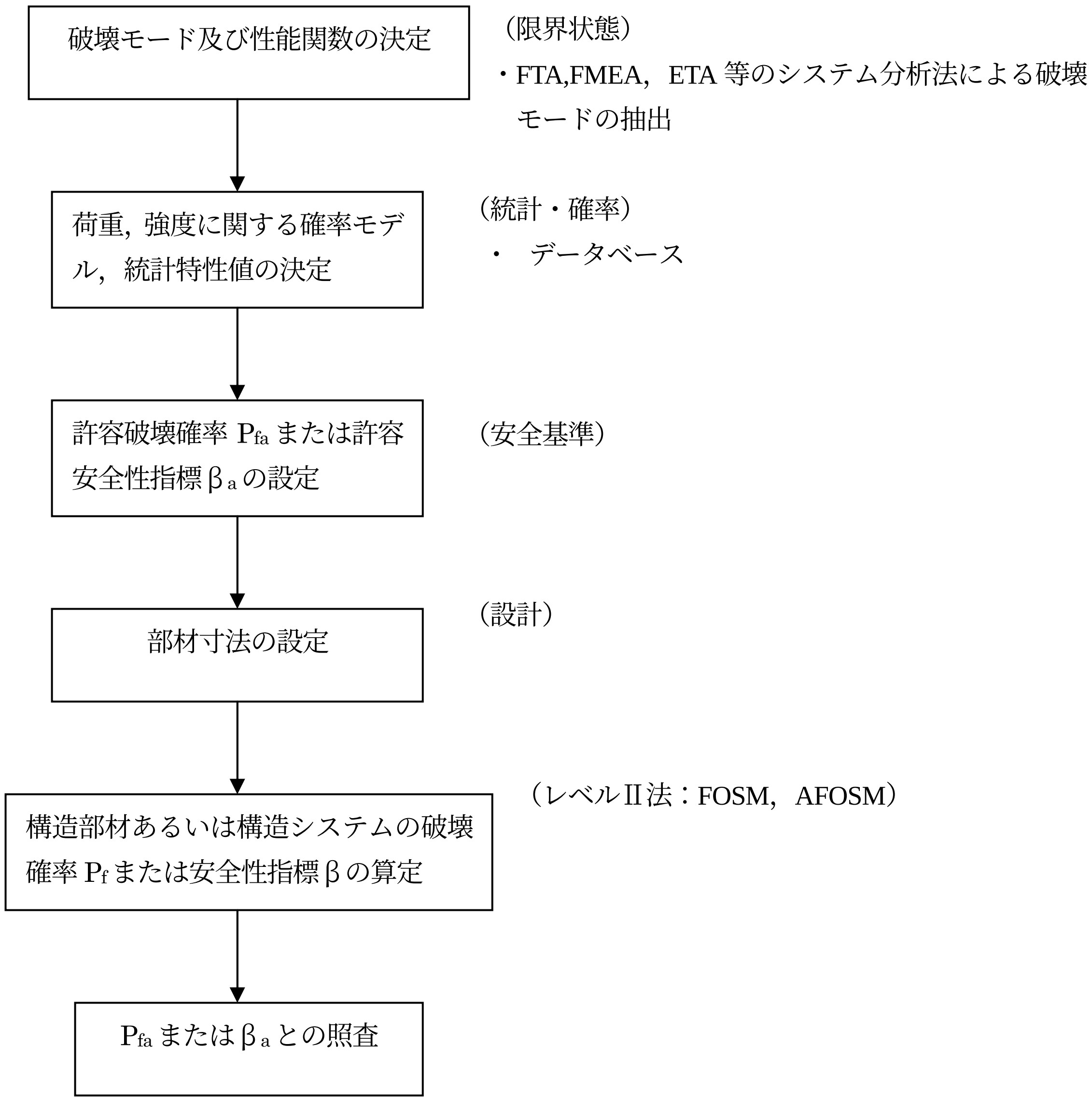
$$\beta = Min\left(\sum_{i=1}^{n} u_i^{\,2}\right)^{1/2} \qquad (4)$$

ここで，$u_i = (X_i - \mu_{X_i}) / \sigma_{X_i}, Z = g(X_1, X_2 \ldots X_n)$

安全性指標 β は，標準化空間の原点と破壊面（Z=0 に対応）との最短距離で定義される。等確率密度線が破壊面に接する点は線形化点あるいは設計点と呼ばれる。安全性指標 β は，この設計点と原点の距離を表す。各変数が正規分布しない場合は，この設計点で確率密度並びに累積確率の等しい等価な正規分布で近似し，その平均値と標準偏差で各変数を正規化すると，安全性指標 β と破損確率 Pｆには（3）式と同様の対応関係が近似的に成立する。この手法は，AFOSM（Advanced First-Order Second-Moment）法と呼ばれる。

（2）構造信頼性設計法

以下に構造信頼性設計法のフロー例を示す。リスクを基に設定された許容破損確率あるいは許容安全性指標に対し，設計案の破損確率が照査され，許容値を満足するまで設計ループを繰り返す。実際には，照査の後に最適化の検討が加味され，費用最小あるいは効果最大化が図られる。


破壊モード及び性能関数の決定
（限界状態）
・FTA,FMEA，ETA 等のシステム分析法による破壊モードの抽出
荷重，強度に関する確率モデル，統計特性値の決定
（統計・確率）
・ データベース
許容破壊確率 Pfa または許容安全性指標βa の設定
（安全基準）
部材寸法の設定
（設計）
構造部材あるいは構造システムの破壊確率 Pf または安全性指標βの算定
（レベルⅡ法：FOSM，AFOSM）
Pfa またはβa との照査

(3) 安全基準の設定

以下に代表的な安全基準設定法を示す。

<table>
<tr><th>方法</th><th>概要</th><th>問題点</th><th>適用例</th></tr>
<tr><td>事故統計に基づく方法</td><td>事故，損傷に関する統計資料から（年）破壊確率を求め，これを参考に許容破壊確率 P_{fa}（あるいは許容安全性指標 β_a）を決定する方法</td><td>・ 母数（対象とする構造物の総数）が定めにくいこと。
・ 事故の原因にはヒューマンエラー等による場合が多く，その影響から設計段階での P_{fa}（β_a）を直接定めることが難しいこと。</td><td>・ P_{fa}（β_a）の決定の際，参考値として用いられる。
・ ダム，橋梁等に対して適用された事例はある。</td></tr>
<tr><td>現行ルールへのキャリブレーションに基づく方法</td><td>現行のルールにより設計された種々の構造物，部材の P_f（β）を求め，その結果に基づいて P_{fa}（β_a）を定める方法</td><td>・ 現行のルールが最適解を与えているという保証はないこと。</td><td>・ 米国鋼構造協会等の多くの示方書改訂は，この方法によっている。
・ ABS/CONOCO の TLP コード</td></tr>
<tr><td>他の災害危険性との比較による方法</td><td>構造物の破壊に伴って予測される（1 名）の死亡危険性を，自然災害あるいは他の人為災害と比べて，ある水準以下に設定する方法</td><td rowspan="2">・ 事故は種々の原因によることから，設計段階での P_{fa}（β_a）を定めることが難しいこと。
・ 海事分野の統計データが必要。
・ 生命の価値を評価することになるため，価値観の相違により容易に受け入れられないことがある。</td><td rowspan="2">・ 石油化学産業，原発，LNG 施設など重要構造物の危険度評価に用いられている。
・ 建築/土木構造物では，構造物の用途，破壊によって生じる人的損失の可能性，破壊予知の難易などを考慮した評価式が提案されている。</td></tr>
<tr><td>人的損失に対する危険回避に要する投資効果による方法</td><td>構造物の破壊に伴って予測される 1 人当たりの死亡率を低減させるのに要する費用の大きさで評価する方法（1 つの生命を救うのに社会が支払う金額には自ずとある基準が存在するとの考え方）</td></tr>
</table>

（星谷[1]，「構造物の信頼性設計法」より抜粋）

許容破損確率あるいは許容安全性指標といった安全基準の最も一般的な設定手法は，現行ルールへのキャリブレーションに基づく方法である。これは，現行のルールに従って設計･建造された構造物の有する信頼度が歴史的にも社会的にも十分容認されており，経済性と安全性についてもある程度までバランスが取れ

ているとの前提に基づくものである。後述する通り，Mansour，Faulkner，海洋工学委員会，SR210 等の報告例がある。

他の災害危険性との比較による方法は，chemical plant や原子力発電所，LNG plant 等のリスク評価で一般的に使われる手法である。この考え方に従った構造物設計への基準として，構造物の用途，重要性，破壊によって生じる人的損失の可能性，さらに破壊予知の難易などを考慮した許容破損確率算式がCIRIA,Allen 等によって提案されている。以下に一例として CIRIA の提案式を示す。

CIRIA[3)] では，社会的な基準を満足するものとして構造物の許容破損確率を次式で与えるものと提案している。

$$P_{fa} = \frac{10^{-4}}{n_r} K_S T \qquad (5)$$

ここで，P_{fa} ：耐用期間中の構造物の許容破損確率（原因は特定しないもの）

T ：構造物の耐用年数（年）

K_S ：社会的基準係数（下表による）

構造物の種類	K_S
公共建築物，学校，病院，ダムなど	0.005
家庭，事務所	0.05
橋梁	0.5
タワー，マスト，海洋構造物	5.0

n_r ：破壊時に構造物の中あるいは近くにいて，被災する可能性のある人間の平均的な数（単位：人）

（4）構造設計における主要不確定性要因

船体構造の信頼性解析を実施する場合に必要となる主要な不確定性要因を以下に示す。

1）荷重に関するもの
- 自然環境：波，風等の不規則変動性
- 環境のモデル化：波，風等の確率分布の推定法
- 環境外力の推定：波，風等による外力の推定法
- 船体運動の推定：船体運動推定法の精度

