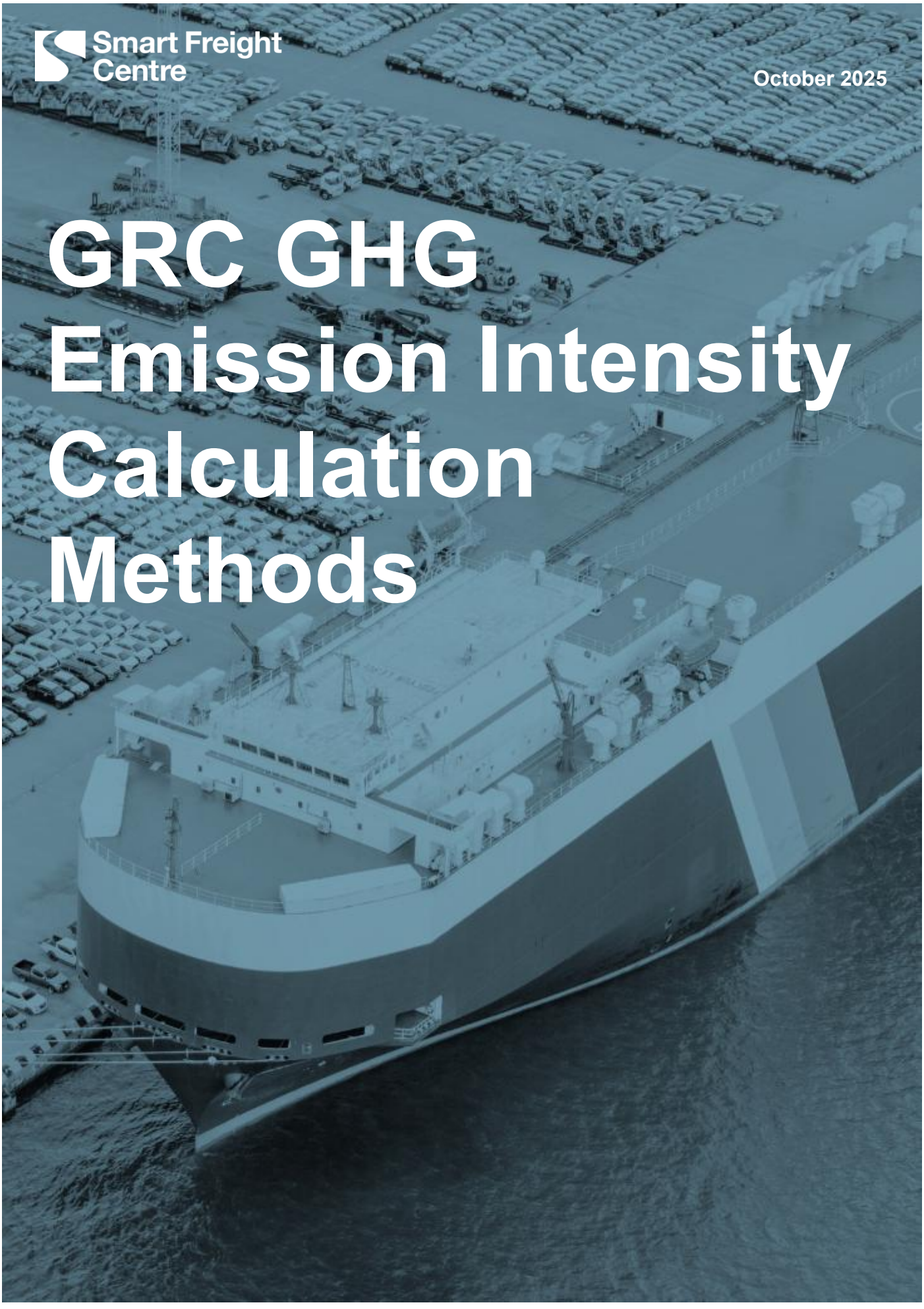
Smart Freight Centre

October 2025

GRC GHG Emission Intensity Calculation Methods



Global Ro-Ro Community

Deep-sea Ro-Ro Ship Greenhouse Gas Emission Intensity Calculations Methods

October 2025

Suggested citation: Smart Freight Centre. Global Ro-Ro Community Deep-sea Ro-Ro Ship Greenhouse Gas Emission Intensity Calculation Methods. October 2025.

Disclaimer
The views expressed in this publication are those of Smart Freight Centre and staff, consultants and management, and do not necessarily reflect the views of the Board of Trustees of Smart Freight Centre. Smart Freight Centre does not guarantee the accuracy of the data included in this publication and does not accept responsibility for consequence of their use.

Acknowledgements
This report was written by GRC Secretariat of Smart Freight Centre.

Smart Freight Centre (SFC) is a globally active non-profit organization for climate action in the freight sector. Our goal is to mobilize the global logistics ecosystem, in particular our members and partners, in tracking and reducing its greenhouse gas emissions. We accelerate the reduction of logistics emissions to achieve a zero-emission global logistics sector by 2050 or earlier, consistent with 1.5° pathways.

Contact
Smart Freight Centre
Keizersgracht 562, 1017 EM, Amsterdam, Netherlands
P.O. Box 11772, 1001 GT, Amsterdam, Netherlands
www.smartfreightcentre.org
info@smartfreightcentre.org

Contents

Summary of Revisions – October 2025

The following updates have been incorporated into this edition of the *Global Ro-Ro Community (GRC) Greenhouse Gas (GHG) Emission Intensity Calculation Methods*, reflecting decisions adopted by the GRC Methods Committee between April and October 2025:

