Ongoing works on CSR revision

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IACS Hull Panel Chair

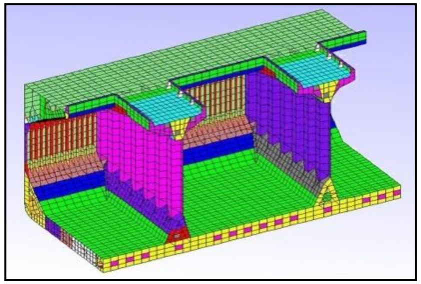
Tripartite 2023

Tokyo, 10 November 2023

A. CSR overview evolving with experience

The ‘Class Cycle’ with IACS Rule Development

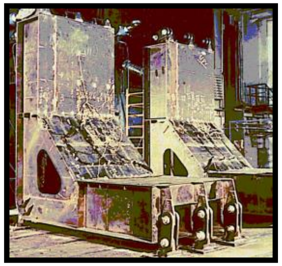
Design approval



Approved

Plans

Rules



Rule Development
- IACS CSR
- IACS UR/UI
- IACS Recommendation
- …

Research
- IACS WG(e.g., Hull Panel)
- Separate project team, e.g., Wave load team
- Joint Working Group
- …

Survey During Construction

Survey in Service

Feedback
- CSR Knowledge Center
- Industry Review on CSR RCP
- External Advisory Group Meeting
- IMO GBS Audit
- IACS/Industry Meeting
- …

IACS Commitments on the Improvement of Safety for BC & OT

CSR-H(BC&OT)
- New Corr. Model
- 7 extended EDWs
- New Buckling Method

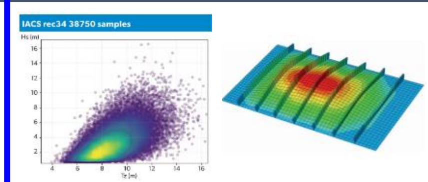
Corrosion Analyses w/ experiences gained

CSR RCP w/ new wave loads, corrosion, enhanced buckling and fatigue req.

UR S11, S11A, S21 w/ new wave loads, corrosion and enhanced buckling req.

Rec.34 Rev.2 w/ new wave scatter diagram

CSR 2023 & UR S35 w/ enhanced buckling req.



Phase 1 Phase 2 Phase 3

2006 2015 2016 2018 2019 2020 2022 2025 202x

CSR-BC, CSR-OT
- Net Scant.
- 3-4 EDWs

IMO GBS Initial Audit

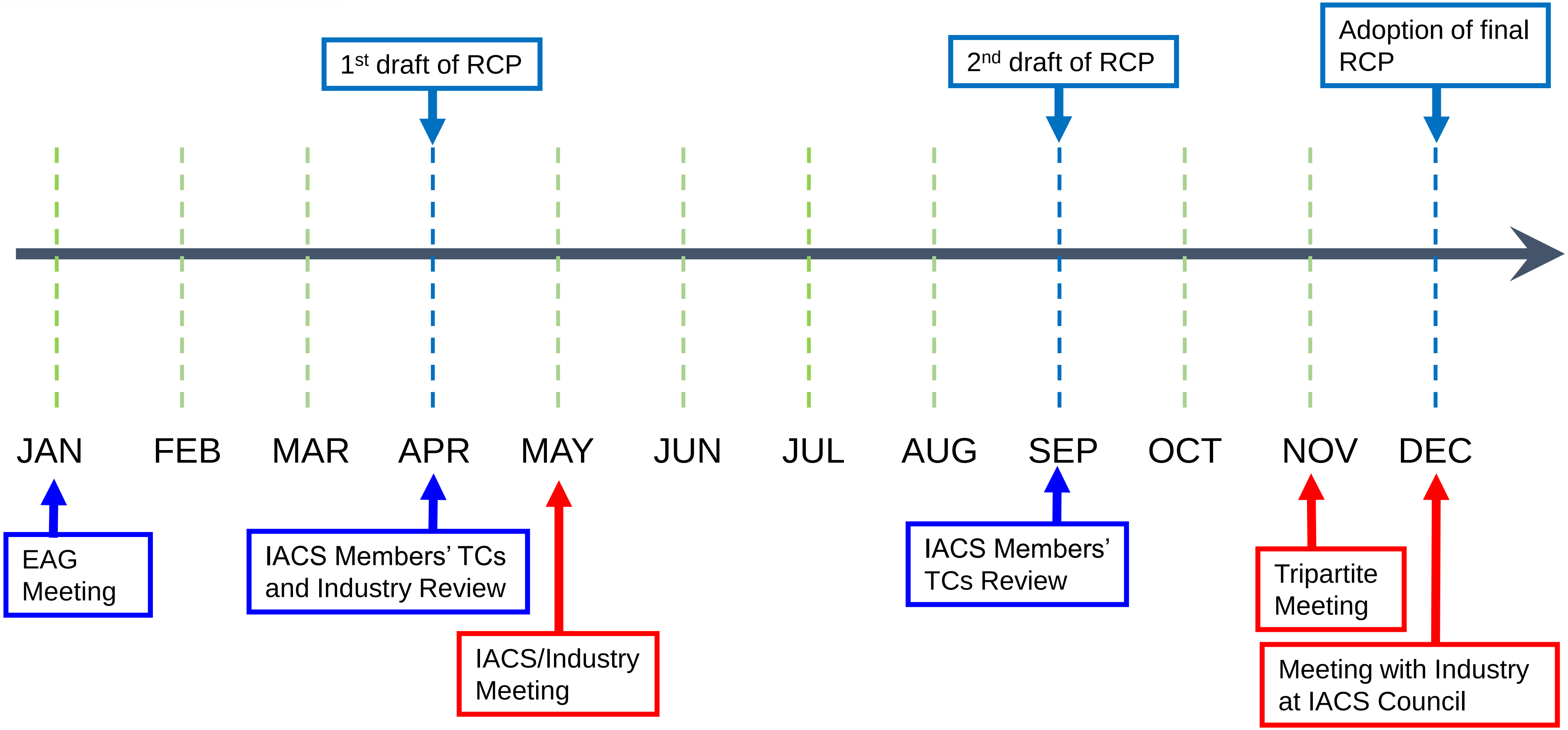
#1 Maintenance

#2 Maintenance

#3 Maintenance(3Y)