2）強度あるいは構造物に関するもの
- 材料の力学的特性：降伏強度，引張強度，ヤング率，靭性，疲労強度
- 寸法，形状：板厚，工作誤差，設計図面と工作物の相違，初期不整
- 重量/重心の推定：計算過程における誤差
- モデル化の不確定性：限界状態に対応した評価（性能）関数の近似や誤差，構造解析モデルによるばらつき，構造解析コードの特性，使い方によるばらつき

（5）構造信頼性設計法における課題

船体構造の信頼性解析における現状の主要課題として次の点が挙げられる。

① 荷重，強度に関する確率モデル，統計特性値がどの程度まで合理的に設定し得るか。

② 性能（評価）関数が設定可能な破壊モードは限定される。

→ せいぜい縦強度まで。横強度は極めて困難。

③ 許容安全基準（P_{fa} または β_a）は，荷重推定法，構造解析手法と一体で考えるべきもの。その意味では，現行の許容応力度設計法と本質的には変わらない。

→ 許容安全基準だけが「一人歩き」することは，設計変数の不確定要因が多いだけに問題となる可能性がある。

6.1.3 リスクベース手法の適用事例調査結果

（1）SR210「新世代造船システムに関する調査研究」[4), 5)]

SR210 部会では，昭和 62 年度及び 63 年度の 2 年間に亘り，当時急速な発展を見せたコンピュータの利用技術や通信ネットワークの基盤整備を背景とした新世代の造船システムのあり方，実現するための重要なブレークスルー技術等に関する調査研究を実施している。その中で，将来の船体構造設計法のあるべき姿として Advanced Design by Analysis （ADDA）構想が提起され，安全性の定量的評価の手段として信頼性評価手法の導入が検討された。

（2）日本造船学会海洋工学委員会構造部会 [6)]

海洋工学委員会構造部会では，海洋構造物への信頼性理論の適用に関する検討を行い，「海洋構造物の信頼性設計指針」としてまとめている。ここでは，従来の資源開発のための海洋構造物に限らず，将来の海洋空間利用のための構造物も含めて合理的な構造設計を行うことをも想定しており，具体的な事例研究も実施している。注目すべきは，既存のコードに設定された安全性指標及び CIRIA，Allen 等の破損確率の設定例を参照し，その要因分析を行って，目標安全性指標設定の定式化を行った点にある。以下に提案式の概要を示す。

$$\beta = -0.4 \cdot \log T + 0.53 \cdot (\log N + \log W) + \beta_0 \qquad (6)$$

ここで，T ：構造物の耐用年数，　N ：被害影響度係数，

W ：破損の前兆を表す係数，　β_0 ：安全基準係数（$N = W = 1$ の時の β ）であり，最終限界状態などの瞬時の破損に対しては 4.0，疲労限界状態のような累積型の破損に関しては 4.6 を 1 つの目安としている。

（3）DnV [7)]

DnV では，Classification Note として信頼性手法のガイダンスを発行している。手法の解説と共に，考慮すべき確率変数とその分布型について提案している。また，目標破損確率及び安全性指標を示している。ここで目標とされた破損確率及び安全性指標は，1982 年にノルウェー建築構造物設計示方書として発表されたものを踏襲しており，SAFEDOR にも引き継がれていることを考えると，欧州においては一定のコンセンサスが得られているものだと考えられる。

以上，3 件の事例調査結果の概要を次葉に取りまとめた。

[参考資料]

１）星谷　石井；「構造物の信頼性設計法」，鹿島出版会　（1986）

２）Christensen,P.T. and Baker,M.J.；Structural Reliability Theory and Its Applications, Springer-Verlag,　（1982）

３）Construction Industry Research and Information Association (CIRIA)；Rationalisation of Safety and Serviceability Factors in Structural Codes, Report63, (1977)

４）造船研究協会　第 210 研究部会；「新世代造船システムに関する調査研究」報告書，（1989）

５）仁保；試設計と設計での活用（試解析ならびに部材重要度の評価等），造船学会船体構造委員会シンポジウム，（1990）

６）造船学会　海洋工学委員会　構造部会；「海洋構造物の信頼性設計指針」，（1993）

７）DET NORSKE VERITAS；STRUCTURAL RELIABILITY METHODS，Classification Note No.30.6 （1991）

リスクベース手法の適用事例調査結果概要

信頼性構造設計、海洋構造物等に関するリスク・アセスメント、船級協会規則等におけるリスクベース・アプローチ手法の適用事例について調査し、概略を以下の表に整理した。

	SR210 新世代造船システムに関する調査研究	造船学会海洋工学委員会構造部会 海洋構造物の信頼性設計指針	DnV Structural Reliability Methods
報告年月	1989 年 3 月	1993 年 8 月	1991 年 9 月
目的	現行設計法の問題点（許容応力の設定等、経験に基づく設計法）を解決し、新形式船舶等の設計に、信頼性評価手法を導入するための可能性について調査研究した。調査項目は次のとおり。 ➢ 信頼性工学の導入 ➢ 部材重要度評価法の導入 ➢ 船体構造強度総合評価法の確立	信頼性理論の適用に関わる諸条件の検討と具体的な事例研究を行い、「海洋構造物の信頼性設計指針」としてまとめる。	荷重、材料特性、モデル等のばらつきを取りあつかい、破損確率で評価する信頼性手法を基に規則化されている。
対象 構造物	船舶	海洋構造物	海洋構造物
検討内容 規則の 流れ	上記３項目について検討	信頼性適用の歴史的背景から、構造信頼性理論の紹介、荷重／強度モデルの推定とその不確定性、信頼性設計の適用結果まで、構造信頼性設計に関連する課題を網羅している。	構造信頼性解析の主なステップを、以下のように与えている。 i. 目標信頼度を設定 ii. 全ての重大な損傷モードを特定 iii. 限界状態関数に対する損傷基準を定式化 iv. 統計的変数と限界状態関数のパラメータを特定 v. 各損傷モードに対して、信頼性解析を

			実施 vi. 算定された信頼度で十分か評価 vii. 感度解析の実施
適用事例	・船体梁崩壊強度 ・タンカーの横断面崩壊解析 ・上甲板防撓構造座屈強度解析〔1〕 ・半没水型双胴船の最終強度評価〔1〕	セミサブ型海洋構造物について、以下の破壊モードに対する信頼性解析を実施 ➢ 各ﾌﾞﾚｰｽとｺﾗﾑとの結合部の降伏 ➢ 最も波浪変動応力の高い水平断面における疲労亀裂 〔参考〕船体上甲板の座屈	Production ship を例に、信頼性設計を紹介
成果概要 規則内容	・ 信頼性設計フローを提案 ・ 部材重要度の導入で、合理的･効率的設計を示唆	海洋構造物の信頼性設計指針完成 以下、参考になりそうなデータを示す。 ・許容破壊確率あるいは目標信頼度の設定にあたっての考え方 →（参考）許容年間破壊確率（DnV（1998）） ・ジャケット型海洋構造物の総合的構造信頼性設計指針の設定の流れ ・部材重要度の評価法と目標信頼度の設定法 ・不確定要因（材料・工作のばらつき等）に関連するデータを紹介。	構造信頼性手法 以下、参考になりそうなデータを示す。 ・許容年間破壊確率（表－１参照） ・不確定要素の設定方法 ・安全性指標の経年変化 他
信頼性 工学導入 の効果	・新しい構造様式の船舶の設計 → 経済性と調和し、安全性を保証 ・新しい材料の採用 → 新材料導入の評価が可能 ・材料や解析技術及び建造技術等の進歩 → 解析技術の進歩に対応可能	構造設計で取り扱う不確定性を適当な方法で定量化し、安全性を合理的に評価できる。 従来から行われてきた経験に依存した諸数値に理論性及び妥当性を与え、安全性に対するより明確な根拠が得られる。	

	→建造技術の進歩に対応可能		
課題	信頼性工学の導入 ・信頼性設計フローの具体的展開 ・より精度の高い信頼性評価法の検討 ・複合荷重下の強度評価 ・材料・工作精度のばらつきデータ 部材重要度評価法の導入 ・機能喪失の定義明確化 船体構造強度総合評価法の確立 ・新形式船舶の試設計 ・工作精度管理手法の検討 他	・統計データの不足 ・不確定要因の定量的把握 ・絶対評価のための基準値（β、Pf）の設定 ・設計用計算ツールの開発 ・全体構造システムの信頼性評価手法 ・信頼性監視システム、フィードバックシステム ・検査方法・プログラム開発	

表 6.1.1　1 年あたりの破損確率（P_f）と安全性指標（β）

	Not serious	Serious	Very serious
強度上の余裕がある部材の破損	$Pf = 10^{-3}$ $\beta = 3.09$	$Pf = 10^{-4}$ $\beta = 3.71$	$Pf = 10^{-5}$ $\beta = 4.26$
強度上の余裕がない部材の破損	$Pf = 10^{-4}$ $\beta = 3.71$	$Pf = 10^{-5}$ $\beta = 4.26$	$Pf = 10^{-6}$ $\beta = 4.75$
大規模な崩壊に至るような破損	$Pf = 10^{-5}$ $\beta = 4.26$	$Pf = 10^{-6}$ $\beta = 4.75$	$Pf = 10^{-7}$ $\beta = 5.20$

6.2 リスク・クライテリアの検討

6.2.1　ISSC の成果

船舶海洋に関するリスク・アセスメントについては、国際船体海洋構造会議（ISSC: International Ship and Offshore Structure Congress）が、Special Committee on Risk Assessment を 1997 年から 2003 年の間設置した。この委員会は、海運だけではなく、種々の産業のリスク・クライテリアに関しても調査して報告している。また、その報告書（2000 年報告書及び 2003 年報告書）は、GBS、特にリスクベース・アプローチに関して重要な情報を掲載していることから、日本はこれらを MSC81 へ文書として提出した（MSC 81/6/3, MSC81/INF.7）。