1. Voyage inclusion and submission timing – Clarified that voyages are included based on voyage end date, ensuring consistent treatment of voyages spanning two reporting years. The annual submission cycle now applies to 2024 operational data submitted in November 2025, and all subsequent reporting years.
2. Ballast voyage definition – Threshold increased from 0 % to 10 % of a vessel's maximum annual cargo mass. Voyage legs at or below this threshold are treated as ballast.
3. Tradelane segmentation – Clarified that a new tradelane begins at the departure port of a "dip" voyage, where cargo mass is lower than both the preceding and following voyages. The previous tradelane ends with the voyage before the dip.
4. Split reporting – Clarified that the *VLSFO-equivalent baseline* (Component 1) is calculated by converting low-emission fuel volumes using standardized energy-density factors, ensuring consistent comparison between fossil and alternative fuel performance.
5. Editorial consistency – Minor updates for alignment with GRC governance procedures, the GRC Verification Guidelines (Oct 2025), ISO 14083 (2023) and the GLEC Framework, emphasizing well-to-wake accounting and standardized units (*g CO_2e / t-km*).
6. Regional definitions – Updated the list of regions and port groupings in Annex 2 to reflect current operational patterns and carrier feedback, ensuring consistency with GRC tradelane reporting and verification.

Key Definitions and Acronyms

Ballast voyage – A voyage or voyage leg carrying ≤ 10% of the vessel's maximum cargo mass carried in the reporting year. (Defined in the GRC Methods and GRC Verification Guidelines.) Emissions from ballast voyages are included via the Ballast Distribution Factor (BDF).

Ballast Distribution Factor (BDF) – Ratio of (laden + ballast) fleet emissions to laden-only fleet emissions for the reporting year; used to scale tradelane intensities to include ballast emissions.

Cargo carried – Mass of cargo (tonnes) transported on a voyage leg.

GLEC Framework – Global Logistics Emissions Council Framework; reference for ISO 14083 implementation.

GRC – Global Ro-Ro Community convened by Smart Freight Centre (SFC) for harmonized GHG accounting in deep-sea Ro-Ro shipping.

ISO 14083 (2023) – Standard for quantifying/reporting GHG emissions from transport chains.

Laden voyage – A voyage leg carrying cargo above the ballast threshold.

Reporting period – Calendar year used for GRC reporting; voyages are included based on the date the voyage ends (voyage-end rule).

Ro-Ro – Roll-on/Roll-off ship type.

SFC – Smart Freight Centre; GRC secretariat and administrator of the GRC Reporting Platform.

Split reporting – Two components reported: (1) VLSFO-equivalent baseline (convert low-emission fuels using energy-density factors), and (2) actual fuel mix.

Tradelane – Directional movement between regions (or intra-regional). Under the "dip" rule, a new tradelane starts at the departure port of a dip voyage (cargo mass lower than both the preceding and following voyages) and the previous tradelane ends with the voyage immediately before the dip.

Transport activity – distance sailed (km) × cargo carried (t) per voyage leg; expressed as tonne-kilometres (t·km).

Verification – Independent third-party assessment confirming conformance with the GRC Methods and GRC Verification Guidelines.

Voyage-end rule – Inclusion of voyages in a reporting year is determined by the voyage end date.

VLSFO – Very Low Sulfur Fuel Oil; fossil baseline for Component 1.

Note: For additional process definitions, verification steps, and examples of data boundaries, refer to the GRC Verification Guidelines (October 2025)

Introduction

This document defines the methods for calculating greenhouse gas (GHG) emission intensities for deep-sea roll-on/roll-off (Ro-Ro) shipping under the Global Ro-Ro Community (GRC). It specifies the data requirements, calculation principles, and reporting procedures needed to ensure consistent, transparent, and verifiable results across participating carriers.

The Global Ro-Ro Community was established by Smart Freight Centre (SFC) in 2024 to harmonize GHG accounting and reporting across the Ro-Ro sector. Method development has been led by the GRC Methods Committee, composed of carrier members and supported by accredited third-party verifiers, with input from cargo owners and other stakeholders. The process is facilitated by SFC in its role as GRC Secretariat, in accordance with the GRC Governance Framework.

Following its launch at Smart Freight Week 2024 in Amsterdam, the methodology was developed through regular committee meetings and released for public consultation at Smart Freight Week 2025 (March 18, 2025). The consultation period remained open until April 11, 2025, and the current edition reflects updates approved by the Methods Committee in October 2025.

The GRC methods align with the Global Logistics Emissions Council (GLEC) Framework and ISO 14083: 2023**,** *Quantification and reporting of greenhouse gas emissions arising from transport chain operations*. Emission intensity is expressed as grams of CO_2-equivalent per tonne-kilometre (g CO_2e/t-km) and calculated on a well-to-wake basis, covering carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other greenhouse gases relevant to marine fuel combustion, based on the latest IPCC assessment factors.

Verification of data and calculations is performed in accordance with the GRC Verification Guidelines (October 2025), which define verification scope, level of assurance, and evidence requirements to ensure transparency and comparability across carriers.

This October 2025 edition supersedes the April 2025 version and applies to 2024 operational data submitted in November 2025, and to all subsequent reporting cycles.

For questions about this document or the Global Ro-Ro Community, please contact Smart Freight Centre (SFC) at *info@smartfreightcentre.org*.

1 High-Level Principles

The following high-level principles were agreed by GRC carrier members at the SFC Maritime Fall Meeting held in Tokyo (October 2024) and form the foundation of this methodology.

1.1 Emission-intensity calculation (general)

1. All GRC carrier members shall implement the agreed methodology when calculating and sharing emission-intensity factors with their customers (cargo owners / OEMs).
2. The primary unit of measuring transport activity shall be tonne-kilometre (t-km) / tonne-mile, while any secondary unit may be determined by each carrier based on customer requirements.
3. Over the reporting year, all voyage legs—laden, ballast, and repositioning—that end within that period shall be included to calculate total GHG emissions and total transport activity on a well-to-wake basis.