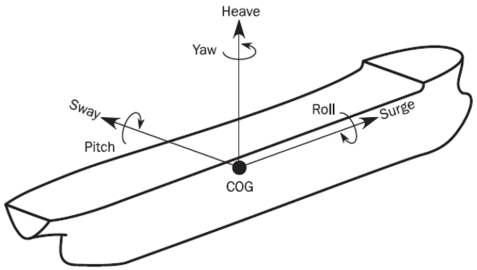
#4 Maintenance(3Y)

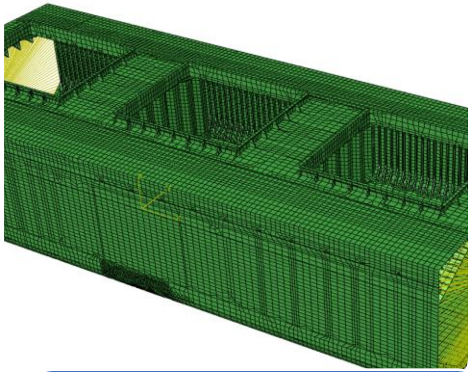
Communication with Industry for IACS CSR



- Other industry fora on request
- via e-mail to IACS CSR Secretary or via a Class Society member of IACS.

IACS Projects – The CSR process





Wave Scatter Diagram - Rec34

- New wave data based on AIS - Hindcast
- Verified Data Source

Wave Loads

- Rule loads w/2022 technology

Structural Analysis and Consequence Assessment

- Structural analyses with transparent Technical Background

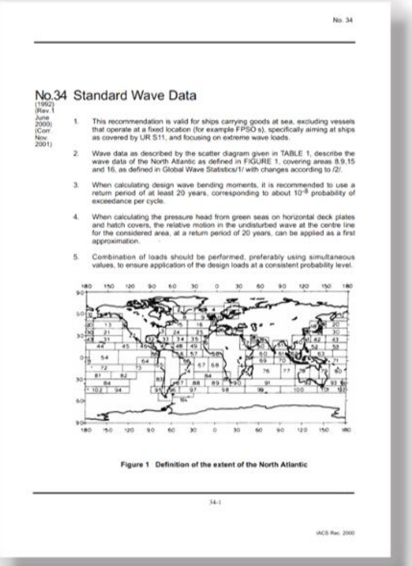
Buckling
Fatigue
Corrosion Analysis

CSR Maintenance Team

B. Introduction of revised Rec. 34 and future development on wave loads based on new Rec. 34

What is Rec No. 34?

- **Wave data based on North Atlantic areas to be used for a safe design of ships sailing world wide**
- **Rec.34 Rev.1 launched 1992, revised in 2000/2001, based on Global Wave Statistics – Visual observations BMT Atlas (1986)**
- **Rec.34 Rev.1 has several known limitations**
    - Inaccuracy of significant wave height and periods due to human eyeball observations
    - Unclear implicit routing effect due to bad weather avoidance
    - Uncertain assumption of uniform distribution of heading to the waves
- **IACS questioned how can assure that the wave data in the rules are sufficient**



No. 34

No.34 Standard Wave Data

(1992) (Rev.1 June 2000) (Corr. Nov. 2001)

1. This recommendation is valid for ships carrying goods at sea, excluding vessels that operate at a fixed location (for example FPSO s), specifically aiming at ships as covered by UR S11, and focusing on extreme wave loads.
2. Wave data as described by the scatter diagram given in TABLE 1, describe the wave data of the North Atlantic as defined in FIGURE 1, covering areas 8,9,15 and 16, as defined in Global Wave Statistics/1/ with changes according to /2/.
3. When calculating design wave bending moments, it is recommended to use a return period of at least 20 years, corresponding to about 10^{-8} probability of exceedance per cycle.
4. When calculating the pressure head from green seas on horizontal deck plates and hatch covers, the relative motion in the undisturbed wave at the centre line for the considered area, at a return period of 20 years, can be applied as a first approximation.
5. Combination of loads should be performed, preferably using simultaneous values, to ensure application of the design loads at a consistent probability level.

Figure 1 Definition of the extent of the North Atlantic

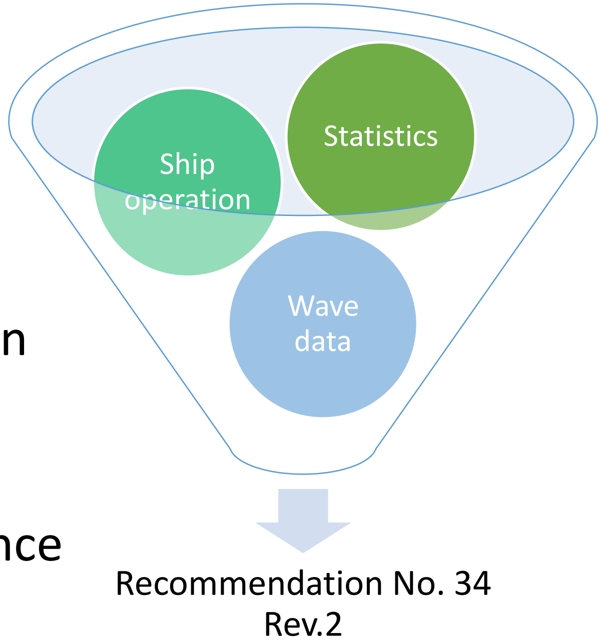
34-1

IACS Rec. 2000

How to update Rec. 34?