6.2.2　リスク・クライテリア

リスク･クライテリアに関する考え方は、ノルウェーが MSC72/16 として過去 MSC へ提出している。この文書では、「リスクは決して許容できるものではないが、利益を得るためにはリスクのある活動はある程度は許容される。」と述べている。これは、有史以前から海運に適用されてきた考え方である。

しかしながら今日では、船員が一般の職業となったため、職場環境としてのリスクとしてとらえらっるようになっている。また、乗客にとっては船舶は公共輸送手段であり、船舶の公共輸送手段としての安全性（リスク）が問われる。さらに、環境影響、環境汚染に対するリスクも考えなければならない。

船舶の設備及び運航に係る IMO における国際規則は、そもそも最初の SOLAS 条約がタイタニック号の遭難事故を契機に作成されたように、従来は重大な海難事故が起こったことを教訓に作成されてきた（Re-active）。このような規則作成方法では、時としてその規則作成あるいは改正提案の内容が国民世論に後押しされたもので、充分に技術的な検討を経たものではないこともあった。

そこで、現在の国際条約にある海上安全・海洋環境保護が充分であるかを吟味し、事故が起こってから手当てするのではなく、事故を未然に防ぐように規則を制定する（Pro-active）方途を探りはじめた。IMO の Formal Safety Assessment（FSA: MSC/Circ.1023/MEPC/Circ.392）、Goal-based Standard（GBS）などはそのような動向の上に立つものである（図 6.2.1）。

FSA は、船舶の安全性の向上、及び海洋環境保護のために、現状のリスク分析と可能な Risk Control Option(RCO)の抽出、費用対効果の解析に基づいた RCO の選定と最終判断という一連の作業の方法を定めたもので、言わば Bottom-up な進め方である。

一方 GBS は、まず海上の安全あるいは海洋環境保護の目標を定め、それを達成するための基本要件を確立し、さらに基本要件を満足して目標を達成する手段を模索するもので、言わば Top-down な進め方である。

GBS の目標達成のために、FSA を利用して RCO を求めていくということが可能かもしれないが、このことは今後、十分に研究する必要がある。さらに言えば、Pro-Active な規則作成方法・手法を確立する必要があろう。

船舶は、国際的な物流において大きな役割を担っており、その運航における経済性の確保も重大な事項である。そういう意味で、GBS の議論は、安全と経済性を如何に両立させるかという議論である。この目的のために、船体構造に関する多くの研究が進められている。また造船業界では、安全性を確保しつつ経済的な運航を実現する船体構造を追及する努力が進められている。さらに船級協会では、船舶の安全性を確保しつつ、海運業界、造船業界の需要を満たす船舶の基準作成の努力が進められている。

要は、海運業、造船業、船員、安全確保の責任がある主管庁、船級協会などの関係者（Stake-holders）が協力して、共通して合意できる GBS の確立を進める必要がある（図 6.2.2)。

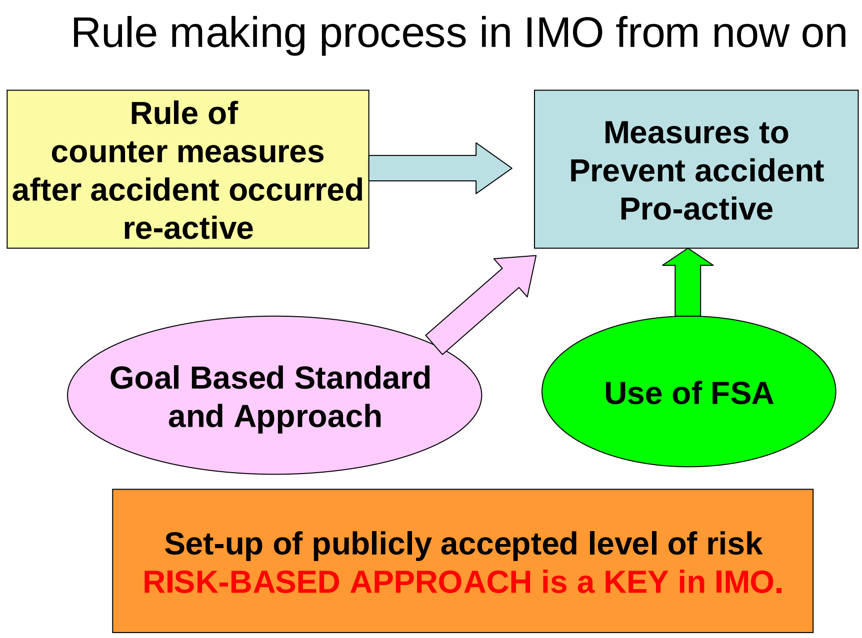


図 6.2.1 IMO Rule making process: from Re-Active to Pro-Active

図 6.2.2 GBS を支えるもの

他の産業では、表 6.2.1 に示すように、すでにリスク・クライテリアを定めている例もある。安全規則を Pro-active に形成する場合、目標としてのリスク・クライテリアを定めるが必要となる。海運・

船舶においても、リスク・クライテリアを検討する時期になっている。

表 6.2.1: Individual Risk Criteria in Use (Annual Fatality Risk)
(from ISSC2000 Risk Assessment Committee)

Authority	**Description**	**Criterion (per year)**
U.K.	Maximum tolerable risk to workers	10^{-3}
HSE (1999)	Maximum tolerable risk to the public	10^{-4}
	Negligible risk	10^{-6}
Netherlands	Maximum tolerable for existing situations	10^{-5}
Bottelberghs(1995)	Maximum tolerable risk for new situations	10^{-6}
New South Wales,	Sensitive developments (hospitals, schools etc.)	$5 \cdot 10^{-7}$
Australia	Residential, hotels, motels, tourist resorts etc.	$1 \cdot 10^{-6}$
DUAP (1997)	Commercial, retail, offices etc	$1 \cdot 10^{-5}$
	Sporting complexes, active open space	$1 \cdot 10^{-5}$
	Industrial	$5 \cdot 10^{-5}$
Western Australia	Sensitive developments (hospitals, schools etc.)	$5 \cdot 10^{-7}$
EPA (1998)	Residential zones	$1 \cdot 10^{-6}$
	Non-industrial (commercial, sporting etc.)	$1 \cdot 10^{-5}$
	Industrial	$5 \cdot 10^{-5}$

HSE (1999). Reducing Risks, Protecting People. Discussion document. Health & Safety Executive
Bottelberghs, P.H. (1995). QRA in the Netherlands. *Conference on Safety Cases*, IBC/DNV, London,
DUAP (Department of Urban Affairs and Planning, Sydney) (1997). *Risk Criteria for Land Use Safety Planning*. Hazardous Industry Planning Advisory Paper No.4
EPA (1998). *Risk Assessment and Management: Offsite Individual Risk from Hazardous Industrial Plant. Preliminary Guidance No.2.* Environmental Protection Authority

MSC72/16(Norway)は、リスクに関していかのように分類している。

.1individual risk for a crew member;
.2individual risk for a passenger;
.3individual risk to third parties;
.4social risk in terms of FN diagrams for crew members;
.5social risk in terms of FN diagrams for passengers; and
.6social risk in terms of FN diagrams for third parties.

日本（社）日本造船研究協会が実施して IMO へ報告したバルクキャリアに関する Formal safety Assesment (FSA)の報告（MSC75/5/2）では、種々の船舶に関して、事故データから現状のリスクレベルを解析した（図 6.2.3）。

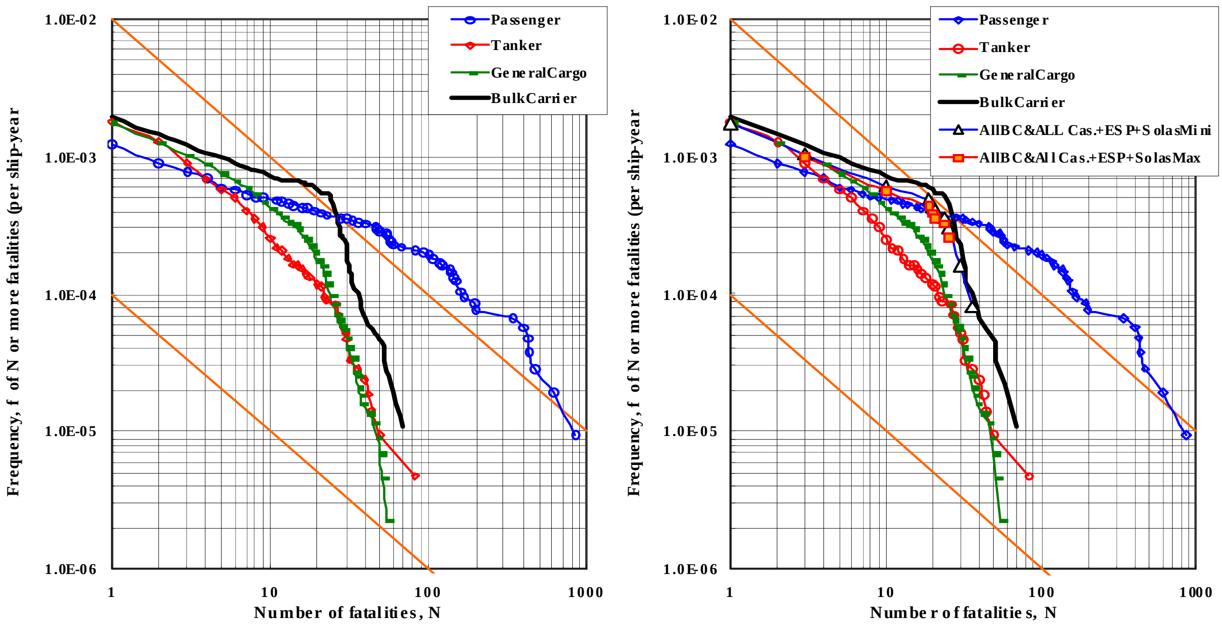


図 6.2.3 種々の船舶の現状のリスクレベル

FSA のステップ４（費用対効果解析）及びステップ５（判断）では、目標としてのリスク・クライテリア（目標リスクレベル）が判断のために必要であるが、FSA そのものはこの目標リスクレベルを設定する方法を持っていない。目標リスクレベルは GBS によって設定されるものであろう。

