Assertion Report of GHG Emission for Financial Year 2021-2022

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Chapter 1 – Organization Profile

1.1 History of Organization

THE GREAT EASTERN SHIPPING COMPANY LTD., incorporated in 1948, has expanded steadily first under the leaderships of Late Vasant J. Sheth, Mr. K.M. Sheth and now Mr B.K. Sheth to become India's largest shipping company in the private sector.

Although established in 1948, the Company traces its roots back to the First World War.

During World War 1, the firm of Jagjiwan Ujamshi Mulji was set up in Bombay by Chunilal, Maneklal and Jagjiwan, the three sons of Ujamshi Natalia. The firm operated as a trader in various commodities for 15 years, until the Great Depression of the late 1920s. In 1929, the brothers joined forces with Sir Dossabhai Bhiwandiwalla, and set up the firm of A.H. Bhiwandiwalla & Co. (AHB as the firm came to be popularly known).

In 1948, AHB acquired a cargo vessel, the Fort Ellice, renamed Jag Vijay. This was meant to be an adjunct to the trading operations: however, it soon became clear that a capital intensive business like shipping needed an autonomous Company.

The Great Eastern Shipping Company Ltd. was, therefore, set up with 40% of its equity subscribed to by Shree Changdeo Sugar Mills, and the rest by the Sheth-Mulji and Bhiwandiwalla families. The operations of the Company were left to Vasant J. Sheth, youngest son of Jagjiwan Ujamshi Mulji, one of the founders of the original trading firm.

During the late 1970s, the Bhiwandiwallas retired from the business, selling their interest in AHB (by now an incorporated Company) to their partners.

Given the cyclic nature of the shipping industry, the need for diversification was always in the mind of the management. When the government decided to throw open the area of offshore supply vessels to the private sector, The G E Shipping was the first to take the plunge in 1982, at the initiative of Mr. K.M. Sheth.

From the very beginning, The G E Shipping has been on the leading edge. The company has not been afraid to try out new technologies, not worried about going against the tide. Not surprisingly the Company has an impressive history of firsts to its credit, e.g. in 1956, the company acquired its first oil tanker – it was also India's first. It proved so successful that Company's tanker fleet has just kept growing. In the same year German ship building company Blohm & Voss produced a revolutionary "pioneer" type of ship. The G E Shipping was the first company in the world to opt for it, and there after ordered four more ships in India, to that design. In 1962, the company was the first shipping company to start regular liner services to carry general cargo from the Pacific coast of the US and Canada to India.

The fleet now comprises tramp ships which includes oil tankers, chemical tankers, gas carriers and bulk carriers. The company's operations are global.

The Company has at its helm the Executive Chairman Mr. K. M. Sheth and the Deputy Chairman and Managing Director Mr. Bharat Sheth. Under their stewardship Company continues to perform and deliver results in an increasingly competitive environment duly deserving the honour of India's premier shipping organization.

1.2 Brief Description of present activities

G E Shipping enjoys a formidable presence in the international maritime industry. The shipping business operates under two main sectors: dry bulk carriers and tankers (oil, chemical and gas). The tankers enjoy approvals from oil giants like SHELL, BP, EXXONMOBIL, CHEVRON TEXACO, TOTALFINA to name a few. As of 31st March 2022, the fleet consisted of 45 vessels (31 Tankers and 14 Bulk Carriers) totalling 3.57 million Deadweight Tonnes with an average age of 13.19 years.

Backed by an enviable clientele comprising industry leaders, international oil companies and governments who vouch for its services, G E Shipping has earned the status of being the most preferred shipping service provider. With a pulse on the global market and a thorough understanding of the ever-evolving market needs, G E Shipping is well-equipped to anticipate the demands of its clients and to deliver on its commitments, successfully and satisfactorily.

The Company operates its vessels on voyage charter (spot) as well as period charter (time).

The company management system is certified to ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018 standards by DNV-GL.

1.3 Objective of this report

The objective of this report is to capture and quantify GHG emission from our owned vessels in a transparent and standardized manner for the information of stakeholders of the Company on a voluntary basis. G. E. Shipping is committed to reduce GHG emission from its vessels and has been taking several measures to do so by way of retrofitting vessels with energy saving devices, better hull surface management, close monitoring of fuel efficient operation of vessels and quantification and reporting of GHG emission from its vessels to facilitate taking informed decisions with respect to further enhancing energy efficiency of ships.

The GHG emission quantification and reporting is done taking into account:

- ISO 14064-1 (2006) "Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals, and
- The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard (Revised edition) published by World Business Council for Sustainable Development and World Resources Institute.

1.4 Roles and responsibilities of Vessel Performance Management Department

Vessel Performance Management Department was established in early 2014 with following responsibilities:

- Fuel Efficiency Performance monitoring of vessels
- Establishing and monitoring related Operational KPIs

- Providing MIS to Management (Quarterly, Annually)
- Identification and review of Energy Saving Technologies
- Preparation / presentation of decision support documents for Management approval;
- Enhancing Fuel Efficiency of Vessels through retrofitment of Energy Saving Devices / Operational Measures in co-ordination with Technical / Operation / IT Depts.;
- Training / Awareness building on Energy Efficiency of Personnel ashore and onboard vessels
- Quantification and reporting of GHG inventory.

1.5 Management System and Policies

1.5.1 Our Vision

- To lead our industry in Safety Standards, Environmental Protection, Energy Optimization and Quality of Operations.
- To be the provider of choice of our customers.

1.5.1 Mission Statement

Consistent with the Company's policy and philosophy of maintaining professional excellence in all spheres of activity involving marine bulk transportation service, including Quality, Heath, Safety, Security, Environment (QHSSE) and Social Responsibility, our mission shall be:

- To own, operate and manage efficient ships with zero spills to sea, zero incidents, zero tolerance to drugs and alcohol, while protecting the lives of shipboard personnel, cargo and company's own assets and reducing environmental emissions by employing best management practices;

- To provide a highly efficient and competitive marine bulk transportation service of quality, cost, reliability, delivery and security;

- To achieve excellence in our management systems and standards through continual improvement, by employing best practices through an efficient, responsive management and empowered and highly motivated work force;

- To create enhanced value for our shareholders and other stake holders.