- **A dedicated PT was formed by IACS in 2018 to investigate the possibility of updating IACS Rec.34 with the following scope;**

  - Select an appropriate wave data source
  - Validate the wave data source
  - Get relevant ship traffic data
  - Select the most relevant geographical area when generating an IACS scatter diagram
  - Account for routing due to bad weather avoidance
  - Select appropriate wave spectrum and spreading



Wave Data Sources

- **Hindcast**
  - Estimation

Provider	Name	Model	Wind	Horizontal resolution	Resolution [deg]	Time step	Spectra	Use of altimeter	Date	Public
Copernicus	Waverys	MFWAM	ECMWF	22km	0.2	3h	No	Assimilation	1993-2020	Yes
ECMWF	ERA-INTERIM	WAM	ECMWF	111km	1	6h	Full	NA	1979-2018	Yes
ECMWF	ERA5	WAM	ECMWF	42km	0.36(0.5)	1h	Full	Assimilation	1979-2022	Yes
IFREMER	IOWAGA	WWIII	ECMWF CFSR	55km	0.5	3h	Partial	Calibration	1990-2020	Yes
NOAA	NOAA	WWIII	CFSR	55km	0.5	3h	Partial	NA	1979-2009	Yes
UTokyo-NK	TodaiWW3-NK	WWIII	CFSR	28kmx31km	0.25/0.28	1h	Full	Calibration	1994-2018	No

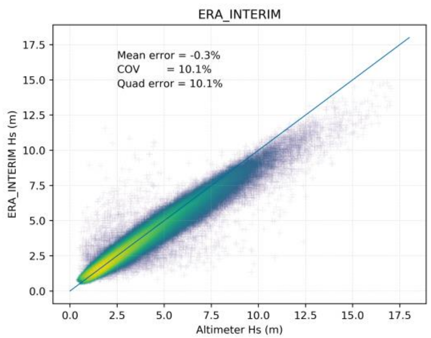
- **Altimeter**
  - Good quality for wave height

- **Observations**
  - Buoys – Near shore
  - Vessels – Human
  - Laser - Lidar

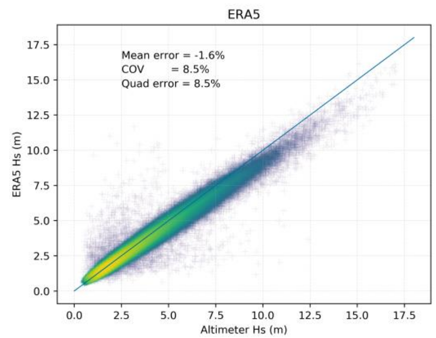
IACS

Validation of Sources

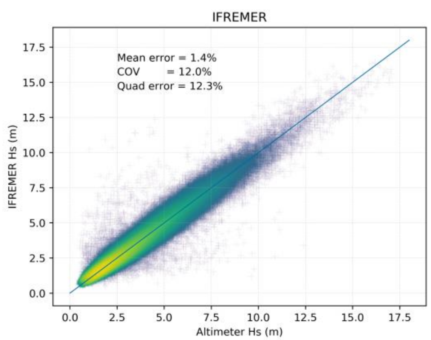
- **Comparison of significant wave height** between altimeters and 4 hindcast datasets in North-Atlantic on the period 2000-2009



