

Improving IAQ on board

Team Rudder

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Solution & Conclusion



Background

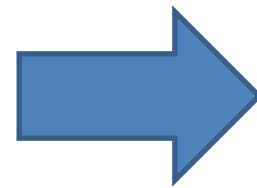
- Part 01** What is IAQ & Current situation
- Part 02** Hazardous substances on board
- Part 03** Characteristics of ship

What is IAQ?



Indoor Air Quality

The air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants.



Focus **on board**

Lack of regulations

1.2 Objectives

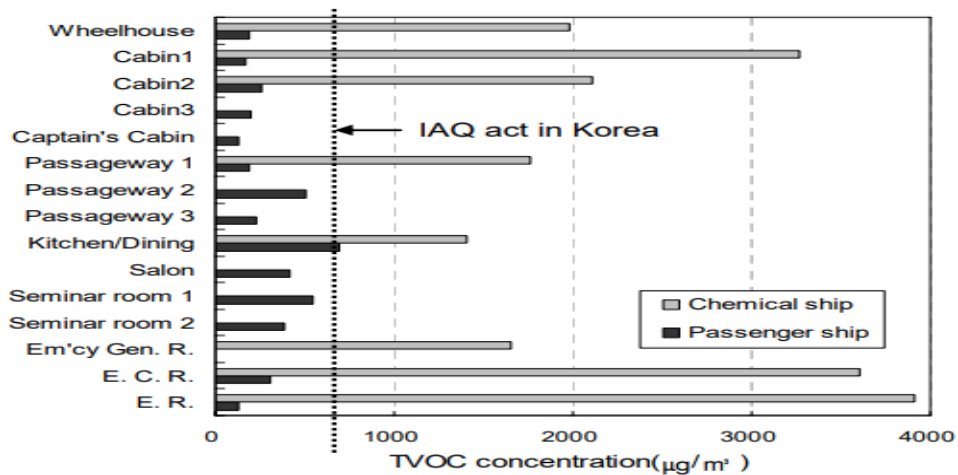
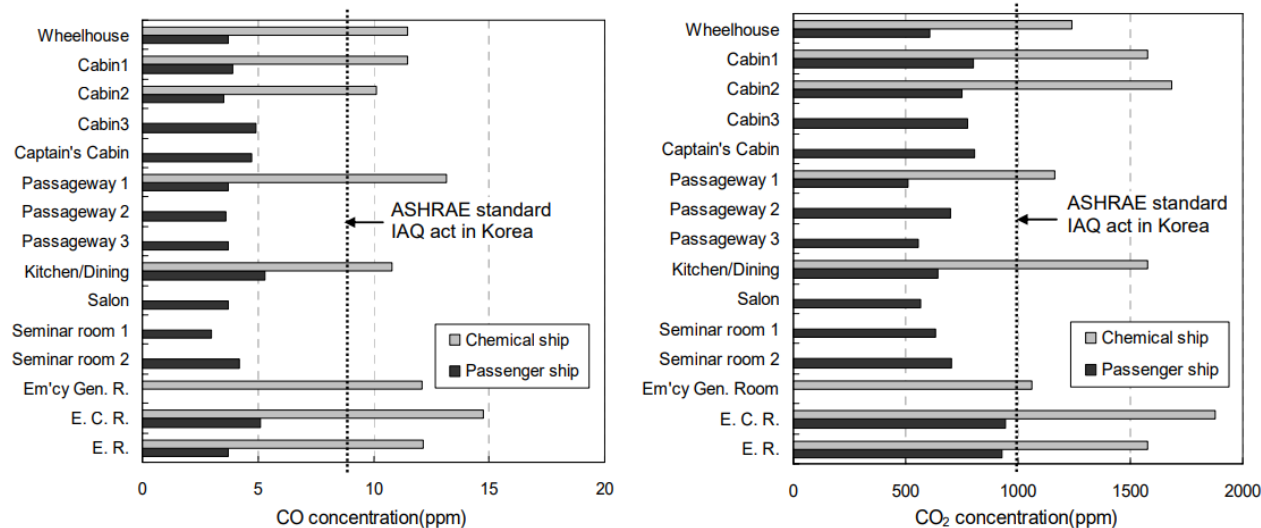
1.2.1 The objectives of the Code are to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular to the marine environment and to property.