1.5.2 INTEGRATED MANAGEMENT SYSTEM POLICY

Recognizing that achieving excellence in respect of Quality, Health, Safety, Security, Environment and Social Responsibility is paramount to the success of our business, we give highest importance to these aspects. Accordingly, we commit ourselves to:

- Understanding the requirements of our customers and striving to exceed their expectations;
- Building mutually beneficial relationships with service providers and company personnel;
- Improving safety, environmental, operational, technical and commercial performance of ships operated by us;
- Complying with applicable Flag and Port State legislations and other requirements, as applicable;
- Maintaining an optimum spare parts inventory based on critical equipment and system redundancy identified on all vessels;

- Providing for safe practices in ship operation and ensuring safe, secure and healthy working environment to personnel ashore and on board ships by employing best management practices;
- Identifying all relevant hazards to safety, health and security, assessing risks and establishing safeguards against all identified hazards;
- Safeguarding all IT and OT assets ashore and on board our ships from cyber-attacks by continuously mitigating cyber risks;
- Ensuring that adequate attention is paid towards selection and career development of shore-based and shipboard personnel, with a view to ensure that all responsible persons are fully competent to perform the task with which they are entrusted;
- Continually enhancing the safety management skills of personnel ashore and on-board ships, including preparing for emergencies related to safety, protection of environment and security;
- Establishing and monitoring the health standards of employees working in shore-based offices and on-board the ships;
- Continually improving the performance and effectiveness of our integrated management system;
- Preventing all types of pollution of sea by oil, garbage, sewage and other harmful substances;
- Reducing air pollution and reducing-recycling-reusing all types of waste;
- Preventing injury, accidents, illnesses, damages, losses and deficiencies in our service;
- Following and enforcing a zero tolerance policy towards drugs and alcohol;
- Conserving all types of natural resources including energy, and committing to fulfill our social responsibility with conviction and determination for the betterment of society at large.

It shall be ensured that all personnel ashore and on-board ships have appropriate experience and training relevant to their roles. Company provides career development for junior officers and aims to recruit senior officers from within the company where possible. Senior officers are encouraged and appraised to always lead by example in safety related issues.

Company commits itself to providing adequate resources and training to its personnel, whether shore-based or on board ships, to meet the requirements of this policy. It shall be ensured that all personnel understand the policy and endeavor their utmost to implement the same at all times.

1.5.3 Policy on Conservation of Energy

As a part of Company's policy for conservation of natural resources and protection of environment, the Company lays importance on conservation of energy. The Company is aware that we all depend on natural resources for all our energy requirements and the Company considers these resources as treasure.

The Company is concerned about the challenges presented by earth's diminishing natural resources and global warming in general and energy supply in particular.

To make our existing energy resources last longer and reduce green house gas emission, the Company is committed to:

- Making a sincere and conscientious effort in reduction of use of fossil fuel with a view to reduction of Green House Gas emission;
- Avoiding inefficient and improper use of resources thus controlling waste of energy;

- Adopting better methods in work area such as proper and timely maintenance of ship and her machinery and equipment.

1.5.4 Corporate Social Responsibility Vision Statement and Objective

For Great Eastern, CSR means responsible business policies that are ethical, equitable, environmentally conscious, gender sensitive, and sensitive towards the differently abled. This policy, which has been formulated in alignment with the vision of the company, lays down guidelines and mechanisms to be adopted by the Company in order to carry out CSR Projects/Programs.

The objectives of this policy are to–

- Demonstrate commitment to the common good through responsible business practices and good governance.

- Actively support the state's development agenda to ensure sustainable and equitable change.

- Set high standards of quality in the delivery of services in the social sector by creating robust processes and replicable models.

- Engender a sense of empathy and equity among employees of GES to motivate them to give back to the society.

The structure for identification of these causes, and the modalities of the investment in these causes, are spelled out in detail in the following sections.

1.5.4.1 Focus Area

Conforming to the activities as mentioned under Schedule VII, Section 135 of the Companies Act and, aligning our commitment to the globally accepted Sustainable Development Goals (SDG's), GE Group's focus areas are:
a. Education: We are committed to support initiatives that aim to improve the quality of education, with a focus on building capacities of teachers and educators.

b. Health: We aim to improve health outcomes for adolescent girls, pregnant women, infants, other women and communities at large.

c. Livelihoods: We aim to enhance livelihood opportunities for women and youth by supporting organisations that focus on skill building, women empowerment and sustainable farming practices.

1.5.5 Overall strategy on energy saving and pollution prevention

The Company has established, implemented and maintains procedure(s) to identify the environmental aspects of its ship and shore-based operations defined within the scope of the environmental management system that it can control and those it can influence, taking into account planned or new developments or new or modified activities and services. The Company determines which environmental aspects have or can have a significant impact on the environment. The Company has documented this information and keeps it up-to-date. Proactive steps are taken to not only ensure compliance with statutory requirements but to stay ahead of the regulatory curve.

The Company ensures that the significant environmental aspects are taken into account in establishing, implementing and maintaining its environmental management system.

1.5.6 Reporting Period

This assertion report is for Financial Year 2021-2022 i.e. 1st April 2021 to 31st March 2022. The first year of GHG emission accounting as per ISO 14064-1 standard was Financial Year 2015-2016.

Chapter 2 – Scope and Boundary of GHG Reporting

2.1 Description of GHG emissions

2.1.1 Organizational Boundary

The organizational boundary for accounting of GHG emission is taken as vessels owned and managed by G.E. Shipping, electricity consumption at its Registered Office in Ocean House, Mumbai and electricity consumption at training academy of the Company known as Great Eastern Institute of Maritime Studies at Lonavala in Maharashtra.

On 31st March 2021 the fleet size was 45 vessels and 3.64 million Deadweight Tonnes. During the reporting period Jag Vayu and Jag Lata were sold and Jag Vikram and Jag Rajiv were acquired, thus the total fleet size as 45 vessels and 3.57 million Deadweight Tonnes.

Since this reporting is being voluntarily made for the stakeholders, the **control approach** is the most appropriate since the Company can be held accountable for vessels under their ownership and technical management only. It is to be also borne in mind that responsibility for ensuring compliance with international regulatory requirements for a vessel rests with ship owner and technical manager. Ships are generally employed under either “Voyage Charter” or “Time Charter”.

A voyage charter can be defined as the hire contract for a vessel for one or a specified number of voyages to carry specified cargo/es at stipulated freight rates (or lumpsum) on agreed terms and conditions between designated load and discharge ports, port ranges or regions. The shipowner pays for all fuel the vessel consumes.

A time charter can be defined as the hire contract of a vessel for a specific period of time; the owner still manages the vessel but the charterer selects the ports and directs the vessel where to go. The charterer pays for all fuel the vessel consumes. The Charterers pay a daily hire for the vessel.