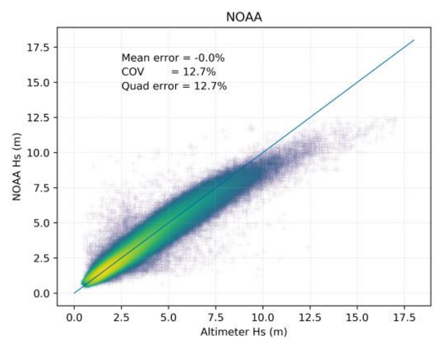
(a) ERA-INTERIM



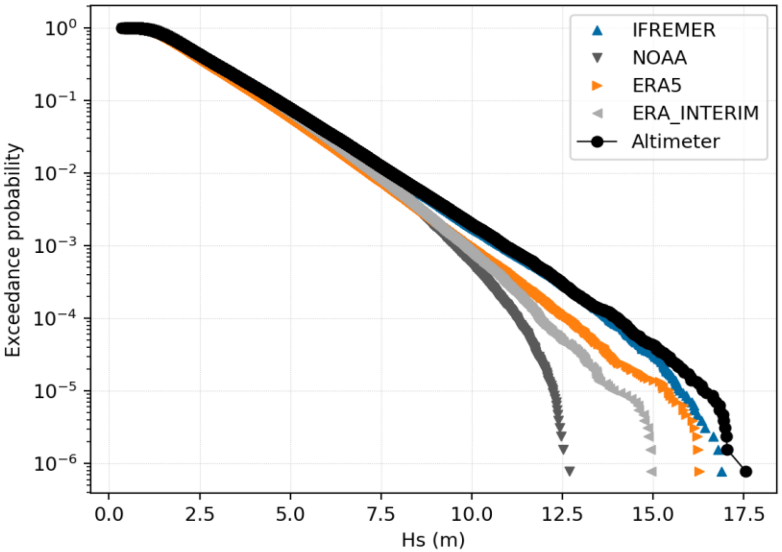
(b) ERA5



(c) IOWAGA



(d) NOAA

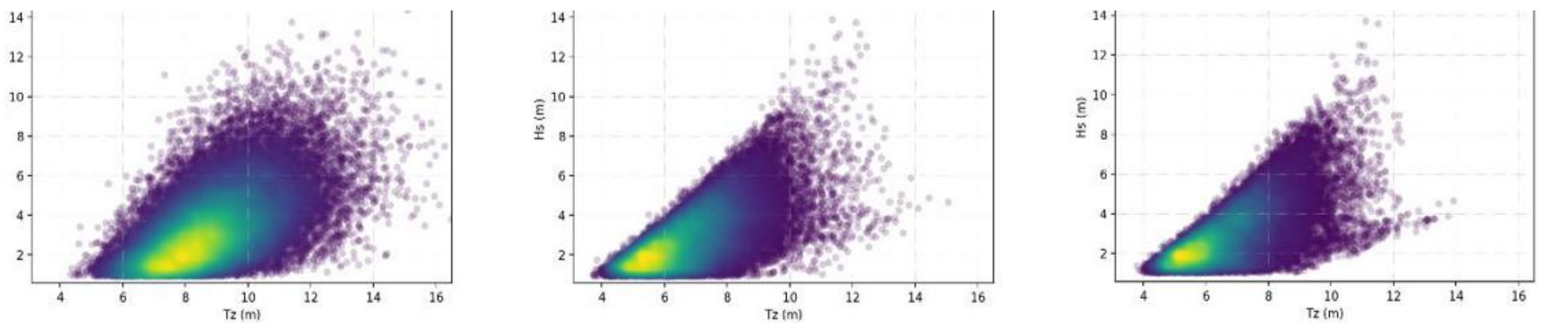


- The modern hindcast datasets are considered accurate enough compared with the measurements to be used as a basis for IACS Rec. No.34 updates, and from the various datasets studied, **IOWAGA form iFREMER** was selected

Wave Scatter Diagram in Rec.34 Rev.2

- **Vessels do avoid storms, and this should be considered when generating scatter diagrams for ship design**
- **IACS Rec.34 Rev.1 is based on visual observations from merchant vessels, routing is implicitly included.**
- **Ship position information together with the unbiased wave measurement is important to consider**
- **IACS Rec.34 Rev.2 considered the routing effect based on the available AIS data since 2013 combined with hindcast data**
    - ~17 Billion recordings worldwide
    - ~5 Billion hourly recordings worldwide
    - ~100 000 distinct IMO numbers
    - ~15 000 distinct IMO numbers in North Atlantic

Wave Scatter Diagram in Rec.34 Rev.2



IACS-REC34 | Buoy measurements | Hindcast numerical model

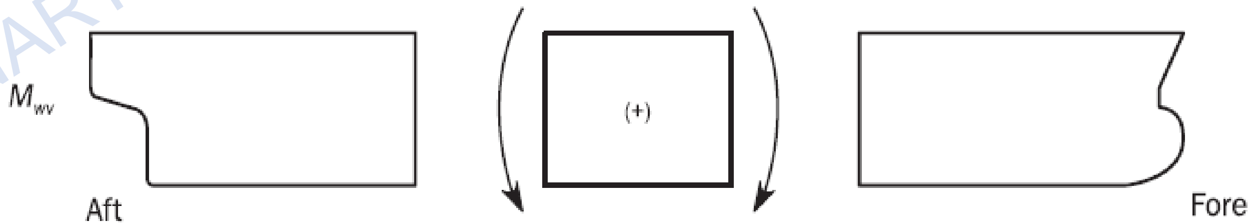
Hs (m) \ T0m1 (s)	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	3.73	5.98	4.08	1.90	0.60	0.13	0.02	0.00	0.00
9.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	9.34	15.15	12.51	7.39	3.12	0.94	0.20	0.03	0.00	0.00
8.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	9.40	38.70	36.80	25.95	13.63	5.33	1.55	0.34	0.05	0.01	0.00
7.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.77	88.62	107.20	86.26	53.35	25.36	9.27	2.60	0.56	0.09	0.01	0.00
6.5	0.00	0.00	0.00	0.00	0.00	0.00	1.02	147.59	305.37	271.71	190.23	104.79	45.42	15.49	4.16	0.88	0.15	0.02	0.00
5.5	0.00	0.00	0.00	0.00	0.00	0.08	149.74	811.81	791.81	609.66	375.67	185.26	73.12	23.09	5.84	1.18	0.19	0.02	0.00
4.5	0.00	0.00	0.00	0.00	0.00	82.06	1759.81	2069.19	1715.42	1151.29	625.51	275.12	97.96	28.24	6.59	1.24	0.19	0.02	0.00
3.5	0.00	0.00	0.00	0.00	23.06	2742.51	4666.81	4100.83	2936.41	1713.38	814.68	315.65	99.66	25.64	5.38	0.92	0.13	0.01	0.00
2.5	0.00	0.00	0.00	3.38	2805.81	8517.73	7835.85	5885.37	3608.30	1805.81	737.71	246.00	66.96	14.88	2.70	0.40	0.05	0.00	0.00
1.5	0.00	0.00	0.33	2028.35	12750.81	11693.38	7215.76	3006.80	846.07	160.77	20.63	1.79	0.10	0.00	0.00	0.00	0.00	0.00	0.00
0.5	0.00	0.00	6.82	202.00	333.61	187.76	45.59	4.74	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Way forward

- **Recalibrate local & global loads in CSR, UR S11 and UR S11A**
- **Linear statistical analyses (~ 4 million evaluations)**
  - 1 scatter diagram
  - 2 loading conditions
  - 2 limit states
  - ~ 240 responses
  - ~ 20 EDWs
  - ~ 200 vessels