1.2.2 Safety management objectives of the company should, inter alia:

- .1 provide for safe practices in ship operation and a safe working environment;
- .2 assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards; and**
- .3 continuously improve safety management skills of personnel ashore and aboard ships, including preparing for emergencies related both to safety and environmental protection.

1

Current situation of IAQ on board



Location	PM _{2.5} (mg/m ³)	Frequency	PM _{2.5} /TSP	PM ₁₀ (mg/m ³)	Temperature (°C)	RH (%)
Staff Quarters 1	7.93	0.00	0.41	17.73	21.0	62.8
Wet and Dry Lab a	9.97	0.03	0.39	23.89	24.2	56.4
Biological Lab a	95.28	1.00	0.65	143.58	22.3	54.2
Staff Quarters 2	1.71	0.00	0.36	4.42	20.4	58.1
Physical Lab a	0.71	0.00	0.21	2.66	26.2	35.9
Physical Lab b	4.79	0.00	0.54	7.58	27.8	23.1
CTD Room	2.76	0.00	0.22	7.64	-	-
Lecture hall	5.99	0.00	0.73	7.97	-	-
Corridor on the second floor	4.82	0.04	0.31	18.95	-	-
Wet and Dry Lab b	14.21	0.48	0.59	17.16	-	-
Chemical Lab	11.28	0.17	0.70	14.31	-	-
Biological Lab b	5.04	0.00	0.62	6.86	-	-
Physical Lab c	21.95	0.63	0.74	28.95	-	-
Physical Lab d	13.71	0.21	0.67	18.18	-	-
Physical Ocean Lab	8.53	0.00	0.52	13.13	-	-
Staff Quarters 3	13.92	0.09	0.59	21.07	-	-
Average	13.91	0.17	0.52	22.13	23.65	48.42

Hazardous substances on board

CO

PM10

CO₂

PM2.5

TVOC

NO_x



FormAldehyde

SO_x

Hazardous substances on board

SOLAS

Chapter XI-1 Special measures to enhance maritime safety

Regulation 1	Authorization of recognized organizations	437
Regulation 2	Enhanced surveys	437
Regulation 2-1	Harmonization of survey periods of cargo ships not subject to the ESP Code.	437
Regulation 3	Ship identification number.	437
Regulation 3-1	Company and registered owner identification number	438
Regulation 4	Port State control on operational requirements.	439
Regulation 5	Continuous Synopsis Record	439
Regulation 6	Additional requirements for the investigation of marine casualties and incidents.	441
Regulation 7	Atmosphere testing instrument for enclosed spaces	441

Unified Interpretations

Regulation 7

Atmosphere testing instrument for enclosed spaces

SEE INTERPRETATION 1

Every ship to which chapter I applies shall carry an appropriate portable atmosphere testing instrument or instruments[†]. As a minimum, these shall be capable of measuring concentrations of oxygen, flammable gases or vapours, hydrogen sulphide and carbon monoxide prior to entry into enclosed spaces[‡]. Instruments carried under other requirements may satisfy this regulation. Suitable means shall be provided for the calibration of all such instruments.

Hazardous substances on board

7 parameters on IAQ

PM

Particulate Matter - first-class carcinogen

CO

Carbon monoxide - angina, dizziness

CO₂

Carbon dioxide - drowsiness, vomiting

TVOC

Total volatile organic compound - deliriousness, nausea

HCHO

Formaldehyde - irritation of skin inflammation, cancer

Temperature

Humidity

Parameters
to
set

Characteristics of ship



Closeness of ship:
Difficult to ventilate



Unable to cure
immediately

5: <https://www.simplyemma.co.uk/royal-yacht-britannia-wheelchair-accessible-tour/>

6: <https://www.healthline.com/health/mens-health-doctors>



Problem Analysis

- | | |
|----------------|---------------------|
| Part 01 | Present situation |
| Part 02 | Diseases |
| Part 03 | Lack on Supervision |