G E Shipping charters out its owned vessels either on Voyage Charter or on Time Charter depending on the nature of charter that will provide best commercial benefit for a vessel at a given point in time. During the financial year, for all completed voyages, the number of sailing days of the fleet vessels was broadly 70% under Voyage Charter and 30% under Time Charter.

G. E. Shipping occasionally, to supplement its owned fleet, hires vessels under time charter over which it has no technical management control and as such these vessels are excluded from boundary of reporting under Scope 1 and Scope 2.

Greatship (India) Limited (GIL), wholly owned subsidiary (WOS) of G. E. Shipping is one of India’s largest offshore oilfield services providers by way of owning and operating fleet of vessels. It is a separate company operated by its own Board of Directors and hence it is not included within the scope of this assertion report.

2.1.2 Operational Boundary

G E Shipping accounts for and reports its emissions of all applicable Kyoto GHGs (i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and hydrofluorocarbons (HFCs) from all direct sources of emissions.

Sulphur Hexafluoride SF6

Sulphur hexafluoride (SF_6) is a colourless, odourless, non-toxic, non-flammable gas that has a high dielectric strength. It has been used as a dielectric in microwave frequencies, as an insulating medium for the power supplies of high-voltage machines on board ships. The use of SF_6 in electrical switchgear in general (all land, air and sea installations) is primarily (90%) concentrated on the high-voltage segment (>36 kV) and the remaining 10% for the medium (1 kV–36 kV) voltage segment (Schneider 2003). None of the G E Shipping vessels and other assets have such high voltage installations and consequently SF_6 emission is not applicable.

Perfluorocarbons (PFCs)

Several binary and ternary blends of various HFC, HCFC, PFC and hydrocarbon refrigerants have been developed to address continuing service demand for CFC-12. These blends are tailored to have physical and thermodynamic properties comparable to the requirements of the original CFC-12 refrigerant charge. In shipping industry this refrigerant is used for deep-freezing purposes (-40°C to -70°C) on reefer vessels and fishing vessels. None of our fleet vessels has such deep freezers and consequently use of PFCs is not applicable.

Scope 1 (Direct GHG emissions)

- Emission resulting from combustion of fuel oils in company owned and managed vessels' main engines, auxiliary engines, boilers, inert gas generators (fitted on some of the tankers) and auxiliary engines for Framo hydraulic power units (fitted on some of the tankers).

- Emission resulting from unintentional releases of hydrofluorocarbon (HFC) used as refrigerants for air conditioning and provision refrigeration plants on company owned and managed vessels.

Scope 2 (Indirect GHG emissions from electricity consumption)

- Emissions due to purchased electricity consumed at Ocean House, Head Office of G E Shipping based in Mumbai and training academy of the Company known as Great Eastern Institute of Maritime Studies at Lonavala in Maharashtra.

2.2 Description of Assets

2.2.1 Assets in FY 2021-2022

Table 2.2.1 – Assets (FY 2021-2022)

Name of Vessel	IMO No.	Type of Vessel	Date of Built	Deadweight (DWT)
Suezmax				
JAG LOK	9293507	Oil Tanker	01-Mar-05	158145.20
JAG LALIT	9297905	Oil Tanker	19-May-05	158344.00
JAG LEENA	9516105	Oil Tanker	09-Feb-10	157671.70
JAG LAKSHYA	9516117	Oil Tanker	05-Jan-11	157641.60
Aframax				
JAG LAVANYA	9237412	Oil Tanker	19-Jan-04	105010.40
JAG LATA	9237618	Oil Tanker	19-May-03	105716.00
JAG LYALL	9308443	Oil Tanker	02-Jan-06	110530.80
JAG LEELA	9568184	Oil Tanker	23-Sep-11	105525.20
JAG LAXMI	9568196	Oil Tanker	05-Jan-12	105525.20
LR2				
JAG LOKESH	9390599	Oil Tanker	05-Jan-09	105599.00
JAG LARA	9488023	Oil Tanker	06-Apr-12	105258.00
LR1				
JAG AABHA	9388948	Oil Tanker	03-Nov-08	74867.70
JAG APARNA	9388936	Oil Tanker	09-Jun-09	74859.30
JAG AMISHA	9388924	Oil Tanker	03-Apr-09	74889.20
JAG AANCHAL	9390161	Oil Tanker	05-Dec-08	74811.16
MR				
JAG PRANAV	9281932	Oil Tanker	05-Jan-05	51383.00
JAG PRANAM	9310680	Oil Tanker	13-Dec-04	48694.00
JAG PRABHA	9270749	Oil Tanker	28-Oct-04	47999.00
JAG PUSHPA	9315733	Oil/Chemical Tanker	27-Apr-07	47848.00
JAG PRERANA	9321952	Oil/Chemical Tanker	04-Oct-07	47824.23
JAG PRAKASH	9315721	Oil/Chemical Tanker	28-Mar-07	47848.23
JAG PANKHI	9258686	Oil/Chemical Tanker	21-May-03	46272.70
JAG PAHEL	9289506	Oil/Chemical Tanker	12-Oct-04	46319.30
JAG PADMA	9325348	Oil Tanker	27-Sep-05	47999.00
JAG POOJA	9310692	Oil Tanker	25-Jun-05	48539.00

JAG PUNIT	9709984	Oil/Chemical Tanker	01-Apr-16	49717.40
JAG PAVITRA	9387956	Oil/Chemical Tanker	24-Dec-08	51463.00
Gas Carrier				
JAG VISHNU (New)	9264908	Gas Carrier	31-Oct-2002	49996.00
JAG VIKRAM	9324734	Gas Carrier	23-Feb-2006	26427.00
JAG VIJAYA	9139696	Gas Carrier	30-July-1997	26897.00
Name of Vessel	**IMO No.**	**Type of Vessel**	**Date of Built**	**Deadweight (DWT)**
JAG VIRAAT	9307762	Gas Carrier	25-July-2007	54450.00
JAG VAYU	9108099	Gas Carrier	29-May-1996	38518.00
JAG VASANT	9307750	Gas Carrier	30-Nov-2006	54478.00
Capesize				
JAG ANAND	9463308	Bulk Carrier	09-Jun-11	179250.00
JAG ALAIA	9551727	Bulk Carrier	07-Feb-14	180694.00
Kamsarmax				
JAG ARNAV	9705354	Bulk Carrier	03-Jun-15	81732.00
JAG AARATI	9478200	Bulk Carrier	25-Feb-11	80325.20
JAG ADITI	9478195	Bulk Carrier	01-Apr-11	80325.20
JAG AJAY	9723849	Bulk Carrier	30-Jun-16	82094.20
JAG AALOK	9706566	Bulk Carrier	29-Jul-16	82022.60
JAG AKSHAY	9706554	Bulk Carrier	29-Aug-16	82044.30
JAG AMAR	9723851	Bulk Carrier	11-Jan-17	82083.80
Supramax				
JAG RAJIV	9643166	Bulk Carrier	24-Apr-13	56103.00
JAG RANI	9456355	Bulk Carrier	08-Jul-11	56718.80
JAG RISHI	9456343	Bulk Carrier	01-Mar-11	56718.80
JAG RADHA	9496135	Bulk Carrier	27-Nov-09	58133.00
JAG ROHAN	9324631	Bulk Carrier	20-Jan-06	52450.00