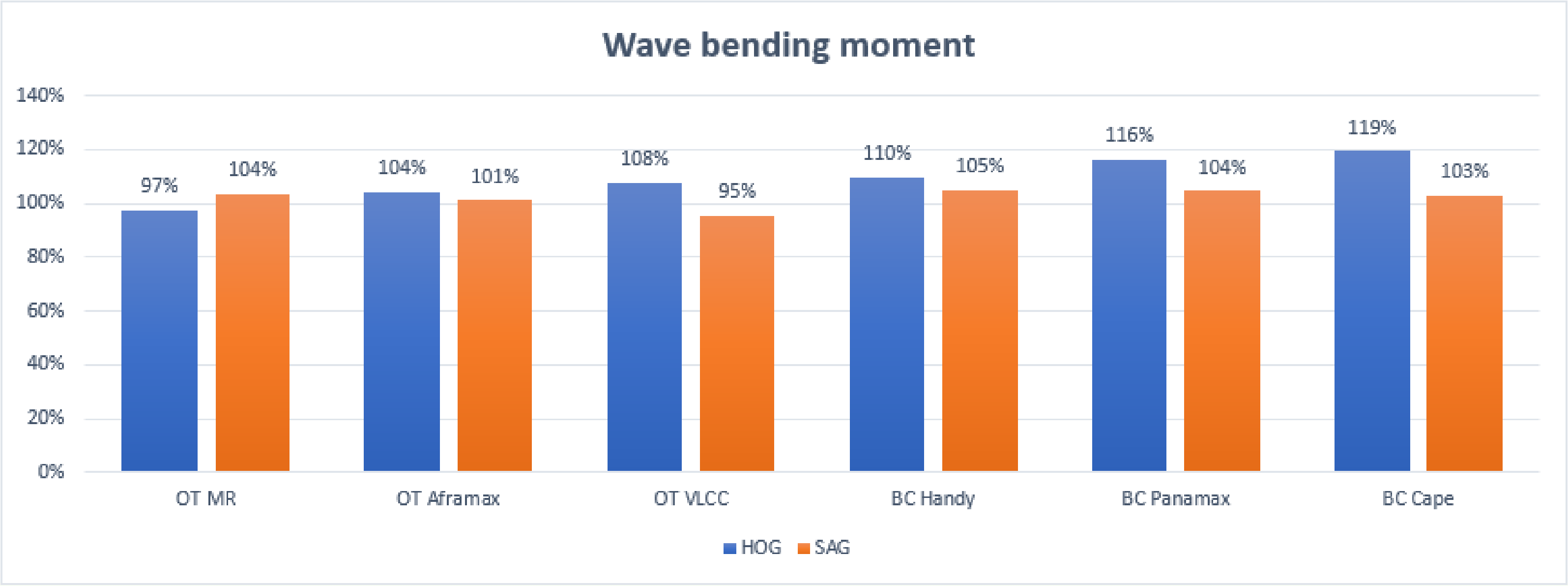
- **Nonlinear statistical**
  - Hull girder loads
- **Use the latest developments in wave load calculations tools**

Preliminary Result on Hull Girder Wave Bending Moment based on Rec.34 Rev.2

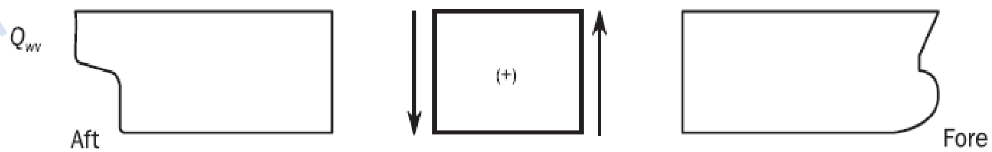


Draft rule M_{WV} amidships based on Rec.34 Rev.2 vs. current CSR

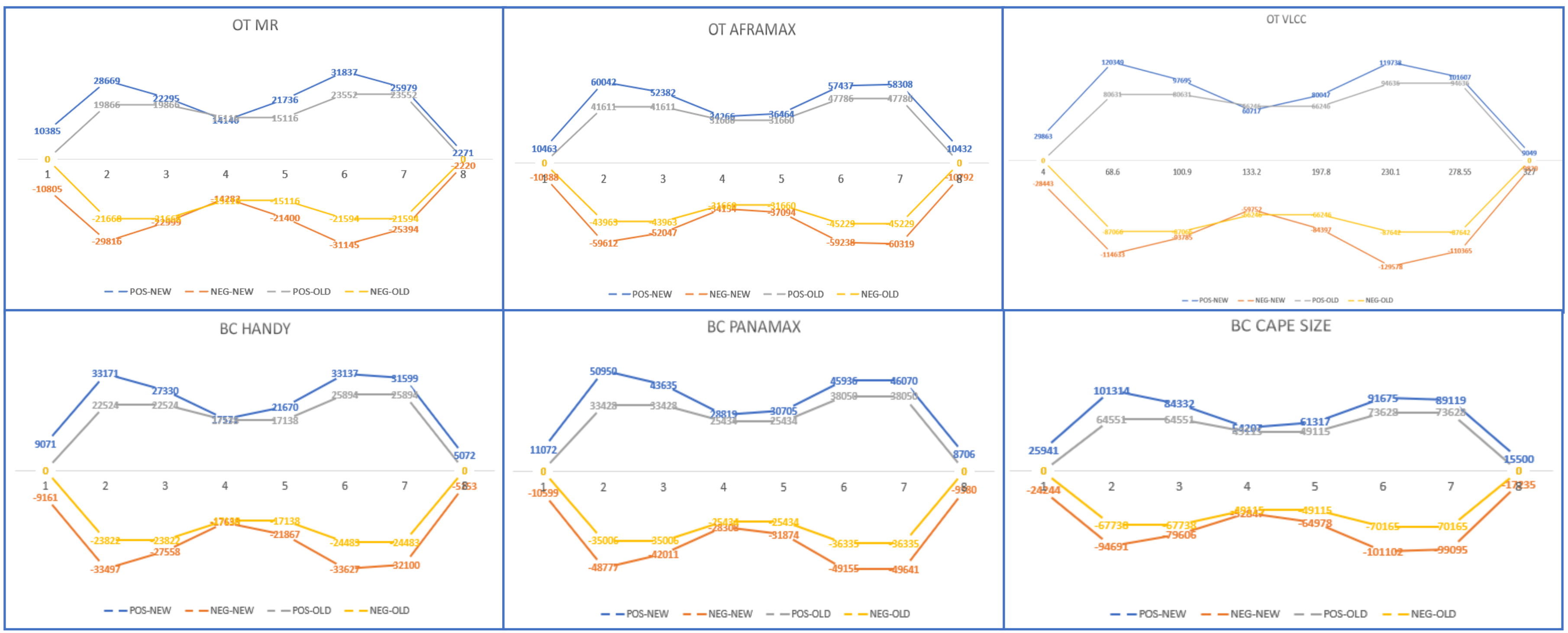
: $M_{WV(new)}$ /$M_{WV(old)}$



Preliminary Result on Hull Girder Wave Shear Force based on Rec.34 Rev.2



Draft rule wave shear force Q_{wv} (new) based on Rec.34 Rev.2 vs. current CSR (old)