1.2 Emission-intensity reporting to OEMs / cargo owners

1. All GRC carrier members may calculate and report emissions to cargo owners using either (A) the GRC methodology described in this document, or (B) an alternative method that follows these high-level principles (for example, a “service-based” calculation approach).
2. When carriers apply their own calculation method, they may define the scope of “service” and the treatment of ballast / repositioning voyages at their discretion, including how emissions from such voyages are allocated to laden activity, provided that the overall reporting remains consistent and transparent.
3. For Scope 3 emissions calculations, OEMs / cargo owners shall continue to use the Shortest Feasible Distance (SFD) + 15 % convention for voyage distance, with SFD sourced from a reputable maritime distance database. This ensures consistency with GRC emission-intensity factors, which are based on carriers’ actual distance sailed.

1.3 GRC average emission intensity

1. The GHG emission-accounting methodology described in this document shall be implemented by all participating carriers when calculating GRC-average emission-intensity factors, which serve as a benchmark for comparison with (A) other vessel types or transport modes and (B) previous reporting years.
2. The GRC averages shall be calculated for each tradelane agreed by the participating carriers, as defined in Annex 2 (Regions and Tradelane Definitions, updated October 2025).

2 Calculating Ro-Ro Ship GHG Emission Performance

2.1 Overview

The GRC GHG emission performance represents the greenhouse-gas (GHG) emission intensity of participating carrier vessels. Emission intensity expresses the total GHG emissions generated per unit of transport activity, where transport activity is measured in tonne-kilometres (t-km). Accordingly, the unit of measure for GRC emission intensities is grams of CO_2-equivalent per tonne-kilometre (g CO_2e / t-km).

The GRC methodology applies a well-to-wake boundary that covers all energy used for propulsion and auxiliary operations, including low-carbon and alternative fuels. This approach ensures comparability with the GLEC Framework and ISO 14083: 2023.

2.2 Emission Intensity Formula

The GRC emission intensity for Ro-Ro ships is calculated using the following equation:

$$\text{Ro-Ro Ship Emission Intensity} = \frac{\text{Fuel Emission Factor} \times \text{Total Fuel Consumption}}{\sum_{i=1}^{n} (\text{Distance Sailed}_i \times \text{Cargo Carried}_i)}$$

Where:

- **Ro-Ro Ship Emission Intensity** – The GHG emission intensity of the vessel, expressed in *g CO_2e / t-km*.
- **Fuel Emission Factor** – The well-to-wake emission factor applicable to each fuel type consumed by the vessel. (See *Annex 1 – Fuel Emission Factors*.)
- **Total Fuel Consumption** – The total mass of all fuels consumed by the vessel (main engines, auxiliary engines, and boilers) during the reporting year. This includes fuel consumed at sea (laden, ballast, and repositioning) and in port.
- **Distance Sailed** – The total distance sailed by the vessel per voyage leg, in kilometres, including sea passages and in-port manoeuvring.
- **Cargo Carried** – The total cargo mass transported by the vessel per voyage leg, in tonnes.
- $\sum_{i=1}^{n} (\text{Distance Sailed}_i \times \text{Cargo Carried}_i)$ – The sum of distance × cargo for all voyage legs, representing the vessel's total transport activity for the reporting year.

2.3 Application

1. Emissions are calculated on a well-to-wake basis, combining direct (tank-to-wake) and upstream (well-to-tank) factors for each fuel type.
2. All fuel types used during the reporting year, including biofuels and alternative fuels, shall be accounted for using the relevant emission factors.
3. Where split reporting is required, Component 1 (VLSFO-equivalent baseline) and Component 2 (actual fuel mix) shall each be calculated using the same formula and activity data.
4. Emissions and activity data are aggregated at the vessel level for the reporting year before being used in *Part 4* to calculate tradelane-level and GRC-average emission intensities.

3 Carrier Data Collection

3.1 Carrier Data

Carriers shall compile the following data, by vessel name and IMO number, for each vessel in their owned or chartered fleet:

- Amount of fuel consumed (for each fuel type, in metric tonnes)
- Amount of cargo carried (in metric tonnes)
- Distance sailed (in kilometres)
- Number of days of operation

These data are used to calculate vessel-specific GHG-emission intensities as described in *Part 2 – Calculating Ro-Ro Ship GHG Emission Performance*. Carriers shall share these data with Smart Freight Centre (SFC) via the GRC reporting platform, where they are made available to verifiers for review and validation.

Ballast voyages — A voyage leg is classified as *ballast* when the cargo mass carried is 10 percent or less of the vessel's maximum cargo mass recorded for that vessel within the same reporting year.

Emissions from ballast and repositioning voyage legs are not assigned to a tradelane but are redistributed to laden voyages using a ballast distribution factor (BDF) derived from the carrier's operational data.

3.2 Tradelane Assignment

Carriers shall assign a tradelane to each laden voyage leg for all reported vessels. Ballast and repositioning voyage legs remain unassigned but their emissions are redistributed as described above.

GRC tradelanes and trade regions are listed in *Annex 2 – Trade Regions and Tradelanes.*

Tradelanes represent sequences of laden voyage legs operated between defined GRC regions. A new tradelane begins at the departure port of a "dip" voyage, where the cargo mass is lower than both the preceding and following voyages. The previous tradelane ends with the voyage immediately before the dip.

Carriers then assign the tradelane corresponding to the region of the departure port of the first dip voyage and the region of the arrival of the second dip voyage. If all voyage legs occur within one region, an intra-regional tradelane applies; if no defined tradelane fits, use "Other."

Tradelane assignments are used to calculate tradelane-level emission intensities as described in *Part 4 – Aggregating Data into Tradelane Emission Intensities.*

3.3 Vessels Covered

Carriers shall report data for all vessels under their operational control, including both owned and chartered vessels.

Vessels that were operational for 90 days or fewer during a reporting year may be omitted from carrier reports.

3.4 Reporting Period

Carriers shall report the data described above once per year.

Voyage inclusion rule — Voyages are included in the dataset for a given reporting year based on the voyage end date, regardless of when the voyage began.

For example, a voyage starting in December 2024 and ending in January 2025 shall be reported under 2025. Conversely, a voyage starting and ending within 2024 is reported under 2024.