2.2.2 Assets acquired and sold in FY 2021 - 2022

Name of Vessel	IMO No.	Type of Vessel	Date of Built	Deadweight	Vessel Sold on
JAG VAYU	9108099	Gas Carrier	29-May-1996	38518.00	28-Jun-2021
JAG LATA	9237618	Oil Tanker	19-May-2003	105716.00	17-Sept-2021

Name of Vessel	IMO No.	Type of Vessel	Date of Built	Deadweight	Vessel Acquired on
JAG VIKRAM	9324734	Gas Carrier	23-Feb-2006	26427.00	19-Apr-2021
JAG RAJIV	9643166	Bulk Carrier	24-Apr-13	56103.00	14-May-2021

2.2.3 Vessels operated on Time Charter in FY 2021 – 2022

Nil.

2.3 Uncertainty assessments and materiality threshold

2.3.1 Uncertainty Assessment
There are a few known sources of uncertainty in our assessment and these are as follows:

1. Accuracy margin of ±1.05% of the fuel flow meters in use on board ships. The fuel flow meters are calibrated against fuel tank soundings for each voyage as per procedure documented in Integrated Management System, Chapter 6, Bunkering Operations section 27
2. Procedure for calculation of mass of fuel consumed from fuel flow meter readings is given in Integrated Management System, Chapter 6, Bunkering Operations section 26. Uncertainty due to human error in incorrect use of the procedure is estimated to be ±0.50%.
3. Total uncertainty is thus considered to be < ±1.55%.

2.3.1.1 Completeness of data

In Live Vessel Information System (LIVIS) a Vessel Report Checklist is incorporated which identifies status of Noon, Arrival and Departure Reports received from vessels for any selected period. Safety feature also exist which prevents sending Noon Report for a day without sending Noon Report of the preceding day. This ensures completeness of data. Quantity and grade of bunker received at any port is reported in Departure Reports and the changes in bunker quantity remaining on board is reflected in Noon Reports.

2.3.2 Materiality threshold

Materiality threshold for omissions of individual sources of emission is considered to be 1.0% and overall materiality threshold is considered to be 5.0%.

2.4 Inclusion / exclusion of assets and emissions

MARPOL Annex V Garbages in categories "C" (Domestic waste), "D" (Used cooking oil) and "F" (Operational waste) – Quantity of such garbage incinerated on board are reported by vessels and the aggregate quantity is found to be 113.71 M^3 for the entire fleet during the reporting period. It is to be noted that the garbage burnt is a mixture of various constituents making it very uncertain to establish carbon content and the GHG emission.

Since the total garbage quantity incinerated falls below Material Threshold limit (1%), it is excluded.

Scope 3

An emission under this head has not been considered. Scope 3 emissions for G E Shipping are as follows:

- Commuting and business travel by employees;
- Fuel used by inchartered vessels;
- Transportation of purchased fuel in bunker barge or road tankers;
- Disposal of waste generated in operation;
- Supply of electricity to vessel during dry docking etc.

The followings are not applicable to the activities of G E Shipping:

- Transportation of an organization's product and materials – G E Shipping transports commodities between different locations and thereby emissions arising from consumption of fuels for propulsion and operation of vessels are included within Scope 1 emission. It does not manufacture or process any product, hence this is not applicable.
- Outsourced activities, contract manufacturing and franchises – None of company's business is outsourced, sub-contracted or franchised.

2.5 Listing of all GHG emission sources and sub-systems

Emissions from Main engines, auxiliary engines, boilers, inert gas generators (fitted on some of the tankers), auxiliary engines for Framo pumps (fitted on some of the tankers) have been considered.

Emissions from other energy-consuming sources (e.g. emergency generator, lifeboat engines etc.) were omitted because the contribution falls below Material Threshold limit.

2.6 Method for estimation for non-combustion emissions (Refrigerants, halogenated hydrocarbons)

R-22, R404a and R407c are used on board vessels for air conditioning and provision cooling purposes.

All these refrigerants have significant Global Warming Potential (GWP). The GWP is reported as CO_2 equivalent (CO_2e): this describes the equivalent amount of CO_2 that would be needed to achieve the same warming effect. The numerical values of GWP for different substances used in this report were taken from the IPCC Sixth Assessment Report and are based on the latest IPCC estimate of CO_2 concentration in the atmosphere.

2.7 Global warming potential of refrigerant emission from ships

The GWP100 is described relative to CO_2 warming potential (IPCC Sixth Assessment Report: Climate Change 2021)

Table 2.7

Refrigerant	GWP for determining CO_{2e}
R-22	1960
R404a	4728
R407c	1907.9

Chapter 3 – Methodology for GHG quantification

3.1 Consolidation Approach

The organizational boundary for accounting of GHG emission is taken as vessels owned and managed by G.E. Shipping. Since this reporting is being voluntarily made for the stakeholders, the control approach is the most appropriate since the Company can be held accountable for vessels under their technical management only.

Emission, for vessels that have been sold or acquired during a specific financial year, have been reported for the period the vessels were under the ownership of the Company.

3.2 Type of Fuel Consumed on fleet vessels and Conversion Factor

Emission Factors are taken from MEPC.308(73) – 2018 Guidelines on the Method of Calculation of the Attained Energy Efficiency Design Index (EEDI) for New Ships.

With effect from 1st January 2020, Regulation 14.1.3 of MARPOL Convention, Annex VI mandates cap on sulphur content of fuel oil to ≤ 0.50% m/m unless the vessel is provided with an approved exhaust gas cleaning system. Such fuel oils fall under “Light Fuel Oil” types. Until this regulation came into force ships could burn fuel oil with sulphur content ≤ 3.50% m/m (Heavy Fuel Oil) with lower Carbon Emission Factor but higher SOx emission.