C. Monitoring the success of corrosion work and future changes of corrosion addition in IACS CSR

IACS Hull Rules Changes - Flowchart

GBS OB: Justification for Net thickness approach with corrosion additions

Corrosion Analysis Phase 3

Update of Corrosion additions

Application of new Wave Loads

New wave scatter diagram, IACS Rec.34 Rev.2

Rules Revising

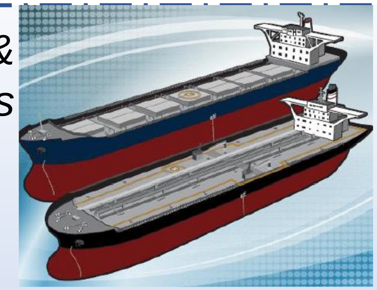
CSR

Unified Requirement S11A

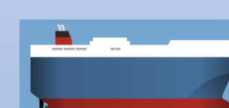
Unified Requirement S11

Consequence Assessment

CSR BCs & OTs

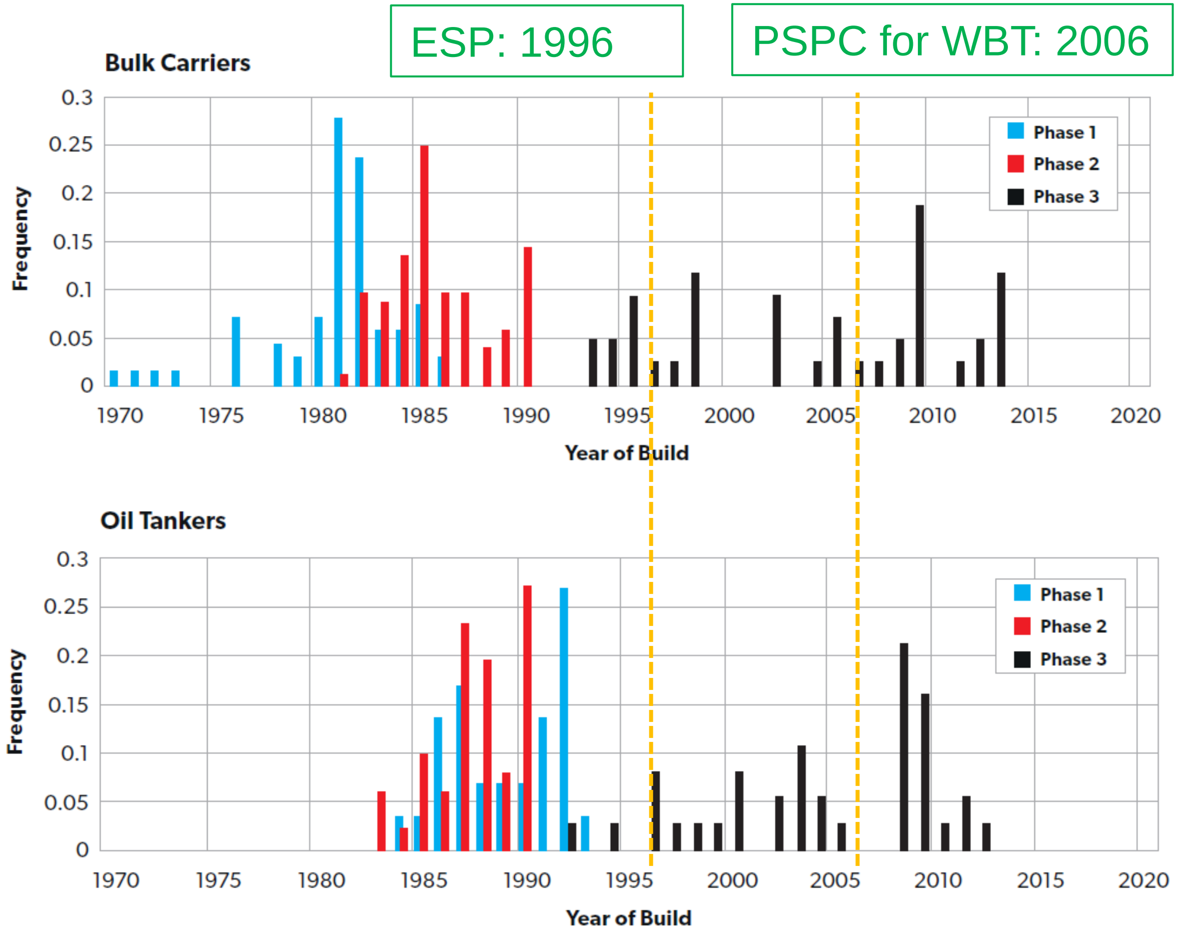


Containerships L≥ 90 m



Other ship types L≥ 90 m

Corrosion analyses CSR - history



<u>IACS Corrosion Analyses:</u>

Phase 1: 2004-2005
Basis for CSR-BC, CSR-OT, CSR-BC&OT

Phase 2: 2010-2012
CSR harmonization

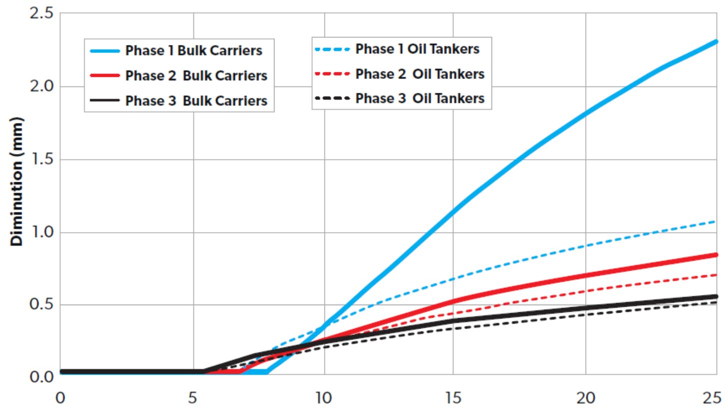
Phase 3: 2018-2019
CSR Maintenance

Comparison of Corrosion in Different Phases

Table 1 Corrosion diminution in mm (both sides) of 90% cumulative probability, for web frames in ballast water side tanks – Application of ESP and coating requirements for ballast water tanks are indicated