GBS に関しては、IMO にて議論され、５階層のモデルが合意されているが、GBS そのものを表現した文書はまだ作成されていない。GBS 審議の透明性を確保し、GBS を正しく組み立てるために、「IMO の GBS に関する指針」なるものを制定する必要がある。

なお、以上の考え方を MSC81 に文書で提出した（資料２）。

6.3 船体構造崩壊に関するシナリオの検討

6.3.1 事故シナリオ構築のために考慮すべき事象

初めに、事故シナリオ構築のために考慮すべき事象を列記する。事故シナリオ構築に当っては、以下の内容を順次チェックする必要がある。

(1) 初期条件（荷重および損傷モード）に関する事象：

- 貨物の積み降ろし手順は適切であるか？
- 貨物はローディングマニュアルに従って正しく積載されているか？
- 海象条件は厳しいか？
- バラスト水管理は正しく実施されているか？
- 腐食による板厚衰耗、溶接部の衰耗あるいは孔食はあるか？
- 疲労による亀裂等の初期損傷はあるか？
- 新造時あるいは修繕時に施工不良はないか？
- グラブ荷重、重量物落下等によるパネルの凹損あるいは防撓材等の初期損傷はあるか？
- 局部座屈発生による凹損や亀裂損傷はあるか？
- 衝突・座礁・爆発などの事故に遭遇して、破断、残留変形等の損傷が生じているか？

(2) 局部構造崩壊に関する事項：

- 構造損傷により浸水は発生するか？
- 浸水により復元性／浮力に関係する問題は発生するか？
- 構造損傷範囲が浸水により他の区画まで拡大するか？
- 浸水により新たな損傷が発生するか？

(3) 全体構造崩壊に関する事項：

- 浸水範囲が水密隔壁の崩壊により拡大するか？
- 浸水範囲の拡大により、復元性／浮力に関係する問題が発生するか？
- 浸水範囲の拡大により、構造強度に関係する問題が発生するか？
- 損傷は局部で止まっているか？拡大するか？全体崩壊に至るか？
- 損傷発生時に、荒天回避するか？

異常荷重に遭遇した場合、あるいは衝突や座礁等によって損傷が発生した場合に、船体構造が全体崩壊に至るシナリオ図が、SR228 における研究の一環として作成されている。これを、図 6.3.1 に示す。船体構造の全体崩壊は、強度が不足しているか、作用荷重が過大か、あるいはこの両者の組合せにより発生する。

ここで、過大荷重は必ずしも異常荷重ではないことに注意を要する。すなわち、設計荷重以下の通常の荷重であっても、衰耗した船体にとっては過大荷重となることもある。その意味で、異常荷重を過大荷重に置き直し、新たに作成し直した事故シナリオを図 6.3.2 に示す。

これらの図は、ラフではあるが上記の事象の因果関係をまとめて表わしており、具体的な事故シナリオ作成の参考資料となるものである。

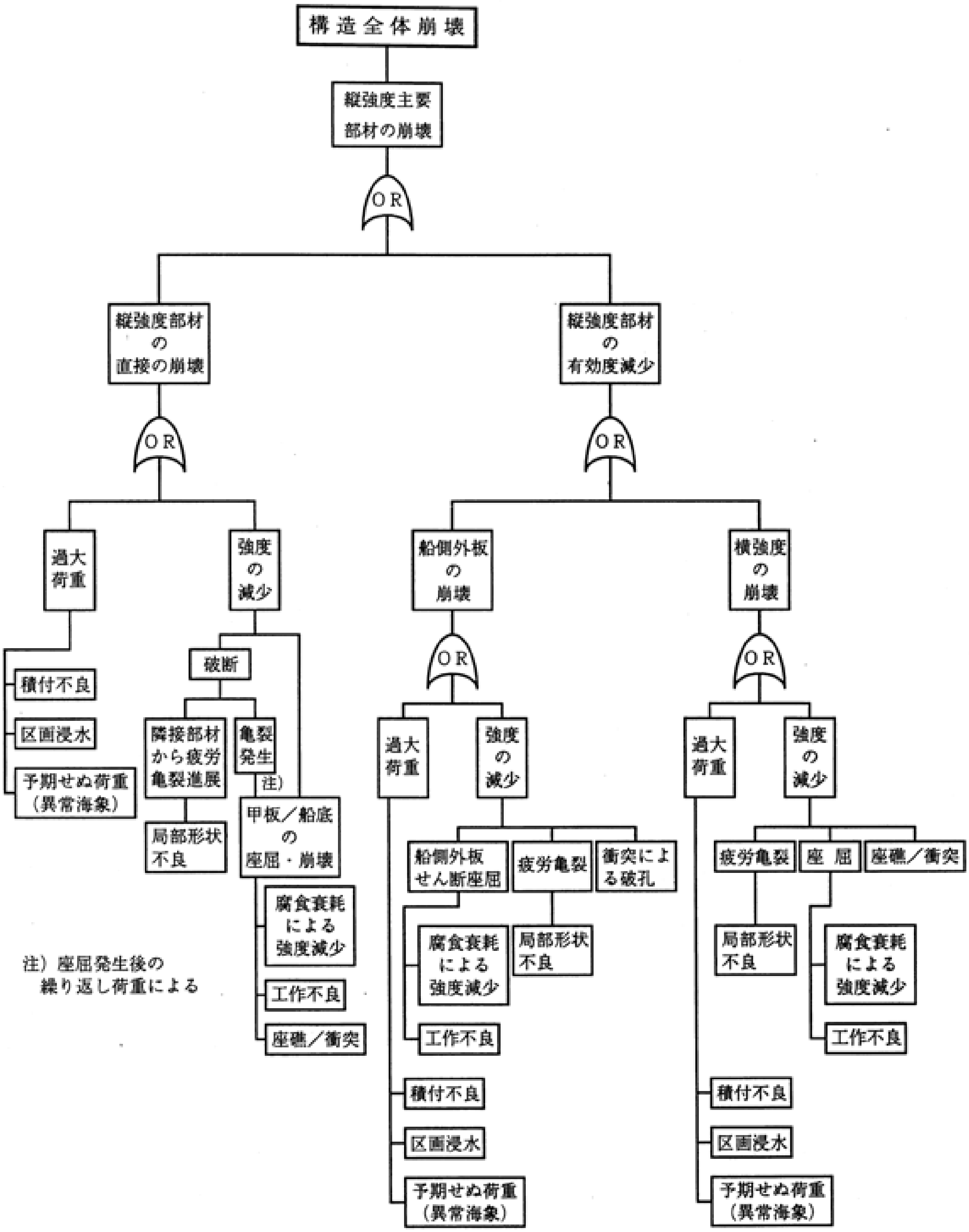


図 6.3.1　船体が全体崩壊へ至る事象（SR228 平成８年度報告書；1996）

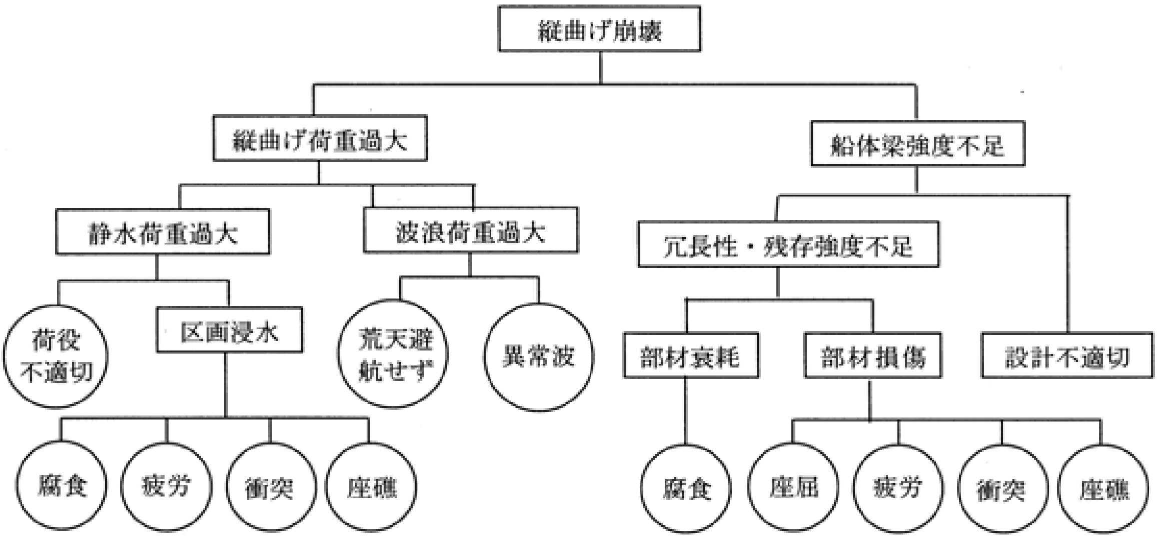


図 6.3.2　船体構造崩壊の概略 FTA

6.3.2 事故シナリオに関する検討

GBS の Tier II に列挙されている 13 の機能要件は、後述のように互いに独立ではないものも多い。その中で、構造崩壊に直接関係した要件は、structural redundancy および residual strength の二つである。ここでは、それぞれ崩壊に関係した事故シナリオで明確にすべきことについて考える。

(1) Structural redundancy

1. パネルの局部座屈 → 防撓パネルの全体座屈 → 船体桁の全体崩壊
   - パネルの局部座屈発生後、防撓パネルが全体崩壊に至るまでの reserve strength の明確化。
   - 防撓パネルの全体崩壊後、船体桁の全体崩壊に至るまでの reserved strength の明確化。
   - 防撓材形状、フレームスペースによる後座屈挙動の差などが縦曲げ強度に関する reserved strength に及ぼす影響の定量化。
   - 初期不整の空間的ばらつき・相関を考慮した最弱パネル崩壊後の reserved strength の明確化。
2. 防撓材の局部損傷 → 防撓パネルの全体座屈 → 船体桁の全体崩壊
   - 防撓材の局部変形、トリピング発生後の reserved strength の明確化。