Vessels fitted with exhaust gas cleaning system can continue to burn fuel oil with sulphur content > 0.50% m/m. Such fuel oils fall under “Heavy Fuel Oil” type.

Table 3.2

Type of Fuel	Reference	Carbon content	Emission Factor (t-CO2 / t-Fuel)
Diesel / Gas Oil	ISO 8217 Grades DMX through DMB	0.8744	3.206
Light Fuel Oil	ISO 8217 Grades RMA through RMD	0.8594	3.151
Heavy Fuel Oil (HFO)	ISO 8217 Grades RME and RMG	0.8493	3.114

3.3 Method used for quantification of GHG emission

Emission from combustion of fuel are determined from fuel consumed over the measurement period, which simply put, is the fuel at the beginning of the period, plus deliveries during the period, minus fuel available at the end of the period on respective ships. Fuel (Metric Tonnes) remaining onboard at the beginning and end of reporting period are collected from Daily Noon Reports and bunker supplied (Metric Tonnes) are collected from Departure Reports. Bunker supplied in a port is reflected in Bunker Delivery Notes and the data is reported in port Departure Report. In the rare event of debunkering, amount of any fuel oil (Metric Tonnes) offloaded is subtracted from the fuel oil consumption of that reporting period. This information is collected from Daily Noon Report. All these reports sent by vessels are available in GE Nautical platform.

The key assumption associated with this approach is that all fuel purchased and determined from the stocktakes of the fuel tanks at the beginning and end of reporting period will be fully consumed. It does not take into account any differential between volume of fuel purchased and the actual volume of fuel consumed. There may be differences in the two quantities due to:
1. sludge and water removed from the fuel following on-board fuel treatment processes, and
2. Bunker Delivery Note (BDN) accuracy.

*(*Tonne - a metric system unit of mass equal to 1,000 kilograms (2,204.6 pounds) or 1 megagram (1 Mg). To avoid confusion with the smaller "short ton" and the slightly larger "long ton", the tonne is also known as a "metric ton"; in this report, the tonne is distinguished by its spelling.)*

At the end of financial year quantities of different grades of fuel consumed on each vessel are collated from GE Nautical platform and multiplied by applicable Emission Factor to arrive at CO_2 emission from combustion of fuels. The same is shown in Table 5.1.

3.4 Estimation of emissions factors

Emission Factors (EFs) for CH_4 and N_2O are obtained from Table 27 – Emissions factors for top-down emissions from combustion of fuel given in Fourth IMO GHG Study 2020. Also, as per IPCCC Assessment Report 6, Global Warming Potential (CO_{2e}) for CH_4 is 27.9 and for N_2O is 273. The emission factors used are as follows:

Table 3.4a

Emission substance	Marine HFO emission factor g/g fuel	Marine MDO emissions factor (g/g fuel)	CO_{2e}
CH_4	0.00005	0.00005	27.9
N_2O	0.00018	0.00018	273

Table 3.4b – Emission sources, type of fuel consumed and conversion factors.

Source	Type of fuel oil	Emission Factor ($t\text{-}CO_2$ / t-Fuel)
Main Engine	Heavy Fuel Oil – High Sulphur (HSFO)	3.114
	Light Fuel Oil (LFO)	3.151
	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Auxiliary Engine	Heavy Fuel Oil – High Sulphur (HSFO)	3.114
	Light Fuel Oil (LFO)	3.151
	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Boiler	Heavy Fuel Oil – High Sulphur (HSFO)	3.114
	Light Fuel Oil (LFO)	3.151
	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Inert gas generators	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Auxiliary engines for Framo pumps	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206

3.5 Quality assurance and control of data

Mass of fuel on board at the beginning and end of reporting period is determined by the stock-take of fuel tanks on-board. As per company procedure these measurements are taken at noon.

Measurements are taken by locally using dip tapes and soundings, or remotely by using automated systems, as applicable.

It uses tank tables relevant to each fuel tank to determine the volume at the time of the fuel tank reading. Volume of fuel is converted into mass using appropriate temperature and density correction.

Vessels report the data in electronic form daily to the office in standardized formats (Arrival, Departure and Noon Reports) in GE Nautical to Office and the data is synced in real time and processed at 5 min interval. The data is then stored, processed, and analyzed ashore.

Database replication is instant at far DR (Disaster Recovery Site) at Hyderabad. Database hot backup is scheduled every day.

Backup restoration testing is done on a quarterly basis.

If required by any Department, backup data is retrieved by IT Department by assigned personnel and provided to the concerned Department.

Data is stored for at least 5 years.

For the FY 2021-2022 the number and types of errors found in the fuel consumption data is shown in Table 3.5 below. All errors were corrected prior to quantification.

Table 3.5

Types of errors	Number of cases	Difference in fuel oil quantity accounting for the year (Tonnes)
Bunker supplied not reported in Departure report	14	6424.17
Error in Bunker ROB	2	222.53
Interchanged reporting of bunker received values between fuel type category	12	Nil
Other errors*	86	1625.23

*Error which did not fall under missed reporting in Departure Report, error in Bunker ROB or interchange error.

3.5.1 GHG reporting roles and responsibilities

Chief Engineers of vessels are responsible for reporting of fuel related data in GE Nautical IT platform as per Company procedures given in Fleet Operation Manual.

Head of Information technology Division is responsible for maintaining IT platform for storing and transmission of data ashore.

Shore Based Personnel:

Data Analyst - Vessel Performance Management Cell is responsible for

- accurate quantification of GHG emission ensuring that all sources of emissions are accounted for;
- Indexing and retention of all relevant supporting records in easily retrievable condition.

Manager – VPM Cell is responsible for

- Uncertainty assessment of fuel flow meters and fuel measurement procedure and documentation of the data.

Head HSEQ – Vessel Performance Management Cell is responsible for

- developing and maintaining documented procedure for quantification and reporting of GHG emission taking into account GHG reporting principles of “relevance”, “completeness”, “consistency”, “transparency” and “accuracy”;
- reviewing and approving GHG emission report;
- Co-ordination with 3rd Party Verification Bodies

Chapter 4 – Energy Saving Initiative

4.1 Description of energy saving initiatives implemented in FY 2021-2022 and earlier years.

4.1.1 Energy Saving Devices FY 2021-2022

During FY 2021-2022 following Energy Saving Devices (ESDs) were retrofitted for reducing fuel consumption of main propulsion system:
Jag Anand, Jag Akshay, Jag Ajay, Jag Aalok, Jag Leela and Jag Laxmi were retrofitted with Mewis Duct, a device which improves the flow of water on to propeller and thus its efficiency.