Reporting schedule — Reporting covers operations for the previous calendar year (1 January – 31 December) and aligns with the GRC annual reporting cycle. Carriers submit verified data through the GRC reporting platform within the submission window announced each year.

For the initial cycle, 2024 operational data shall be submitted by November 2025.

3.5 Split Reporting

With split reporting, emission-intensity factors based on both a fossil baseline (VLSFO basis) and the actual fuel mix shall be calculated.

- Component 1 – VLSFO-equivalent baseline – All low-emission fuel volumes are converted to *VLSFO-equivalent* volumes using energy-density conversion factors published by GRC, providing a fossil-fuel reference baseline.
- Component 2 – Actual fuel mix – Emission-intensity factors are calculated using the vessel's actual fuel consumption by type.

The following principles apply:

- Carriers use both components for internal analysis and benchmarking.
- Cargo owners and OEMs calculating Scope 3 emissions shall use Component 1 (VLSFO-equivalent baseline) only.
- When using *Shortest Feasible Distance (SFD)* in Scope 3 calculations, cargo owners shall apply a 15 percent distance-adjustment in accordance with GLEC and ISO 14083.
- Emission-intensity factors based on the actual fuel mix are intended only for carriers' own performance tracking and shall not be used by cargo owners for Scope 3 reporting.

4 Aggregating Data Into Tradelane Emission Intensities

As described in *Part 2*, GRC carrier data are collected at the vessel level. This vessel-level data are aggregated to carrier-specific tradelane emission-intensity factors using the following steps.

All steps are performed separately for Component 1 (VLSFO-equivalent baseline) and Component 2 (actual fuel mix).

- **STEP 1 – Transport activity**

  Calculate the total transport activity for each tradelane that the vessels in the carrier's fleet are assigned to (see Part 3.2 – Tradelane Assignment; tradelanes are assigned only to laden voyage legs).

  Transport activity is the sum of the products of distance sailed and cargo carried for each voyage leg assigned to a tradelane.

- **STEP 2 – Laden-voyages emission**

  Calculate the total emissions generated by laden voyages for each tradelane that the vessels in the carrier's fleet are assigned to.

  These emissions are obtained by multiplying the fuel-emission factor by the total fuel consumed for laden voyages, by fuel type.

- **STEP 3 – Ballast-voyages emission**

  Calculate the total emissions generated by ballast voyages (≤ 10 percent of the vessel's maximum annual cargo mass) conducted by the vessels in the carrier's fleet.

  These emissions are obtained by multiplying the fuel-emission factor by the total fuel consumed for ballast voyages, by fuel type.

  Note: Transport activity for ballast voyages is not assigned to tradelanes and is not redistributed.

- **STEP 4 – Tradelane emission intensity based on laden voyages only**

  Divide the total laden-voyage emissions (Step 2) by the total transport activity (Step 1) for all vessels in the carrier's fleet assigned to each tradelane.

- **STEP 5 – Final tradelane emission intensity including ballast emissions (BDF)**

  Multiply the laden-voyage emission intensity (Step 4) by the Ballast Distribution Factor (BDF) – the ratio of the carrier's total annual fleet emissions (laden + ballast) to total laden-voyage emissions.

  This scales the laden-only intensity to include ballast-voyage emissions.

  Mathematically, equivalent formulations may be used.

Note: The narrative steps above describe the process conceptually. The following example illustrates the same process using a simplified structure with three vessels and three tradelanes.

4.1 Calculation Example

4.1.1 Example structure

- **Vessel 1:** Tradelanes A and B
- **Vessel 2:** Tradelanes B and C
- **Vessel 3:** Tradelanes C and A

4.1.2 Clarification of Notation

Symbol	Meaning
Σ	Summation across relevant voyage legs or vessels
t	GRC tradelane (e.g., A, B, C)
v	Individual vessel (e.g., 1, 2, 3)
EI	Emission intensity (g CO_2e / t·km)
E	Emissions (t CO_2e)
TA	Transport activity (t·km)
BDF	Ballast Distribution Factor
Fuel Emission Factor	Well-to-wake factor (t CO_2e / t fuel)

4.1.3 STEP 1 – Transport activity

Each vessel reports transport activity per tradelane as:

$$TA_{t,v} = \sum_{Voyage\ legs} (Distance\ Sailed \times Cargo\ Carried)$$

For this example: Vessel 1 reports $TA_{A,1}$ and $TA_{B,1}$; Vessel 2 reports $TA_{B,2}$ and $TA_{C,2}$; Vessel 3 reports $TA_{C,3}$ and $TA_{A,3}$

These six vessel–tradelane values are then summed by tradelane:

$$TA_A = TA_{A,1} + TA_{A,3};\ TA_B = TA_{B,1} + TA_{B,2};\ TA_C = TA_{C,2} + TA_{C,3}$$

Values calculated: 6 vessel–tradelane transport activities → 3 tradelane totals (A, B, C).

4.1.4 STEP 2 – Laden-voyages emission

Each vessel calculates laden-voyage emissions per tradelane:

$$E_{t,v}^{laden} = (Fuel\ Consumed_{t,v}^{laden}) \times (Fuel\ Emission\ Factor)$$

For this example: Vessel 1 reports $E_{A,1}^{laden}$and $E_{B,1}^{laden}$; Vessel 2 reports $E_{B,2}^{laden}$and $E_{C,2}^{laden}$; Vessel 3 reports $E_{C,3}^{laden}$and $E_{A,3}^{laden}$

These six values are then summed by tradelane:

$$E_A^{laden} = E_{A,1}^{laden} + E_{A,3}^{laden};\ E_B^{laden} = E_{B,1}^{laden} + E_{B,2}^{laden};\ E_C^{laden} = E_{C,2}^{laden} + E_{C,3}^{laden}$$

Fleet total (for BDF calculation):

$$E_{fleet}^{laden} = E_A^{laden} + E_B^{laden} + E_C^{laden}$$

Values calculated: 6 vessel–tradelane laden emissions → 3 tradelane totals → 1 fleet total.