(2) Residual strength

1. 腐食による甲板・船底外板部材の板厚衰耗 → 縦曲げ強度低下
   - 腐食によるパネル板厚減が防撓パネルの座屈崩壊強度へ及ぼす影響の定量化。
   - 腐食による防撓材の脱落後、防撓パネルが全体崩壊に至るまでの residual strength の明確化。
2. ホールドフレームの腐食衰耗 → ホールドフレームの機能喪失 → 船側外板の破断 → ホールドへの浸水 → 水密隔壁の崩壊 → 浸水範囲の拡大 → 縦曲げ崩壊
   - ホールドフレームの機能喪失が船側外板耐水圧強度低下に及ぼす影響の定量化。
   - 水密隔壁の耐水圧強度の定量化。
3. 船側外板の腐食衰耗 → 船側外板の破断 → ホールドへの浸水 → 水密隔壁の崩壊 → 浸水範囲の拡大 → 縦曲げ崩壊
   - 船側外板の板厚衰耗が剪断強度に及ぼす影響の定量化。

・ 船側外板の板厚衰耗が耐水圧強度に及ぼす影響の定量化。

4. 衝突・座礁・爆発 → 大規模損傷 → 縦曲げ崩壊

・ 損傷規模の特定。

・ 損傷形状の 2 次元的、3 次元的拡がりの影響の明確化とモデル化。

5. 亀裂発生 → 剛性の変化 → 内力分布の変化 → 不安定亀裂発生 → 縦曲げ崩壊

・ 不安定亀裂発生条件の明確化。

6.3.3 具体的な事故シナリオの例

6.3.1 および 6.3.2 に列挙した事項を適用して、具体的な事故シナリオ例のリストアップを行う。

(1) 甲板あるいは船底外板が座屈損傷した場合：

初期たわみ／残留応力／施工不良／工作誤差

↓

板厚衰耗

↓

過大荷重（波浪荷重／貨物積み付けミス／バラスト水管理ミス）

↓

局部パネルの局部座屈 and/or ロンジ材の局部座屈（または脱落）

↓

局部座屈崩壊範囲の拡大

↓

防撓パネルとしての全体座屈

↓

船体が縦曲げ崩壊して折損

↓

大きな座屈変形箇所から低サイクル疲労亀裂発生

（ホギング状態では船底外板から浸水）

↓

甲板または船底外板の破断

↓

沈没

(2) 甲板あるいは船底外板が亀裂損傷した場合：

初期たわみ／残留応力／施工不良／工作誤差

↓

板厚衰耗

↓

高応力集中 and/or 繰り返し荷重

↓

局部パネル、ロンジ材 and/or 両者の接合部分に亀裂発生

↓

疲労亀裂が進展

↓

甲板／船底外板 and/or ロンジ材が破断
（破断が船底外板の場合は浸水）

↓

船体縦曲げの圧縮側で座屈崩壊が発生

↓

大きな座屈変形箇所から低サイクル疲労亀裂発生

↓

甲板または船底外板の破断

↓

船体が縦曲げ崩壊して折損・破断

↓

沈没

(3) 船側外板座屈損傷が発生した場合：

初期たわみ／残留応力／施工不良／工作誤差

↓

板厚衰耗

↓

過大荷重（波浪荷重／貨物積み付けミス／バラスト水管理ミス）

↓

局部パネル／フレーム／ロンジ材の局部座屈

and/or

フレーム／ロンジ材の脱落

↓

局部座屈崩壊範囲の拡大

↓

大きな座屈変形箇所から低サイクル疲労亀裂発生

↓

船側外板の破断

↓

ホールドへの浸水

↓

水密隔壁の崩壊

↓

浸水範囲の拡大

↓

復元力／浮力喪失 and/or 縦曲げ崩壊

↓

沈没

(4) バルクキャリア船側外板に亀裂損傷が発生した場合：

初期たわみ／残留応力／施工不良／工作誤差

↓

ホールドフレームの板厚衰耗

↓

高い応力集中 and/or 繰り返し荷重

↓

ホールドフレームの機能喪失（脱落）

↓

疲労亀裂の船側外板への伝播

↓

船側外板の破断

↓

ホールドへの浸水

↓

水密隔壁の崩壊

↓

浸水範囲の拡大

↓

復元力／浮力喪失 and/or 縦曲げ崩壊

↓

沈没

(5) ハッチカヴァーおよび閉鎖装置が損傷した場合：

ハッチカヴァー and/or 閉鎖装置が損傷

↓

１ホールドに浸水

↓

水密隔壁の崩壊

↓

浸水範囲の拡大

↓

復元力／浮力喪失 and/or 縦曲げ崩壊

↓

沈没

あるいは、

ハッチカヴァー and/or 閉鎖装置が損傷

↓

貨物倉へ空気が侵入

↓

爆発雰囲気の形成 and/or 火災発生の可能性

↓

爆発 and/or 火災が発生

↓

水密隔壁の崩壊

↓

浸水範囲の拡大

↓

復元力／浮力喪失 and/or 縦曲げ崩壊

↓

沈没

例示した以上の事故シナリオに基づいて破損確率を求めようとする場合、それぞれの下向き矢印の箇所で分岐確率を指定する必要がある。しかしながら、分岐確率を報告されている事故データから求めることはほとんど不可能であり、専門家判断に委ねざるを得ないと考えられる。さらに、事故報告そのものも、様々な理由で真の事故原因が示されていない場合も多いことに注意を要する。

6.3.4 過去の事例に基づく事故シナリオ

過去の発生した事故を対象に、事故シナリオを整理する。具体的には、

- 菱洋丸

・ Energy Concentration
・ Nakhodka
・ Erika
・ Prestage
・ バルクキャリアの代表的事故

などが考えられる。Nakhodka の事故原因調査の過程で、爆発説、浮遊物との衝突説及び波浪外力説の３つの可能性が検討され、それぞれの事故シナリオに対応した FTA が作成された。ここでは、それぞれの説に基づく FTA を図 6.3.3、図 6.3.4 および図 6.3.5 に示す。

6.3.5 事故シナリオに基づく信頼性解析手法

リスク解析のためには、まず信頼性解析を実施し、破損の確率を明らかにする必要がある。次年度、6.3.3 で挙げたいくつかの事故シナリオに対応した損傷に対して信頼性解析を実施し、破損確率を計算する。破損確率の計算に当っては、船体構造の部材あるいは船体桁の縦曲げ最終強度など、構造物の capacity を計算する必要がある。同時に、船体構造に作用する外力も計算する必要がある。

構造部材の最終強度を計算するために、基本的には有限要素法による非線形構造解析を実施する。また、バルクキャリアの水密横隔壁並びにハッチカヴァーの崩壊強度を計算するためには、既存の簡易計算法を適用する。一方、船体桁の縦曲げ最終強度の計算には HULLST を使用し、種々の損傷が縦曲げ最終強度に及ぼす影響を明らかにする。さらに、必要に応じて理想化構造要素法も適用する。

これに対して船体に作用する外力を算定するためには、船体運動の非線形時刻歴解析を実施する。また、ハッチカヴァーに作用する青波荷重などに関しては、既存の簡易計算式を使用する。