Following vessels were fitted with LED lights during 2021-2022
Jag Anand, Jag Alaia, Jag Aditi, Jag Aarati and Jag Aalok were fitted with LED lights. The use of LED lights will reduce the electrical power requirement and consequently the GHG emissions from each ship and also provide savings in consumables since the lifetime of LED lights are far longer than replaced Fluorescent lights/Mercury/sodium lamps plus added advantage of lesser e-waste generation.

To further reduce the fuel consumption of main propulsion system the hull is applied with High Performance Anti-fouling coating. This coating has a very low coefficient of friction and do not allow the marine organisms to adhere on the surface easily and thus keep the surface clean for longer time durations. Following vessels were applied with this coating during FY 2021-2022
Jag Anand, Jag Aditi, Jag Aarati, Jag Ajay, Jag Aalok, Jag Rishi, Jag Rani, Jag Vasant, Jag Leela, Jag Laxmi.

Total cost for all the above Energy Efficiency measures is USD 3.288 million.

4.1.2 Year wise cumulative savings

Table 4.1.4

Financial Years	Estimated Reduction of CO_2 emission due to retrofitment of Energy Saving Devices and application of superior antifouling hull coatings
2014-2015	7008 MT
2015-2016	13,900 MT
2016-2017	13,973 MT
2017-2018	15,771 MT
2018-2019	16,550 MT
2019-2020	18,800 MT
2020-2021	19,570 MT

2021-2022	18,537 MT

4.2 GHG Reduction strategy and target

4.2.1 Mandatory Requirements

Ships on international trade are subjected to mandatory requirement of reduction / control of GHG emission since 1st January 2013 as per Chapter 4, Annex VI of MARPOL Convention. The technical requirements aimed to reduce GHG emissions from ships include two types of measures:

.1 Energy Efficiency Design Index (EEDI) for new ships;
.2 Ship Energy Efficiency Management Plan (SEEMP) for all ships

The intent of EEDI is to set a mandatory benchmark for the efficient design i.e. fuel consumption and thereby give an indication of its carbon dioxide emissions, of new ships. The formula is targeted at creating a benchmark level for emissions from ship types and size ranges by way of giving an indication of the grammes of CO2 emitted per tonne mile of cargo moved. The benchmark level is lowered in a phased manner as technology and design improvements make vessels more efficient.

SEEMP is a system for monitoring, recording and reporting of ship performance, which will be used by ship operators to enhance the energy efficiency and the emissions performance of their ships by applying technical and operational measures to improve fuel efficiency.

All our new buildings are built in compliance with EEDI requirements and existing ships are provided with SEEMP and issued with International Energy Efficiency Certificates as per MARPOL Convention.

As per regulation 27 of Chapter 4, Annex VI of MARPOL Convention with effect from 1st January 2019 all ships of 5,000 GT and above are required to report their annual fuel oil consumption data along with distance travelled and sailing hours to their respective flag states. Flag states following satisfactory verification of the same are required to submit the data to IMO. IMO would be using that data for a better understanding of the energy efficiency of world fleet and would help IMO to identify further possible measures to improve efficiency and reduction of GHG emission.

After the end of calendar year 2023 and after the end of each following calendar year, each ship of 5,000 gross tonnage shall calculate the attained annual operational Carbon Intensity Indicator (CII) over a 12-month period from 1 January to 31 December for the preceding calendar year, using the data collected in accordance with regulation 27. The attained annual operational CII shall be documented and verified against the required annual operational CII to determine operational carbon intensity rating A, B, C, D or E

4.2.2 Company GHG reduction strategy

G E Shipping, as a strategy, believes in maintaining its ships in as fuel efficient condition as possible for following reasons:

1. To maintain competitive advantage for its vessels in chartering market;
2. To reduce its carbon footprint for environmental benefit and as a fight against climate change;
3. To remain prepared for any future regulatory requirement related to GHG reduction and climate change;
4. Sustainability of business.

The Company has a strategy of replacing its older tonnage with younger and more fuel efficient ships as well as enhancing the energy efficiency of individual identified vessels through technological retrofits.

4.2.3 Setting GHG reduction target

G E Shipping is tracking energy efficiency intensity of its vessels as per "MEPC.1/Circ.684 - Guidelines for voluntary use of the Ship Energy Efficiency Operational Indicator (EEOI)" since 2010 and have been setting EEOI reduction targets against Baseline Average EEOI (Loaded voyages) values established during 2010-2011 for individual vessels based on their operational profiles for each biennial starting from 2012-2013. In case of new acquisition, it is important to determine and understand the ship's status of energy usage. The target KPI (i.e. the EEOI) for the vessel's SEEMP is determined after the baseline is established. 12 months data is required to establish the baseline. The intent of EEOI is to provide a measure of how efficiently a given ship is operated, i.e. how much cargo it moves for the fuel used. It works by calculating cargo, fuel and distance for each voyage leg, averaged over a period (usually 6 months) as it will provide a standardized way of communicating a ship's energy performance in operation. While some ships met the target some could not. Company found several limitations in setting a reduction target based on EEOI due to following reasons:

1. The speed of a ship varies in accordance with the prevailing charter hire rate and bunker price. These two elements, in varying degrees, influence a vessel's speed and consequently fuel consumption. These in turn create difficulty in trying to establish a fuel efficiency standard for the existing ships since a ship's speed is not constant over time.

2. It is also a fact that in a depressed freight market the fuel efficiency values of the individual ships (e.g. kg/nm, gm/t-nm) would remain low but with an improved freight market the ships will increase their speeds resulting in higher fuel consumption and consequently kg/nm and gm/t-nm values.

3. Moreover, fuel consumption of a ship (considering the machineries are in efficient condition) varies based on quantity of cargo carried, trim, weather condition (specifically wind force and wave) and hull roughness. All these factors influence the fuel efficiency of a vessel. Without carrying out detailed calculations normalizing the effects of all these factors it is futile trying to establish a fuel efficiency standard of ships.

However, a good correlation between the Energy Efficiency Design Index (EEDI) and the EEOI across different ship sizes were noted.