4.1.5 STEP 3 – Ballast-voyages emission

Each vessel calculates its own ballast-voyage emissions:

$$E_v^{ballast} = (Fuel\ Consumed_v^{ballast}) \times (Fuel\ Emission\ Factor)$$

For this example: Vessel 1 reports $E_1^{ballast}$; Vessel 2 reports $E_2^{ballast}$; Vessel 3 reports $E_3^{ballast}$

These are summed to the fleet total:

$$E_{fleet}^{ballast} = E_1^{ballast} + E_2^{ballast} + E_3^{ballast}$$

Values calculated: 3 vessel ballast emissions → 1 fleet ballast total.

A ballast voyage is defined as carrying ≤ 10 % of the vessel's maximum annual cargo mass. Transport activity from ballast voyages is not assigned to tradelanes.

4.1.6 STEP 4 – Tradelane emission intensity based on laden-voyages

Laden-voyage emission intensities are calculated directly at the tradelane level by aggregating the vessel-level emissions and transport activities.

This reflects how carriers and verifiers calculate results — no intermediate vessel-level intensities are needed.

$$EI_t^{laden} = \frac{\sum_v E_{t,v}^{laden}}{\sum_v TA_{t,v}} \times 10^6 [g\ CO_2e/t \cdot km]$$

For this example:

$$EI_A^{laden} = \frac{E_{A,1}^{laden} + E_{A,3}^{laden}}{TA_{A,1} + TA_{A,3}} \times 10^6;\ EI_B^{laden} = \frac{E_{B,1}^{laden} + E_{B,2}^{laden}}{TA_{B,1} + TA_{B,2}} \times 10^6;\ EI_C^{laden} = \frac{E_{C,2}^{laden} + E_{C,3}^{laden}}{TA_{C,2} + TA_{C,3}} \times 10^6$$

Values calculated: Three tradelane laden-only emission intensities (A, B, C). These form the basis for the final tradelane results once ballast emissions are incorporated.

4.1.7 STEP 5 – Final Tradelane Emission Intensity (incl. Ballast)

To account for emissions from ballast voyages, a BDF is calculated at the fleet level. This factor is applied uniformly across all tradelanes to ensure total emissions (laden + ballast) are represented.

$$BDF = \frac{E_{fleet}^{laden} + E_{fleet}^{ballast}}{E_{fleet}^{laden}}$$

The BDF scales the laden-only intensities to obtain the final tradelane intensities:

$$EI_A^{final} = EI_A^{laden} \times BDF;\ EI_B^{final} = EI_B^{laden} \times BDF;\ EI_C^{final} = EI_C^{laden} \times BDF$$

Values calculated: 1 BDF (for the carrier) → 3 final tradelane intensities (A, B, C).

The resulting values represent emission intensities that account for both laden and ballast emissions, expressed in g CO_2e / t·km.

5 Verification of Carrier Data

Carriers must have all data submitted to Smart Freight Centre (SFC) verified by an independent third-party verifier, in line with the principles and procedures described in the GRC Verification Guidelines. Verification confirms that the data reported by carriers conform to the GRC GHG Emission Intensity Calculation Methods and the GRC Verification Guidelines.

Carriers submit their verified annual data to SFC through the GRC Reporting Platform, covering all voyages that end within the reporting period. Each submission must include a verification statement issued by the verifier confirming that verification has been completed for the reporting year.

Verification follows the process described in the GRC Verification Guidelines (October 2025) and includes:

- Review of fuel consumption, cargo carried, and distance sailed at the voyage level;
- Checks on voyage inclusion, fuel type allocation, and tradelane assignment;
- Confirmation of data completeness, consistency, and alignment with the GRC methodology.

Verification is conducted annually, following carrier data submission and prior to SFC aggregating verified data for calculation of GRC-average and carrier-specific emission intensities. Only data verified in accordance with the GRC Verification Guidelines are included in the final GRC dataset.

Further details on the verification scope, process, and roles are provided in the GRC Verification Guidelines.

Annex 1: Fuel Emission Factors

The emission factors used for GRC calculations are based on the following table.

Fuel types	Emission factor WTW CO2e	Emission factor TTW CO2e	LCV (MJ/g)	Data source
HFO (VLSFO)	3.84	3.165	0.0402	IMO MEPC 81
HFO (HSHFO)	3.73	3.165	0.0402	IMO MEPC 81
LFO (ULSFO)	3.75	3.202	0.0412	IMO MEPC 81
LFO (VLSFO)	3.75	3.202	0.0412	IMO MEPC 81
MDO / MGO (ULSFO)	4.01	3.257	0.0427	IMO MEPC 81
MDO / MGO (VLSFO)	3.87	3.257	0.0427	IMO MEPC 81
LPG (Propane)	3.41	3.051	0.0463	IMO MEPC 81
LPG (Butane)	3.44	3.081	0.0463	IMO MEPC 81
LNG (Otto dual fuel medium speed)	4.61	3.726	0.048	IMO MEPC 81
LNG (Otto dual fuel slow speed)	4.13	3.239	0.048	IMO MEPC 81
LNG (LNG diesel)	3.71	2.821	0.048	IMO MEPC 81
LNG (LBSI)	4.37	3.483	0.048	IMO MEPC 81
LNG (Steam turbine and boilers)	3.67	2.783	0.048	IMO MEPC 81
Methanol	2.00	1.379	0.0199	Fuel.EU Maritime amended; RED II; and ifeu, infras & Fraunhofer IML, 2024
Other	3.84	3.165		HFO (VLSFO)
Bio-LNG (Otto dual fuel medium speed)	2.43	0.981	0.05	IMO MEPC 81 and ifeu, infras & Fraunhofer IML, 2024
Bio-LNG (Otto dual fuel slow speed)	1.94	0.492	0.05	IMO MEPC 81 and ifeu, infras & Fraunhofer IML, 2024
Bio-LNG (LNG diesel)	1.52	0.071	0.05	IMO MEPC 81 and ifeu, infras & Fraunhofer IML, 2024
Bio-LNG (LBSI)	2.18	0.736	0.05	IMO MEPC 81 and ifeu, infras & Fraunhofer IML, 2024
Bio-LNG (Steam turbine and boilers)	1.48	0.033	0.05	IMO MEPC 81 and ifeu, infras & Fraunhofer IML, 2024
Bio-Diesel	0.82	0.051	0.0372	Fuel.EU Maritime amended and RED II