信頼性解析には、FOSM 法などの近似法と同時に、より高精度を有する結果が期待できる Monte Carlo Simulation の実施も考える。

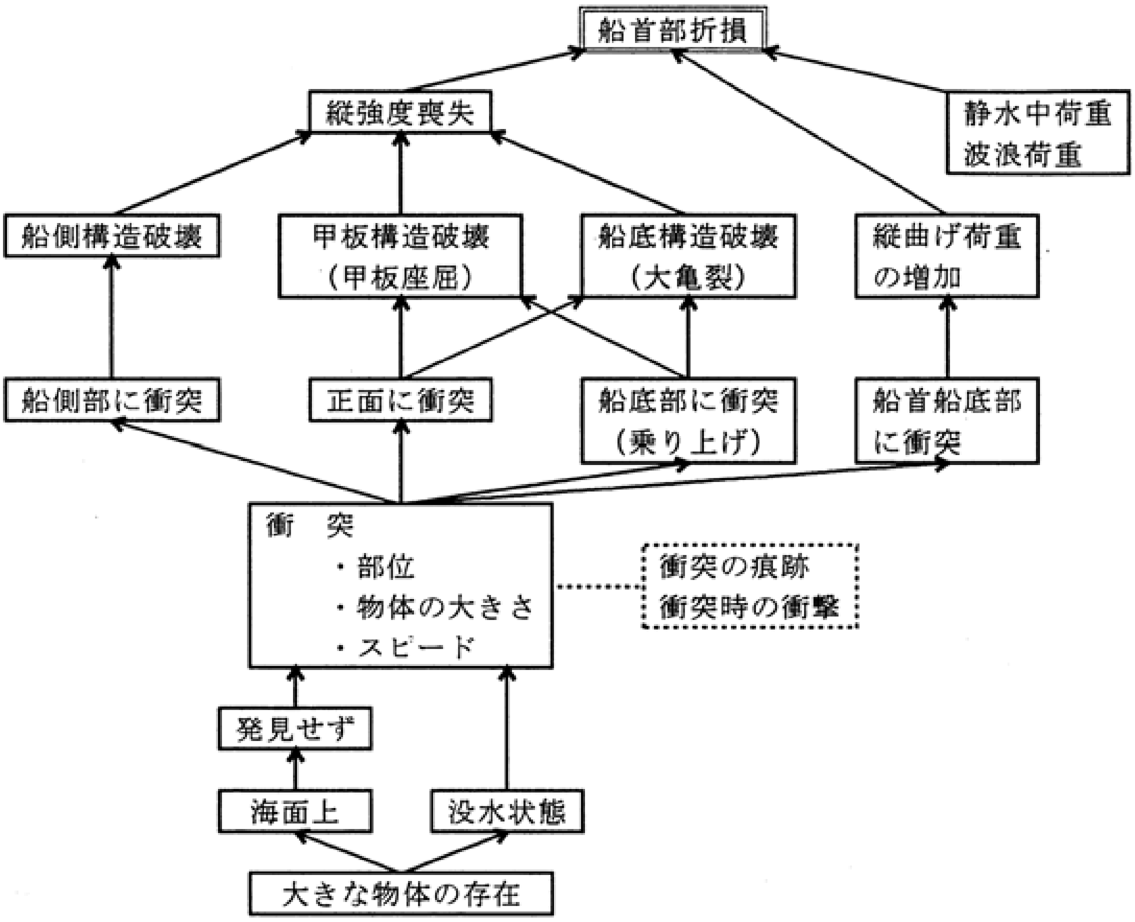


図 6.3.3　ナホトカ号事故の衝突説に基づく FTA
（ナホトカ号事故原因調査委員会報告書；1997）

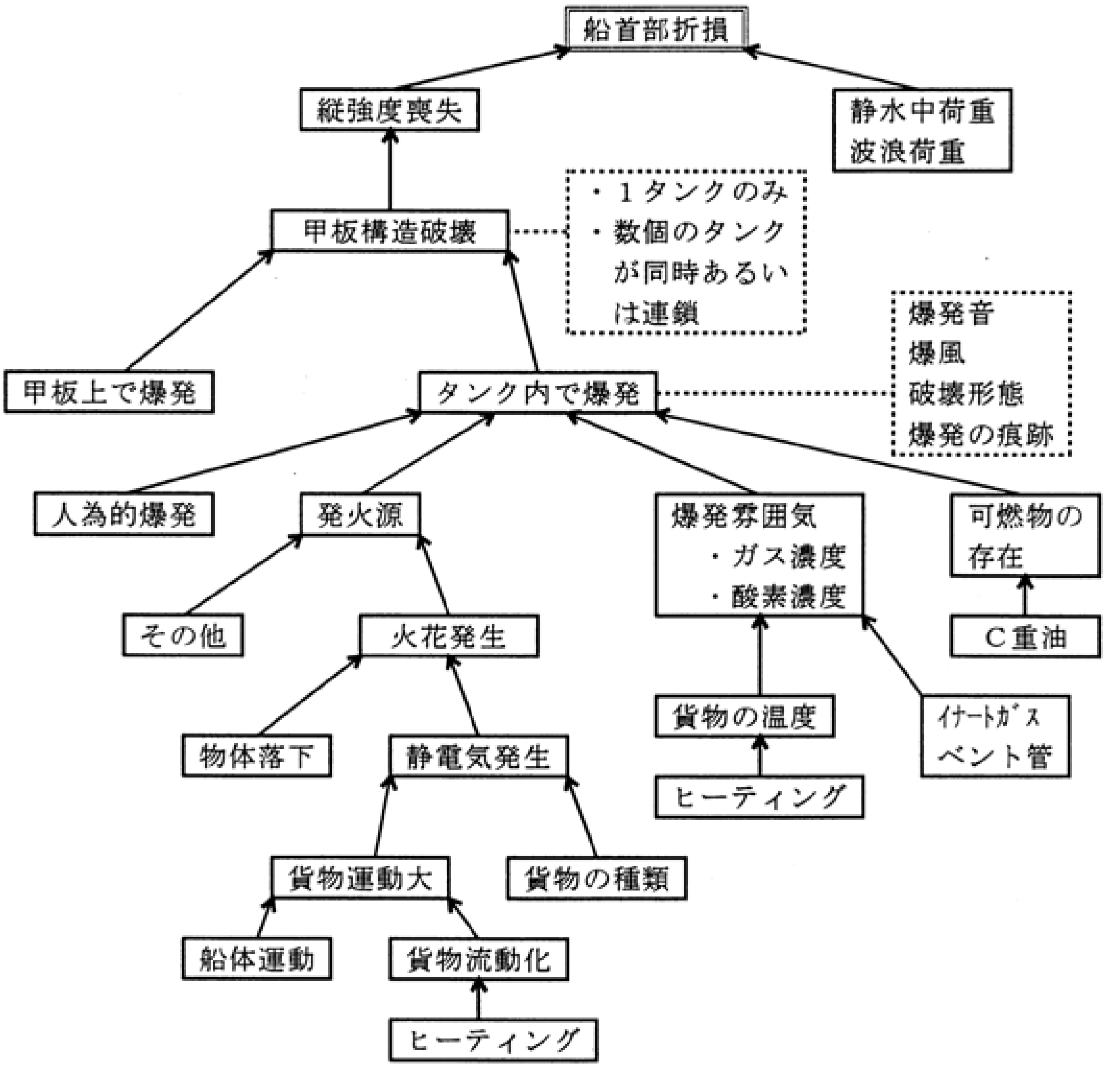


図 6.3.4　ナホトカ号事故の爆発説に基づく FTA
（ナホトカ号事故原因調査委員会報告書；1997）

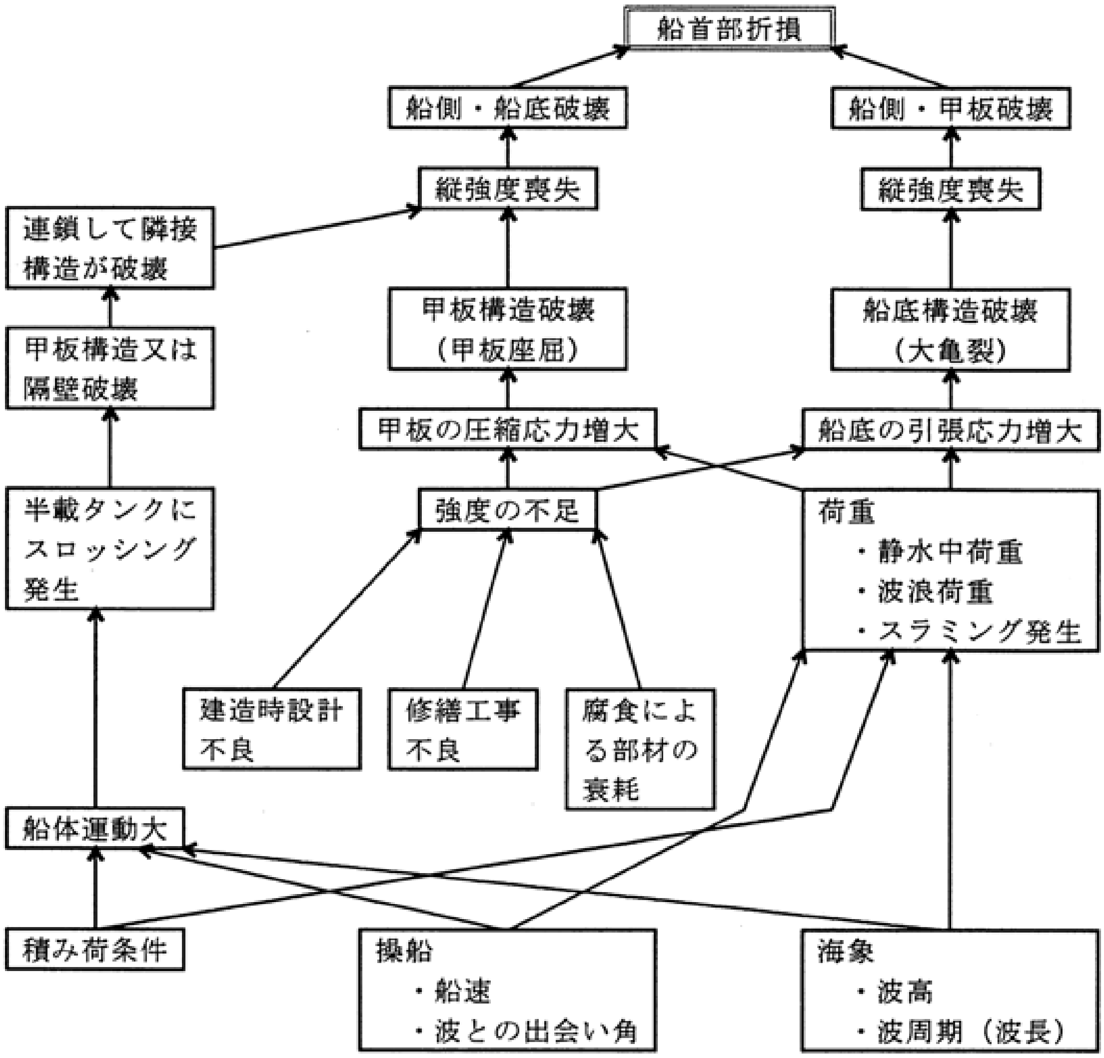


図 6.3.5　ナホトカ号事故の波浪外板説に基づく FTA
（ナホトカ号事故原因調査委員会報告書；1997）

6.4 GBS Tier II性能要件のゴールへの寄与の検討

GBS Tier IIでは、設計、建造、就航中の3段階に分けて基本性能要件が示されている。これらの要件がTier I ゴール達成のための基本性能要件として適切か否かを判断するためには、各性能要件のTier I ゴールへの寄与度を検討する必要がある。また、そのためには性能要件間の相互関係とその関連の度合いについても把握しておく必要がある。ここでは、Tier II性能要件を紹介した後、性能要件間の相互関係について考察する。さらに、各性能要件のTier I ゴールへの寄与度の評価法について基礎的検討を加える。

6.4.1 IMO/GBS Tier II 性能要件の内容

GBS Tier II性能要件の内容は次のとおりである。

<u>設計に関わる性能要件</u>

II.1 設計寿命

設計寿命は、25年未満であってはならない。

II.2 環境条件

船舶は、北大西洋環境条件と関連する長期波浪頻度分布表に従って設計されなければならない。

II.3 構造強度

船舶は、適切な安全余裕を持って設計されなければならない。

1 ネット寸法、intact状態で、就航中に想定されるすべての環境条件および荷重条件、すなわち満載均等積み/隔倉積み、部分積み、多港/バラスト航海、荷役中の過荷重などに耐えるよう、また