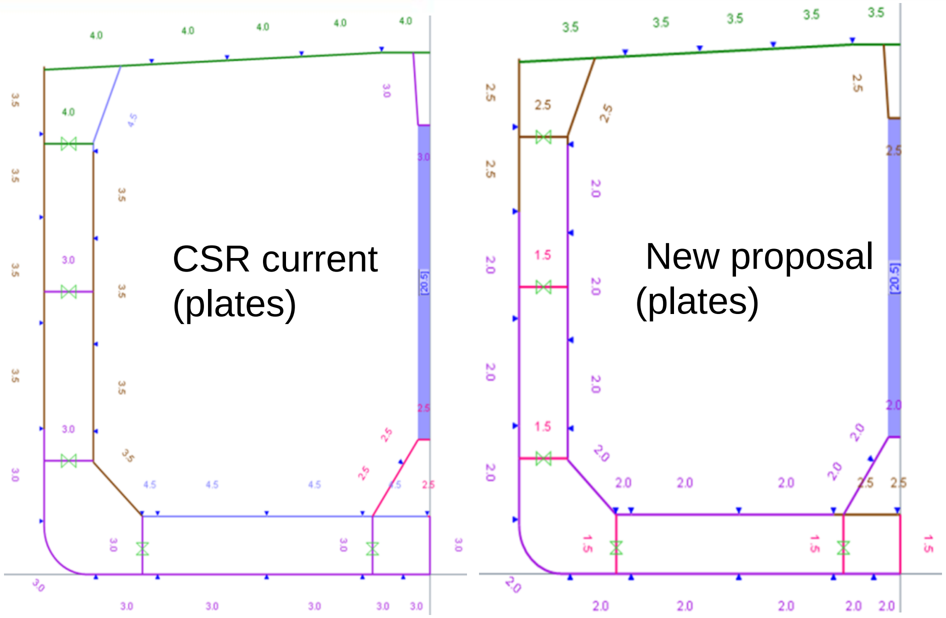
Vessel type		Phase 1	Phase 2	Phase 3
Bulk Carrier		2.3 mm	0.82 mm	0.53 mm
Oil Tanker		1.1 mm	0.68 mm	0.50 mm
Requirements	Enhanced Survey Program (ESP)	No	Yes	Yes
	Ballast tank coating requirement	No	No	Yes

Figure 5 Corrosion diminution in mm (both sides) of 90% cumulative probability, for web frames in ballast water side tanks – Phase 1-3 for bulk carriers and oil tankers

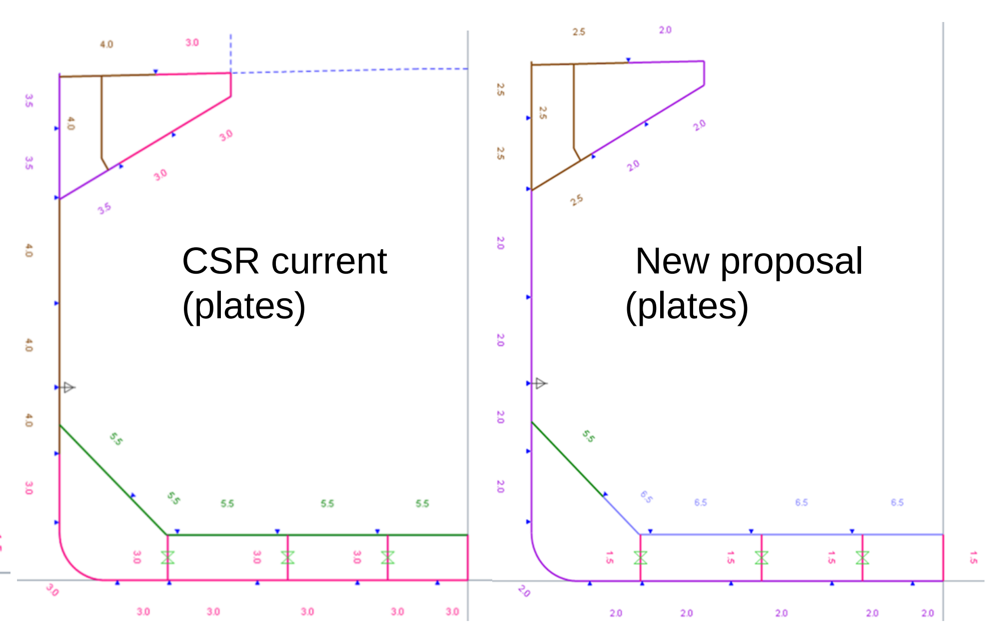


- Corrosion in B/W tanks significantly reduced between Phase 1 and Phase 2, and the main difference is the implementation of ESP
- Comparing the results from Phase 2 & 3, a small reduction is observed, and the improved corrosion protection from the implementation of coating requirements to ballast tanks in addition to ESP contributed to the reduction in Phase 3
- Therefore, an improved inspection regime of ship structures during operation (ESP) combined with improved corrosion protection (coatings) has resulted in a large reduction in corrosion diminution in ballast tanks and contributed to improved structural safety in the latest ship design