HVO	0.71	0.051	0.044	Fuel.EU Maritime amended and RED II
Bio-Methanol	0.33	0.004	0.0199	Fuel.EU Maritime amended; RED II; and ifeu, infras & Fraunhofer IML, 2024

Annex 2: Trade regions and Tradelanes

Coverage	Name
Global	South Africa / West Africa to Europe
Global	Americas to Africa
Global	Americas to Middle East / India
Global	Far East / South East Asia to India / Middle East
Global	Far East / South East Asia to East / South Africa
Global	Far East / South East Asia to West Africa
Global	Far East / South East Asia to Europe
Global	Far East / South East Asia to North America East Coast & Gulf Coast / Central America East Coast / Caribbean / South America East Coast
Global	Far East / South-East Asia to North America West Coast
Global	Far East / South-East Asia to Oceania
Global	Far East / South-East Asia to Central America West Coast / South America West Coast
Global	India / Middle East to South Africa
Global	India to Middle East
Global	India / Middle East to Far East / South-East Asia
Global	Europe to Far East / South-East Asia
Global	Europe to India / Middle East
Global	Europe to North America East Coast & Gulf Coast
Global	Europe to North America West Coast
Global	Europe to Oceania
Global	Europe to South America East Coast
Global	Europe to South America West Coast
Global	North America East Coast & Gulf Coast to Europe
Regional	Intra Americas
Regional	Intra Asia
Regional	Intra Europe
Others	Others

Trade Region	Countries in Region	Selected Ports in Region
Africa - East Africa	Eritrea Kenya Madagascar Mauritius Mayotte Réunion Tanzania, United Republic of	Dar es Salaam (TZDAR) Le Port (Port Reunion) (RELPT) Longoni (YTLON) Massawa (ERMSW) Mombasa (KEMBA) Port Louis (MUPLU) Tamatave (MGTMM)
Africa - North Africa	Algeria Egypt Libya Morocco Tunisia	Abu Kir (EGAKI) Alexandria (EG) (EGALY) Algiers (DZALG) Bingazi (Benghazi) (LYBEN) Casablanca (MACAS) Djen-Djen (DZDJE) Misurata (LYMRA) Mostaganem (DZMOS) Port Said (EGPSD) Sokhna Port (EGSOK) Tanger Med (MAPTM) Tripoli (Libya) (LYTIP) Tunis (TNTUN)
Africa - South Africa	Mozambique South Africa	Cape Town (ZACPT) Durban (ZADUR) East London (ZAELS) Maputo (MZMPM) Port Elizabeth (ZAPLZ)
Africa – West Africa	Angola Benin Cameroon Congo Gabon Ghana Ghana Guinea Liberia Mauritania Namibia Nigeria Senegal Sierra Leone Togo	Conakry (GNCKY) Cotonou (BJCOO) Dakar (SNDKR) Douala (CMDLA) Freetown (SLFNA) Lome (TGLFW) Luanda (AOLAD) Monrovia (LRMLW) Nouakchott (MRNKC) Owendo (GAOWE) Pointe-Noire (CGPNR) Takoradi (GHTKD) Tema (GHTEM) Tincan/Lagos (NGTIN) Walvis Bay (NAWVB)
Americas - North America East Coast & Gulf Coast	Canada Mexico Perto Rico USA	Altamira (MXATM) Baltimore (US) (USBAL) Boston (USBOS) Brunswick (USSSI) Charleston (USCHS) Davisville (USDVV) Freeport (USFPO) Galveston (USGLS) Grays Harbor (Aberdeen) (USGHC) Halifax (CAHAL) Houston (USHOU) Jacksonville (USJAX) Mobile (USMOB) New York (USNYC) Newark (USEWR) Newport News (USNNS) Norfolk (USORF) Pensacola (USPNS) Philadelphia (USPHL) Ponce (PRPSE) Port Everglades (USPEF)

		Providence (USPVD) San Juan (PRSJU) Savannah (USSAV) Tampa (USTPA) Tuxpan (MXTUX) Vera Cruz (MX) (MXVER) Wilmington (USILG)
Americas - North America West Coast	Canada Mexico USA	Acapulco (MXACA) Anchorage (USANC) Benicia (USBNC) Everett (USPAE) Hilo (USITO) Honolulu (USHNL) Kahului (USOGG) Lázaro Cárdenas (MXLZC) Long Beach (USLGB) Los Angeles (USLAX) Manzanillo (MXZLO) Mazatlan (MXMZT) Nanaimo (CANNO) New Westminster (CANWE) Pearl Harbor (USPEA) Port Hueneme (USNTD) Portland (USPDX) Richmond (USRCH) San Diego (USSAN) San Francisco (USSFO) Tacoma (USTIW) Vancouver (USVAN)
Americas - Central America East Coast	Costa Rica Guatemala Honduras Panama	Manzanillo (PAMIT) Puerto Cortés (HNPCR) Puerto Limón (CRLIO) Puerto Santo Tomás de Castilla (GTSTC)
Americas - Central America West Coast	Costa Rica El Salvador Guatemala Honduras Nicaragua Panama	Acajutla (SVAQJ) Balboa (PABLB) Caldera (CRCAL) Corinto (NICIO) Puerto Quetzal (GTPRQ) San Lorenzo (HNSLO)
Americas - Carribean	Antigua and Barbuda Aruba Barbados Cayman Islands Cuba Curaçao Dominica Dominican Republic French Guiana Grenada Guadeloupe Guyana Haiti Jamaica Martinique Saint Kitts and Nevis Saint Lucia Saint Vincent and the Grenadines Sint Maarten Trinidad and Tobago Virgin Islands (British)	Antigua (AGANU) Barcadera (AWBAR) Basseterre. Saint Kitts (KNBAS) Bridgetown (BBBGI) Cap Haitien (HTCAP) Castries (LCCAS) Caucedo (DOCAU) Chaguaramas (TTCHA) Dégrad-des-Cannes (GFDDC) Fort-de-France (MQFDF) Freeport (BSFPO) George Town (KYGEC) Georgetown (GYGEO) Gonaives (HTGVS) Havana (CUHAV) Kingston (JMKIN) Kingstown (VCKTN) Mariel (CUMAR) Miragoâne (HTMIR) Nassau (BSNAS) Oranjestad (AWORJ) Philipsburg (SXPHI) Point-à-Pitre Apt (GPPTP) Port Purcell (VGPUR)