2 荷重、構造モデル化、疲労、腐食、材料不整、工作誤差、座屈と残存強度などに含まれている不確実性の度合いを含むすべての設計変数に対して適切であるよう。

II.4 疲労強度

II.2で規定した環境条件の下で、船の設計寿命以上の耐疲労強度を有しなければならない。

II.5 残存強度

衝突、座礁、浸水などの損傷状態で波浪/内圧荷重に耐え得る十分な強度を有していること。残存強度の計算に当っては、永久変形や後座屈挙動などを考慮に入れて船体梁の残存最終強度を考えなければならない。これについては、現実に予測される事故シナリオについて実用的に可能な限り検討しなければならない。

II.6 耐腐食性

設計寿命にわたって構造強度要件を満足するネット寸法を保持するための耐腐食性の基準。

II.6.1 塗装寿命

塗装は、表面処理、塗装剤選択、適用、保持などに関する製造者の指示に合致するよう適用・維持されなければならない。塗装には、その設計寿命が指定されなければならない。実際の塗装寿命は、船体の状態と保守に依存して、設計寿命より長くも短くもなり得る。塗装は、電気防食やその他の方法を含む防食システムの中の一つとして選ばれるべきである。

II.6.2 腐食予備厚

設計寿命に適合した適切な腐食予備厚をネット板厚に加える。腐食予備厚は、腐食環境、防食の有無等に基づいて決められるべきである。腐食予備厚は、実測あるいは加速試験等の結果に基づいて決められるべきである。実際の腐食速度は、船体の状態と保守に依存して、設計腐食速度より早くも遅くもなり得る。

II.7 構造冗長性

船舶は、如何なるひとつの構造部材の局部的な損傷も、他の構造部材の崩壊に直ちに結びつき、船体構造の強度や水密性の喪失などの重大な結果に至ることがないよう、十分な冗長性を持つよう設計・建造されなければならない。

II.8 水密性並びに風雨密性

船舶は意図された航海に対して適切な水密性と風雨密性を有し、船体開口の閉鎖装置は十分な強度と冗長性を有するよう設計されなければならない。

II.9 設計透明性

船舶は、知的財産権に適切な配慮を払いつつ、新造船の安全性を確保するために必要とする範囲内で検証可能な、信頼性が高く制御され透明性のある手順に従って設計されなければならない。main goal-based parameter およびオペレーションの制限に関わる設計パラメータが示されなければならない。

<u>建造に関わる性能要件</u>

II.10 建造品質管理手順

船舶は、知的財産権に適切な配慮を払いつつ、制御されて透明性のある品質管理基準に従って建造されなければならない。船舶建造品質管理手順は、材料、製造方法、アラインメント、組立て、接合、溶接手順、表面処理と塗装などの指定を含まなければならないが、同時に、これらだけに限られるものではない。

II.11 検査

検査計画が、船舶のタイプと設計に応じて、建造段階において開発されていなければならない。検査計画は、船級協会規則とGBSに従う建造を保障できるよう、一連の要求を含んでいなければならない。また検査計画は、船舶の一生を通しての検査中特に注意を払われるべき箇所を明記しなければならない。

<u>就航中の性能要件</u>

II.12 保守

船舶は、保守し易いように建造・設計されなければならない。特に、適切な保守作業ができないような狭隘スペースを造ってはいけない。

II.13 アクセス

船舶は、全ての内構部材に対する概観検査と詳細検査並びに板厚計測を実施するための適切なアクセス手段を提供するよう設計、建造、装備されなければならない。

6.4.2 性能要件間の関係

Tier II性能要件の相互関係として以下の点が指摘できる。

(1) II.3構造強度～II.8水密性並びに風雨密性が、構造強度に関する直接の性能要件（限界状態）を与える。

(2) II.1設計寿命、II.2環境条件は、荷重条件と耐用期間を定めるものであり、II.3～II.8の強度要件に対する基本設計条件を与える。

(3) II.10～II.11の建造時における品質管理と検査計画の策定、およびII.12～II.13の就航中の点検・維持を考慮した設計・建造は、II.3～II.8のすべての強度要件に対する影響因子となる。ここでの品質のバラツキ（初期不整等）、点検・維持の不確実性は強度の不確定因子として取り扱う必要がある。

(4) II.9設計透明性は、設計内容そのものとは別次元の要件であり、安全レベルの定量的評価の対象外の項目である。ただし、main goal-based parameter およびオペレーションの制限に関する設計パラメータの設定はII.3～II.8のすべての強度要件に関わる事項である。
(5) II.6.1塗装寿命とII.6.2腐食予備厚は相互に強く関係し独立に論じることはできない。これらは、すべての強度要件に対する支配的な影響因子の一つとなる。また条文に明記されているように、実際の塗装寿命と腐食速度は、船体の状態と保守、したがってII.10～II.13の建造品質ならびに就航中の点検・維持に依存する。
(6) II.3構造強度は、net scantlingで適切な安全性を有することを要求している。II.6はそのnetを確保することを要求し、そのためにはII.12～13による適切な維持管理方策が必要である。II.3に至る確率は、それらの相互関係を考慮して評価する必要がある。
(7) II.4の疲労強度についても，(6)と同じことが言える。
(8) II.5の衝突・座礁は確率に乗らないイベントであって、発生シナリオ自体は他項目と独立である。残存強度は、II.6耐腐食性、II.7冗長性に依存する。
(9) II.5の浸水は原因事象としてII.4疲労、II.5衝突・座礁、II.6腐食、II.8の水密性・風雨密性が関係する。
(10) II.5は、major damaged conditionにおけるhull girderのsurvivability確保に関する要件である。II.7は局部部材破損後のprogressive failureに対する要件である。II.3がintact状態での基本的な構造安全性確保を要求するのに対し、II.5およびII.3は事故時の安全性及び過大荷重に対する安全余裕の確保を要求する。

6.4.3 Tier II性能要件のTier I ゴールへの寄与度の評価法

Tier II性能要件のTier Iゴールへの寄与度は、対象とする破壊シナリオに対するEvent Treeを描き、各段階での分岐確率の累積値として当該要件が破壊事象の生起にどの程度影響するかを解析することによって原理的に求められる。この際、6.4.2に示した基本性能要件の相互依存性を考慮する。ただし、現実の破壊シナリオでは、分岐確率を事故データから求めることがほとんど不可能な場合や、人的過誤など確率的に評価が難しい場合が数多く存在する。このような場合には、専門家判断により分岐確率を評価する。

6.5 FSA と GBS の関係（MSC 81/INF.6，IACS）について

6.5.1 Executive Summary

IACS は，MSC81/INF.6 において，構造信頼性解析及び限界状態設計と呼ばれる，世界的に合意され且つ標準化された手法及びツールを使って，構造設計規則が如何に開発され，説明できるかの例を提示している。

6.5.2 Main texts

⑴ MSC 79 及び MSC 80 において，GBS と FSA の関係及び構造信頼性解析(SRA)と GBS の関係について活発な議論が行なわれた。

⑵ IACS は，上記に関する IMO の理解を助けるために，リスク基準手法を採用した場合に，これらが如何に強調して働くかの例を提示することとした。

⑶ 例示した手法は，CEA(Cost Effectiveness Assessment)を含めて，如何に FSA が各種損傷モード

（限界状態，Tier II）に対する目標信頼性(Tier I)を導出するのに用いられるか，部分安全係数及び実際の規則の記述(Tier IV)の導出及び説明に用いられるかを明らかにしている。規則自体は基本的なパラメータに対して検証することは非常に困難であるけれども, FSA 或いは SRA 解析はレビューを前提として検証され得る。したがって，この例では，Tier IV の規則をどのように検証する(Tier III)のかの提案も含んでいる。

(4) 文書では，標準化 SRA を使って，規則の記述が如何に導出されるかの例を示している。具体的には，ダブルハルタンカーの最も重要な損傷モードであるハルガーダの最終強度が，如何に明示的に制御できるのかを示している。ハルガーダの最終強度の判定基準は部分安全係数を用いて表現され, SRA を使って較正されている。SRA に関する専門用語を使えば，この例は'Rule Commentary'（規則解説）にあたる。基本的な用語については，MSC 80/6/6 で解説しているが，これらは多くの業界で標準化されているものである。

(5) この手法の利点は, 結果として得られる規則(Tier IV)及び構造寸法と安全レベル或いはリスクレベル(the goal in Tier I)とを結びつけることである。その解析を開発するにおいては，全ての基本仮定，メカニカルモデル，不確実性及び変数が文書化され，それによって，レビューを受けることができる(Tier III)。従って，ANNEX として添付した解析は，規則の導出及び説明に用いられているが，適切な経歴をもつ専門家により検証することが可能である。

５．IACS としては，全ての規則が SRA を使って説明されるべきと示唆しているわけではない。多くの規則が経験則に基づいており，それによって長年に渡って産業界に安全な船を提供している。IACS が示唆しようとしていることは，安全上最も重要な規則について，それを改正する際に，SRA を用いるべきであるということである。さらに言えば，革新的な船種については，経験に頼ることが出来ないため，SRA を常に使うべきであるということも示唆したい。

(6) 安全係数は，物理モデル，統計データ，不確実性及び較正手続きを含む SRA の結果であることに留意すべきである。したがって，該当規則においてのみ適用でき，有効なものであるので，これらと無関係に独善的に変更すべきではない。目標信頼性は，事故等の結果の重大性を考慮して IMO が決定すべきものであるけれど，付録に添付した例では，目標信頼性が FSA で用いられる CEA 解析を用いて導出し得ることを例示している。