Marine Environment Protection Committee of IMO during its 76th Session (June 2021) has adopted a Carbon Intensity Indicator metrics called Annual Efficiency Ratio (AER). It indicates the average CO_2 emission per transport work of a ship during a Calendar Year. It is calculated as the ratio of the total mass of CO_2 emitted to the total transport work undertaken in a given calendar year. The total mass of CO_2 is the sum of CO_2 emissions (in grams) from all the fuel oil consumed on board a ship in a given calendar year while the transport work is defined as the product of a ship's capacity (DWT or GT depending on ship type) and the distance travelled in the same period.

AER is being used for measuring individual ship's Operational Carbon Intensity from Calendar year 2019.

G E Shipping is committed on continuous improvement in energy saving and reduction of GHG emission from ships. Towards this end we as a leading stakeholder actively contribute in development

of international regulatory regimes and guidelines related to reduction of GHG emission from international shipping at Marine Environment Protection Committee of International Maritime Organization.

Chapter 5 – GHG Disclosure

Scope 1 emission

- Emission resulting from combustion of fuel oils in company owned and managed vessels' main engines, auxiliary engines, boilers, inert gas generators (fitted on some of the tankers) and auxiliary engines for Framo pumps (fitted on some of the tankers).

- Emission resulting from unintentional releases of hydrofluorocarbon (HFC) used as refrigerants for air conditioning and provision refrigeration plants on company owned and managed vessels.

Table 5.1 - FY 2021-2022 (All figures are in MT)

Vessel	HSFO	VLSFO	MDO	LSMGO	Total CO_2
SUEZMAX					
Jag Lalit	0.000	35606.552	0.000	2847.633	38454.185
Jag Lok	30477.995	0.000	0.000	8354.939	38832.933
Jag Lakshya	30000.743	0.000	0.000	7809.976	37810.719
Jag Leena	26811.540	0.000	0.000	11528.648	38340.188
AFRAMAX					
Jag Lata	0.000	10997.085	0.000	211.340	11208.424
Jag Lavanya	0.000	25899.509	0.000	245.580	26145.089
Jag Laxmi	0.000	15493.467	0.000	6984.784	22478.251
Jag Leela	0.000	21780.468	0.000	4530.014	26310.482
Jag Lyall	20475.173	0.000	0.000	8635.105	29110.277
LR1					
Jag Aabha	0.000	21321.938	0.000	1612.233	22934.171
Jag Aanchal	0.000	20280.151	0.000	2673.067	22953.218
Jag Amisha	0.000	22016.667	0.000	1741.660	23758.327
Jag Aparna	0.000	23543.610	0.000	1338.697	24882.308
LR2					
Jag Lokesh	26608.601	0.000	0.000	3949.600	30558.200
Jag Lara	0.000	26895.424	0.000	67.230	26962.653
MR					
Jag Padma	0.000	13845.116	0.000	252.120	14097.236
Jag Pahel	0.000	12757.926	0.000	911.786	13669.713

Vessel	HSFO	VLSFO	MDO	LSMGO	Total CO_2
Jag Pankhi	0.000	15095.212	0.000	817.177	15912.389
Jag Pavitra	0.000	16490.475	0.000	1489.476	17979.950
Jag Pooja	0.000	16285.291	0.000	50.911	16336.203
Jag Prabha	0.000	18534.024	0.000	173.445	18707.469
Jag Pranam	0.000	15526.962	0.000	88.197	15615.159
Jag Pranav	0.000	13688.385	0.000	913.037	14601.422
Jag Prakash	0.000	17248.763	0.000	1431.800	18680.563
Jag Prerana	0.000	17416.954	0.000	1099.337	18516.291
Jag Pushpa	0.000	16213.754	0.000	859.881	17073.635
Jag Punit	0.000	12592.593	0.000	665.886	13258.480
GAS CARRIER					
Jag Vasant	0.000	20445.358	0.000	306.013	20751.371
Jag Vayu	0.000	4728.863	0.000	36.837	4765.700
Jag Vijaya	0.000	15481.304	112.691	110.383	15704.378
Jag Vikram	0.000	15593.045	0.000	205.569	15798.614
Jag Viraat	0.000	28227.131	0.000	165.686	28392.817
Jag Vishnu	0.000	23396.837	0.000	160.909	23557.746
CAPESIZE					
Jag Anand	15506.194	3568.508	0.000	3957.294	23031.996
Jag Alaia	0.000	29462.764	0.000	625.459	30088.222
KAMSARMAX					
Jag Aalok	0.000	16943.179	0.000	535.851	17479.030
Jag Aarati	0.000	17537.206	0.000	1251.334	18788.539
Jag Aditi	0.000	16704.207	0.000	790.664	17494.871
Jag Ajay	0.000	16574.102	0.000	971.707	17545.809
Jag Akshay	0.000	15458.774	0.000	558.485	16017.260
Jag Amar	0.000	21159.721	0.000	73.257	21232.978
Jag Arnav	0.000	16579.176	0.000	775.980	17355.156
SUPRAMAX					
Jag Radha	0.000	16117.144	0.000	575.766	16692.910
Jag Rajiv	0.000	11045.263	0.000	1863.808	12909.071
Jag Rani	0.000	14127.540	0.000	684.641	14812.181
Jag Rishi	0.000	14234.359	0.000	724.748	14959.107
Jag Rohan	0.000	15964.888	0.000	575.926	16540.814
				TOTAL	**979106.505**

Emission of CH_4 and N_2O from combustion of above fuel is derived from Table 3.4 and given in Table 5.2 below in CO_2e.

Table 5.2 – CO_2e from emission of CH_4 and N_2O from fuel burnt during FY 2021-2022

Type of Fuel	Mass of Fuel (MT)	CO_2e of CH4 (MT)	CO_2e of N2O (MT)	Total CO_2e (MT)
Total HFO (HSFO + LFO)	283891.08	396.028	13950.408	14346.436
Total MDO (MDO + LSMGO)	26932.80	37.371	1323.478	1361.049

Total	**15707.485**

Emission of refrigerants from Provision cooling plants and Air conditioning plants of individual vessels were recorded from Monthly EMS data sent from ships. Total emission from refrigerants during the Reporting period and its CO_2e is given in Table 5.3 below. Emission Factors are taken from Table 2.7.

Table 5.3 – Emission of refrigerant and its CO2e

Type of refrigerant	Mass in Kgs.	CO_2e (MT)
R 22	73	143.080
R 404a	777.5	3676.020
R 407c	62	118.290
Total		**3937.390**

Total Scope 1 CO2e emission from all sources Table 5.1 + Table 5.2 + Table 5.3 = 998751.380 MT

Scope 2 Emission

- Emission from generation of purchased electricity consumed at Ocean House, Head Office of G E Shipping based in Mumbai and training academy of the Company known as Great Eastern Institute of Maritime Studies at Lonavala in Maharashtra.