		Port-au-Prince (HTPAP) Port-of-Spain (TTPOS) Rio Haina (DOHAI) Roseau (DMRSU) Saint Johns (AGSJO) Saint Marc (HTSMC) Santo Domingo (DOSDQ) St. George's (GDSTG) Willemstad (CWWIL)
Americas - South America East Coast	Argentina Brazil Colombia Suriname Uruguay Venezuela	Cartagena (CO) (COCTG) Itajai (BRITJ) Montevideo (UYMVD) Paramaribo (SRPBM) Paranaguá (BRPNG) Porto de Suape (BRSUA) Puerto Cabello (VEPBL) Rio De Janeiro (BR) (BRRIO) Rio Grande (Brazil) (BRRIG) Santa Marta (COSMR) Santos (BRSSZ) Vitória (BRVIX) Zárate (ARZAE)
Americas - South America West Coast	Chile Colombia Ecuador Peru	Arica (CLARI) Buenaventura (COBUN) Callao (PECLL) Esmeraldas (ECESM) Iquique (CLIQQ) Manta (ECMEC) Pisco (PEPIO) San Antonio (CLSAI)
Asia – Far East Asia	China Japan Korea Russia (Pacific) Taiwan	AmagasakiNishinomiya (JPAMX) Busan (KRPUS) Busan New Port (KRBNP) Changbai Island (CNCGB) Chiba (JPCHB) Chongming (CNCGM) Dalian (CNDAL) Fushikitoyama Port (JPFTX) Gamagori (JPGAM) Guangzhou (CNGZG) Gunsan (KRKUV) Gwangyang (KRKAN) Hachinohe (JPHHE) Hakata/Fukuoka (JPHKT) Higashiharima (JPHHR) Hiroshima (JPHIJ) Hitachi (JPHTC) Hitachinaka (JPHIC) Hong Kong (HKHKG) Huangpu Pt (CNHUA) Incheon (KRINC) Kanazawa (JPKNZ) Kanda. Fukuoka (JPKND) Kawasaki (JPKWS) Keelung (Chilung) (TWKEL) Kisarazu (JPKZU) Kobe (JPUKB) Lianyungang (CNLYG) Masan (KRMAS) Matsuyama (JPMYJ) Meishan (CNMSN) Mizushima (JPMIZ) Moji/Kitakyushu (JPMOJ)

		Mokpo (KRMOK) Nagoya (JPNGO) Naha. Okinawa (JPNAH) Nakanoseki (JPNAN) Nakatsu (JPNAT) Nakhodka (RUNJK) Nanjing (CNNJI) Nansha Pt (CNNSA) Nantong (CNNTG) Ningbo (CNNBO) Omaezaki (JPOMZ) Osaka (JPOSA) Pyeongtaek (KRPTK) Qingdao (CNQIN) Sakaide (JPSKD) Sendai (JPSGM) Shanghai (CNSGH) Shigei (JPSIG) Shimonoseki (JPSHS) Shinmoji (JPSMJ) Taicang Pt (CNTAC) Taichung (TWTXG) Taipei (TWTPE) Tianjin Xingang (CNTXG) Tokyo (JPTYO) Tomakomai (JPTMK) Toyohashi (JPTHS) Tsuneishi (JPTNI) Ulsan (KRUSN) Vladivostok (RUVVO) Xiamen Pt (CNXMG) Yantai Pt (CNYTG) Yokkaichi (JPYKK) Yokohama (JPYOK) Yokosuka (JPYOS) Yongning (CNYNN) Yura. Wakayama (JPYUR) Zhangjiagang (CNZJG) Zhoushan (CNZOS)
Asia - South East Asia	Bangladesh Brunei Cambodia Indonesia Malaysia Myanmar Philippines Singapore Thailand Vietnam	Batam Island (IDBTM) Batangas/Luzon (PHBTG) Bauan/Batangas (PHBAU) Bintulu (MYBTU) Chattogram (BDCGP) Haiphong (VNHPH) Jakarta. Java (IDJKT) Kâmpóng Saôm (KHKOS) Kota Kinabalu. Sabah (MYBKI) Kuching. Sarawak (MYKCH) Laem Chabang (THLCH) Manila (PHMNL) Muara (BNMUA) Patimban* (IDPTB) Port Klang (MYPKG) Ho Chi Minh / Saigon (VNSGN) Sembawang Port (SGSEM) Singapore (SGSIN)
Europe – Mediterranean *Black Sea ports included	Cyprus France Georgia Gibraltar Greece Israel	Algeciras (ESALG) Ambarli (TRAMR) Ashdod (ILASH) Astakos Port (GRAST) Autoport (TRAUT) Barcelona (ESBCN)