New proposal at 98% prob. vs current CSR corrosion additions



Product MR Tanker



Supramax Bulk Carrier

Product MR Tanker: Major DECREASES to higlight in corrosion addition

Structural member	CSR corrosion [mm]	New corrosion [mm]	Difference New-CSR [mm]	Ratio New/CSR%
Side longi	3	1.5	-1.5	-50%
Inn.Bottom	4.5	2	-2.5	-56%
Bottom shell & stiffener	3	1.5	-1.5	-50%
Inn.Hull plate & stiffener	3.5	1.5	-2	-57%
Inn.Bottom longi	3.5	1.5	-2	-57%

Supramax Bulk Carrier: Major DECREASES to higlight in corrosion addition

Structural member	CSR corrosion [mm]	New corrosion [mm]	Difference New-CSR [mm]	Ratio New/CSR%
Deck plate above WBT	4	2.5	-1.5	-38%
T.S.T stiffeners on internal bhd FOT/WBT	4.5	2.5	-2	-44%
Side shell in C.H.	4	2	-2	-50%
Bottom and Inner Bottom stiffeners	3	1.5	-1.5	-50%
IB Side Girders plate	3	1.5	-1.5	-50%

Supramax Bulk Carrier: Major INCREASES to higlight in corrosion addition

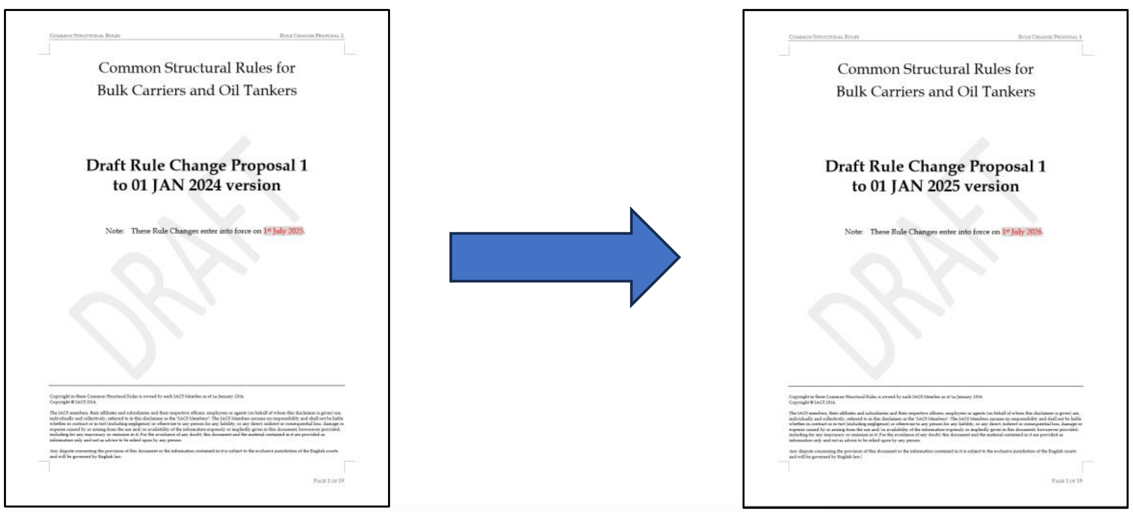
Structural member	CSR corrosion [mm]	New corrosion [mm]	Difference New-CSR [mm]	Ratio New/CSR%
Inner bottom	5.5	6.5	1	18%

Corrosion analysis - ongoing

- In 2020, IACS carried out comprehensive statistical analyses of corrosion data obtained from thickness measurements on Bulk Carriers and Oil Tankers over the last 20-25 years. It is found that the application of the ESP(1996) and IMO PSPC for WBT (2006) and COT (2013) has resulted in a large reduction in corrosion diminution in ballast tanks and contributed to improving structural safety
- Therefore, IACS has collected additional corrosion data for BCs & OTs to investigate the corrosion state of ships in service and is developing new corrosion additions to be used in IACS CSR as well as IACS URs
- The probability level used in the new corrosion model is more conservative than the current CSR by increasing from 90% to 98% and the corrosion addition of the inner bottom plate has increased based on the new corrosion model. Furthermore, IACS will review survey regime for steel renewal with a view to keeping robustness in terms of steel renewal
- The reduction of lightweight may give an environmental and commercial benefit, and better distribution and use of steel material will help to address the risks in a more efficient, effective and rationalized way

CSR RCP 2024

- IACS decided to skip RCP 2024 with the following reasons
  - ✓ High possibility of revisiting RCP 2024 based on the changes in RCP 2025 with new wave loads and corrosion additions
  - ✓ Concentrate on the significant amendments with comprehensive technical backgrounds and consequence assessments coming from the ongoing project teams for new wave loads and corrosion additions
- EAG 7 meeting scheduled in Jan. of 2024 will not be held, but IACS will ensure appropriate communication to industry on RCP 2025 progress throughout 2024



Summary

- **IACS has initiated large projects to develop new wave loads based on Rec.34 Rev.2 and new corrosion additions as a result of improved inspection regimes and coat performance in CSR**
- **The basis for new wave loads and corrosion addition is more transparent, and it provides a more comprehensive and technically sound background compared to the previous CSR based on experience gained in service and benchmark data**
- **Detailed consequence/impact assessment of the rule changes will be delivered with the dedicated technical background in due course**
- **In addition to the existing mechanism of collaboration, IACS also is preparing/initiating a more proactive engagement with the industry to inform stakeholders in advance about potential CSR developments**

Summary

תודה
Dankie
Gracias
Спасибо
شكرا
Merci
Takk
Köszönjük
Terima kasih
Grazie
Dziękujemy
Dėkojame
Ďakujeme
Vielen Dank
Paldies
Kiitos
Täname teid
Thank You
谢谢
Tak
感謝您
Obrigado
Teşekkür Ederiz
감사합니다
Σας ευχαριστούμε
ขอบคุณ
Bedankt
Děkujeme vám
ありがとうございます
Tack