(7) 付録の図 A.14 は目標信頼性とライフサイクルコストの関係を示すとともに，最適解が得られることを例示している。この図では，人命損失及び環境汚染を回避することのコストは含まれていない。図 A.15 は，人命損失の回避コストの許容基準の関数を示しており，水平性は共通に使われている 3 百万ドルを示している。図 A.15 では環境汚染を回避するコストは示されていない。それについては，図 A.16 に，流出油１トン当りの環境汚染の回避コスト（Cost of Averting a Ton of oil Spilled (CATS)）として示した。

(8) 付録に添付したように，規則解説（rule commentary）の内容は，全般的に以下のようである。

・ 規則の対象の定義
・ コード較正における例示のスペック

- 限界状態の表現
- 手法
- メカニカルモデル
- 環境荷重
- 荷重及び応答モデル
- 不確実性及び変数（分布及び分布パラメータ）
- 特性値を含むコードの記述
- 感度解析を含む信頼性の結果
- 目標安全性及び事故シナリオ及び FSA を使って如何に導出するか
- 最終的なコード（較正された部分安全係数）

6.6 今後のIMOでの検討

MSC81では、従来の方針に沿って、タンカーとバルクキャリアに関する仕様的GBSの完成を急ぐグループと、GBSをリスクベースで再構築しようとするグループの間での議論があるものと思われる。

仕様的GBSは、MSC81で、Tier IIIが評価手続きのみとして、判定基準は別途定めるか、あるいは評価グループで検討することにで合意できれば、Tier I,II,及びIIIのGBSはMSC81で一応完成することも可能であろう。Tier IIIの判定のための基準作成は、さらに１年以上は掛かる場合もあろう。

リスクベース・アプローチは、欧州のSAFEDORが主導し、それに我が国も入って推進している。SAFEDORは実質上、2005年から３年計画で作業を開始しており、2008の完結を目指している。GBSのリスクベース・アプローチはSAFEDORのシケジュールとも密接に関係すると思われる。2006年のMSC81では、リスクベース・アプローチの可能性に合意できれば、2006年12月のMSC82及び2007年5月のMSC83で中身の実質的な検討を行い、2008年に完成させることが考えられる。

図6.6.1に、考えられるスケジュールを示した。

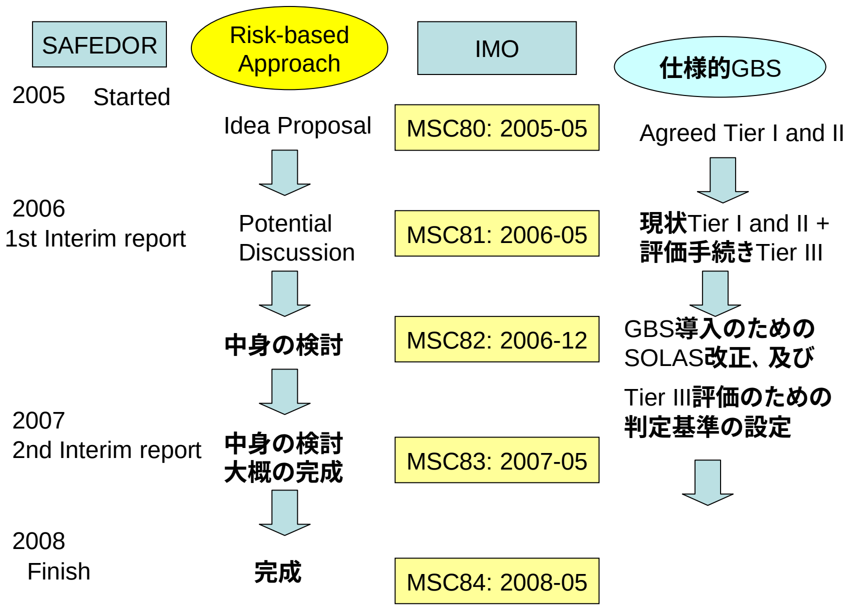


図6.6.1　GBS 考えられるスケジュール

6.7 リスクベース・アプローチが目指すもの

6.7.1 リスクベース。アプローチの利点

- リスクベース・アプローチは、「リスク」を物差しとして、ある基準（要件）が確保する安全レベル（ゴール）を定量的に設定するという取り組みである。
- リスクベースのゴールを定量的に設定し、これを達成するための性能要件も、リスクベースで定量的に把握できるように定める。
- このアプローチのメリットは、

①目標とした安全レベルを確保する合理的な基準体系を確立できる。

②従来の基準体系も、Tier IIIの評価によってTier I 及びIIの定量的基準に合致していることが評価されれば、従来どおり使用できる。構造がほぼ決まっているタンカーやバルクキャリアでは、このルートを取ることができる。

③従来の基準体系から逸脱する船舶（新形式船舶や新しい概念の代替措置）について直接的な評価が可能となる。

④目標田制のための手段の組み合わせによる安全性達成の度合いを図ることができる（腐食予備厚と塗装による防護など)。

- セイフティレベル・アプローチを使った場合、ＧＢＳは次の図6.7.1ようなイメージとなる。

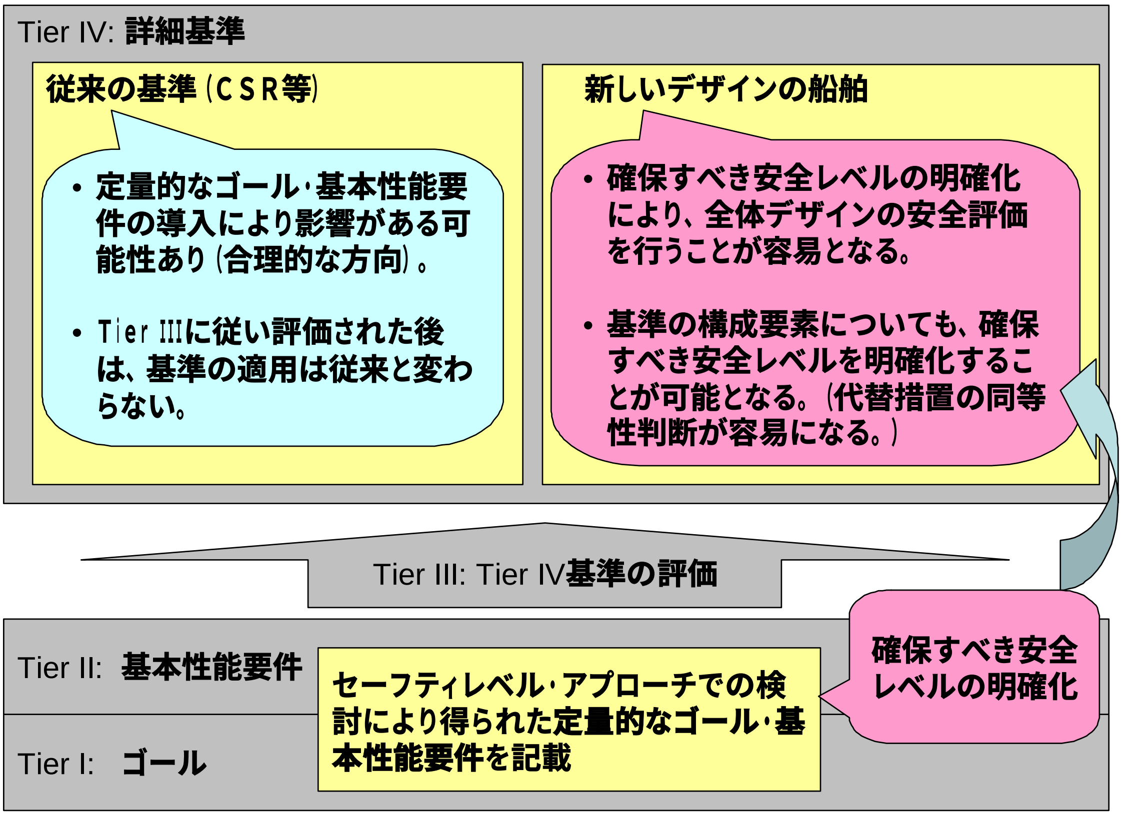


図6.7.1 リスクベース・アプローチによるGBSのイメージ

6.7.2 セイフティレベル・アプローチの活用方策

ＧＢＳにおけるセイフティレベル・アプローチの導入については、次のように活用することが考えられる。

＜ゴール及び基本性能要件に定量的な安全レベルを導入する段階＞

１）ゴール及び基本性能要件に、過剰なゴール及び基本性能要件を導入することを防ぐことが比較的容易になる（安全ならば安全なほど良いという議論に対して、定量的に議論が出来ることになるため）

２）リスクベースGBS構築には今後時間がかかるため、ＣＳＲが現状のまま運用されることとなる。ＣＳＲ（従来よりも安全性を強化した規則）の安全性向上の度合いが評価できる。

＜ＧＢＳの活用段階＞

１） 新しいデザインの船舶を導入することが容易となる。

７．まとめ

平成１７年度の当プロジェクトでは、次の検討を推進して、IMO におけるゴールベース・スタンダード（GBS）におけるリスクベース・アプローチを日本が主導する基盤を提供してきた。

(1) GBS におけるリスクベース・アプローチを考察し、その概要を把握した。
(2) 欧州のリスクベース・アプローチを追及する SAFEDOR の動向を調査し、これに積極的に関与し、協調してリスクベース・アプローチを検討した。
(3) リスクベース・アプローチとして従来から存在する信頼性構造設計の手法及びその実用例を調査し、GBS への利用方法を検討した。
(4) 船体崩壊に関するシナリオを抽出し、定量的解析の基礎を得た。
(5) GBS の Tier II 性能要件が Tier I のゴールへ寄与する度合いを検討し、検討の手法を把握した。
(6) リスクベース GBS において、安全性の定量的ゴール（目標リスクレベル）を設定する方途を検討し、可能性を示した。

以上の成果の一部は、IMO の MSC81 へ文書として提出した。また、MSC81 への対処の資料となった。
今後はさらに、リスクベース GBS の各論（各 Tier）の中身を検討して、提案する。

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