	Italy Lebanon Malta Portugal Romania Russian Federation Slovenia Spain Syria Turkey Ukraine	Bari (ITBRI) Beirut (LBBEY) Brindisi Port (ITBDS) Cagliari (ITCAG) Catania (ITCTA) Civitavecchia (ITCVV) Constanta (ROCND) Derince (TRDRC) Diliskelesi (TRDIL) Fos-sur-Mer (FRFOS) Gemlik (TRGEM) Genova (ITGOA) Gibraltar (GIGIB) Gioia Tauro (ITGIT) Haifa (ILHFA) Haydarpasa (TRHAY) Igoumenitsa (GRIGO) Illichevsk (UAILK) Iskenderun (TRISK) Izmir (TRIZM) Koper (SIKOP) Larnaca (CYLCA) Leixões (PTLEI) Limassol (CYLMS) Livorno (ITLIV) Málaga (ESAGP) Marseille (FRMRS) Mersin (TRMER) Monfalcone (ITMNF) Novorossiysk (RUNVS) Palermo (ITPMO) Patras (GRGPA) Piraeus (GRPIR) Porto Torres (ITPTO) Poti (GEPTI) Ravenna (ITRAN) Sagunto (ESSAG) Salerno (ITSAL) Savona (ITSVN) Sète (FRSET) Tarragona (ESTAR) Tartus (SYTTS) Toulon (FRTLN) Trieste (ITTRS) Tripoli (Lebanon) (LBKYE) Valencia (ESVLC) Valletta (MTMLA) Venezia (ITVCE) Yalova (TRYAL) Yarimca (TRYAR) Yenikoy (TRYEK)
Europe - North Continental Europe	Belgium Denmark Estonia Finland France Germany Ireland Latvia Netherlands Norway Portugal Russian Federation	Aarhus (DKAAR) Amsterdam (NLAMS) Antwerp (BEANR) Arrecife de Lanzarote (ESACE) Avonmouth (GBAVO) Belfast (UK) (GBBEL) Bilbao (ESBIO) Bremerhaven (DEBRV) Brevik (NOBVK) Bristol (GBBRS) / Royal Portbury Dock (GBPRU) Calais (FRCQF)

	Spain Sweden United Kingdom	Cuxhaven (DECUX) Dagenham (GBDAG) Drammen (NODRM) Dublin (IEDUB) Dunkirk (FR) (FRDKK) Emden (DEEME) Esbjerg (DKEBJ) Felixstowe (GBFXT) Ghent (BEGNE) Gothenburg (SEGOT) Grimsby (GBGSY) Halden (NOHAL) Halmstad (SEHAD) Hamburg (DEHAM) Hangö (Hanko) (FIHKO) Harwich International (GBHRW) Heysham (GBHYM) IJmuiden (NLIJM) Immingham (GBIMM) Killingholme (GBKGH) Kotka (FIKTK) Las Palmas (ESLPA) Le Havre (FRLEH) Lindo (DKLIN) Liverpool (UK) (GBLIV) Malmö (SEMMA) Montoir-de-Bretagne (FRMTX) Nantes (FRNTE) Oslo (NOOSL) Paldiski Lounasadam (EEPLS) Pasajes (ESPAS) Riga (LVRIX) Ringaskiddy (IERIN) Rosslare (IEROE) Rostock (DERSK) Rotterdam (NLRTM) Saint Petersburg (ex Leningrad) (RULED) Santa Cruz de Tenerife (ESSCT) Santander (ESSDR) Sas Van Gent (NLSVG) Setúbal (PTSET) Sheerness (GBSHS) Sodertalje (SESOE) Southampton (GBSOU) Teesport (GBTEE) Terneuzen (NLTNZ) Thorlakshofn (ISTHH) Tilbury (GBTIL) Travemunde (DETRV) Trelleborg (SETRG) Turku (FITKU) Tyne (GBTYN) Uusikaupunki (FIUKI) Vigo (ESVGO) Vlissingen (NLVLI) Vuosaari (FIVSS) Wallhamn (SEWAL) Warrenpoint (GBWPT) Wilhelmshaven (DEWVN) Zeebrugge (BEZEE)
India / South Asia	India Sri Lanka	Chennai (ex Madras) (INMAA) Colombo (LKCMB) Ennore (INENR)

		Hambantota (LKHBA) Mumbai (ex Bombay) (INBOM) Mundra (INMUN) Pipavav (Victor) Port (INPAV)
Middle East - Arabian Gulf	Bahrain Iran Iraq Kuwait Oman Qatar Saudi Arabia United Arab Emirates	Ad Dammam (SADMM) Al Duqm (OMDQM) Bandar Abbas (IRBND) Hamad (QAHMD) Jafza Jebel Ali (AEJEA) Jubail Port (SAJUB) Khalifa Bin Salman Port (BHKBS) Kuwait (KWKWI) Mina Khalifa/Abu Dhabi (AEKHL) Sharjah (AESHJ) Shuaiba (KWSAA) Sohar (OMSOH) Umm al Quwain (AEQIW) Umm Qasr (IQUQR)
Middle East - Red Sea	Djibouti Israel Jordan Saudi Arabia Sudan Yemen	Aden (YEADE) Al 'Aqabah (JOAQJ) Djibouti (DJJIB) Elat (Eilath) (ILETH) Jeddah (SAJED) Port Sudan (SDPZU) Yanbu (SAYNB)
Oceania	Australia Fiji French Polynesia Guam New Caledonia New Zealand Northern Mariana Islands Papua New Guinea	Adelaide (AUADL) Auckland (NZAKL) Brisbane (AUBNE) Darwin (AUDRW) Fremantle (AUFRE) Geelong (AUGEX) Guam (GUGUM) Lyttelton (NZLYT) Melbourne (AUMEL) Nelson (NZNSN) Newcastle (AU) (AUNTL) Nouméa (NCNOU) Papeete (PFPPT) Port Kembla (AUPKL) Port Moresby (PGPOM) Saipan (MPSPN) Suva (FJSUV) Townsville (AUTSV) Wellington (NZWLG)