Table 5.4 - Electricity Consumed and CO_2e Emission during FY 2021-2022

Purchased and consumed electricity				
At Ocean House, Head Office of G E Shipping in Mumbai (MWh)	**At Great Eastern Institute of Maritime Studies at Lonavala in Maharashtra (MWh)**	**Total (MWh)**	**CO_2 emission Factor as per CO2 Baseline Database for the Indian Power Sector (Version 14.0, December 2018) published by Government of India**	**Total CO_2e (MT)**
474.469	246.278	720.747	0.79	569.390

*Please see Table 5.4.1

- 300 KW Solar Power Plant has been installed and commissioned at GEIMS in Lonavala with effect from September 2020. The roof top Solar power plant consists of 858 panels with a combined generating capacity of 350 KW. The DC power produced by Photo Voltic cells is converted to AC power with the help of Inverters. The AC power output is 3 phase 440 V 50 Hz which is fed to the local substation. The generated power is fed to the Maharashtra State Electricity Distribution Company Ltd. transmission Grid under a Net Metering arrangement. The excess power generated during daylight is exported to the Grid while importing power when there is no generation e.g. at night and during cloud cover.

Table 5.4.1 - Details of Electricity consumed at GEIMS, Lonavala FY 2020-2021

	MWh
Electricity imported from MSEDCL	351.790
Electricity exported to MSEDCL (from the installed solar panels)	105.512
Net electricity consumed from MSEDCL	246.278

Total Scope 2 CO_2e emission from all sources Table 5.4 = 569.390 **MT**

Chapter 7 – Report Conclusion

G E Shipping is committed to low carbon shipping for sustainable development.

G E Shipping has been taking proactive steps for reduction of GHG emission from its vessels for past many years and has been monitoring GHG emission per unit of transport work for fleet vessels since 2010 for bench marking its performance. In order to ensure that the quantification and reporting of GHG emission from fleet vessels is done as per recognized international standard duly verified by third party, G E Shipping has decided to follow ISO 14064-1 and is publishing this report for all its stakeholders.

Financial year	Scope 1	Scope 2
2021-2022 (1st April 2021 – 31st March 2022)	**998751.380 MT**	**569.390 MT**

Chapter 8 - References

- MEPC.308(73) – 2018 Guidelines on the Method of Calculation of the Attained Energy Efficiency Design Index (EEDI) for New Ships.
- Third IMO GHG Study 2014
- Fourth IMO GHG Study 2020
- IPCC Sixth Assessment Report: Climate Change 2021

Chapter 9 -Abbreviations

AER – Annual Efficiency Ratio

CSR – Corporate Social Responsibility

CFC - Chlorofluorocarbons

HFC – Hydrofluorocarbons

HCFC – hydrochlorofluorocarbons

HFO – Heavy fuel oil

EF – Emission factor

HSFO – High sulphur fuel oil

GHG – Green House Gas

IT – Information Technology

IMO – International Maritime Organization

KPI – Key Performance Indicator

GWP – Global Warming Potential

IPCC – Intergovernmental Panel on Climate Change

ISO – International Organization for Standardization

LSMGO – Low sulphur marine gas oil

LFO – Light fuel oil

MIS – Management information system

MARPOL - International Convention for the Prevention of Pollution from Ships

MEPC – Marine Environment Protection Committee

MDO – Marine diesel oil

Annexure I

Conversion Factors

1. The various conversion factors / emission factors used in this assertion Report are as follows:

1.1 Global warming potential of refrigerant emission from ships

The GWP100 is described relative to CO_2 warming potential (IPCC Sixth Assessment Report: Climate Change 2021)

Refrigerant	CO_{2e}
R-22	1960
R404a	4728
R407c	1907.9

1.2 Type of Fuel Consumed on fleet vessels and Conversion Factor

Type of Fuel	**Reference**	**Carbon content**	**Emission Factor (t-CO2 / t-Fuel)**
Diesel / Gas Oil	ISO 8217 Grades DMX	0.8744	3.206
Light Fuel Oil	ISO 8217 Grades RMA through RMD	0.8594	3.151
Heavy Fuel Oil (HFO)	ISO 8217 Grades RME and RMG	0.8493	3.114

1.2.1 Sources of emission, types of fuels used and their conversion factors

Source	**Type of fuel oil**	**Emission Factor ($t\text{-}CO_2$ / t-Fuel)**
Main Engine	Heavy Fuel Oil – High Sulphur (HSFO)	3.114
	Light Fuel Oil (LFO)	3.151
	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Auxiliary Engine	Heavy Fuel Oil – High Sulphur (HSFO)	3.114
	Light Fuel Oil (LFO)	3.151
	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Boiler	Heavy Fuel Oil – High Sulphur (HSFO)	3.114
	Light Fuel Oil (LFO)	3.151
	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Inert gas generators	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206
Source	**Type of fuel oil**	**Emission Factor ($t\text{-}CO_2$ / t-Fuel)**
Auxiliary engines for Framo pumps	Marine Diesel Oil (MDO)	3.206
	Low Sulphur Marine Gas Oil (LSMGO)	3.206

1.3 Estimation of emissions factors

Emission Factors (EFs) are obtained from Table 27 – Emissions factors for top-down emissions from combustion of fuel given in Fourth IMO GHG Study 2020. GWP values are as per IPCC AR6.

Emission substance	Marine HFO emission factor g/g fuel	Marine MDO emissions factor (g/g fuel)	CO_{2e}
CO_2	3.11400	3.20600	1
CH_4	0.00005	0.00005	27.9
N_2O	0.00018	0.00018	273

1.4 CO_2e emission Factor for unit of electricity consumed

As per CO2 Baseline Database for the Indian Power Sector (Version 16.0, March 2021) published by Government of India, Ministry of Power, Central Electricity Authority CO_2e emission factor for every MWh electricity consumed: 0.79.

Table S-1: Weighted average emission factor, simple operating margin (OM), build margin (BM) and combined margin (CM) of the Indian Grid for FY 2019-20 (adjusted for cross-border electricity transfers), in t CO_2/MWh

Average	OM	BM	CM
0.79	0.96	0.87	0.91

Average is the average emission of all stations in the grid, weighted by net generation.

OM is the average emission from all stations excluding the low cost/must run sources.

BM is the average emission of the 20% (by net generation) most recent capacity addition in the grid.

CM is a weighted average of the OM and BM (here weighted 50: 50).

Annexure II

Trend Charts