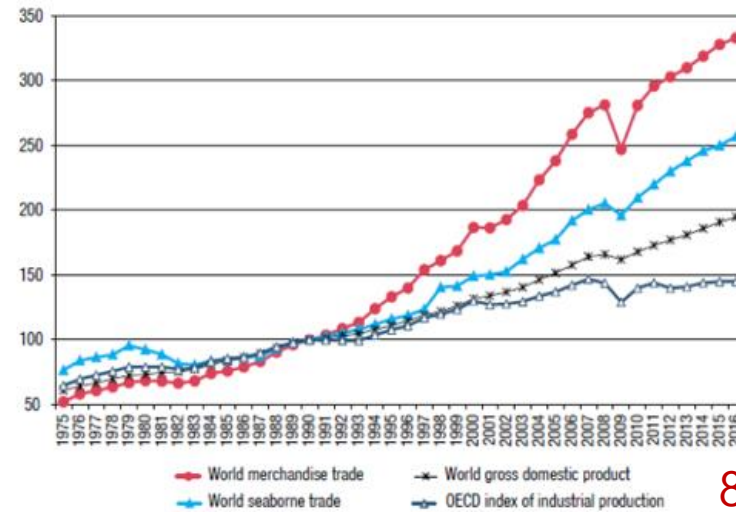
Present situation

Economic development



7

Shipping industry



8

Increasing passengers of Cruise



9

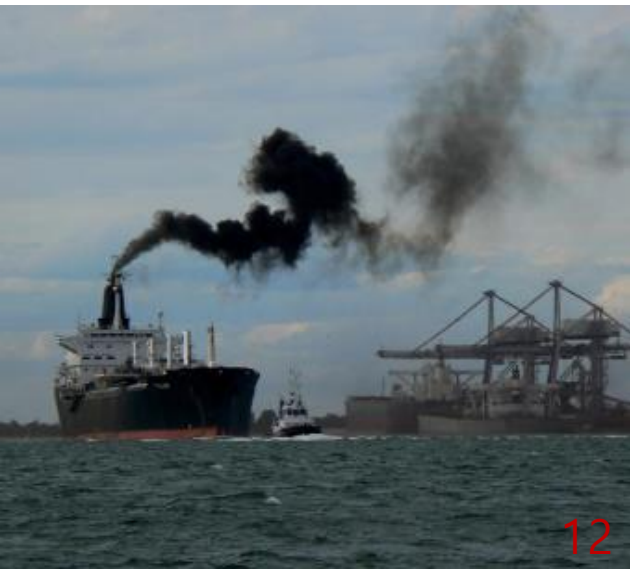
Current situation: Differences between Land and on board

On Land



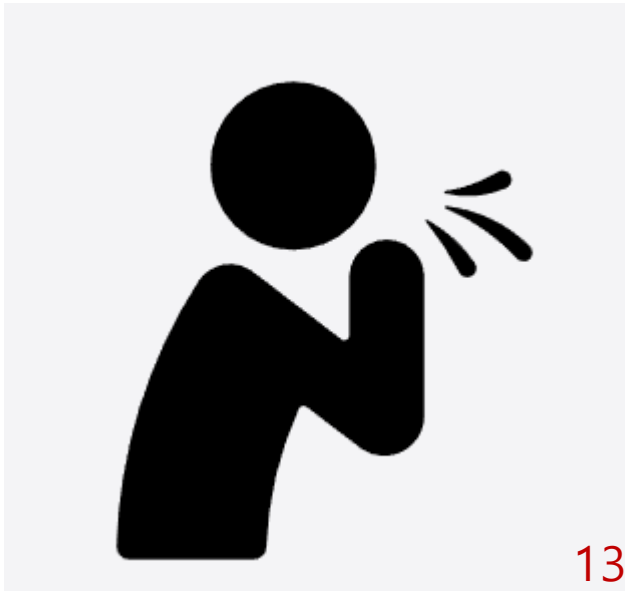
On Board

- : Few study paper on IAQ
- and concentrated on emission of greenhouse effect
- Structural Safety
- Water tightness
- Energy Efficiency



Diseases

Progress of Diseases



Diseases

COPD



COPD
CHRONIC
OBSTRUCTIVE
PULMONARY
DISEASE

15



16

Diseases - COPD



16

Coughing



17

Phlegm

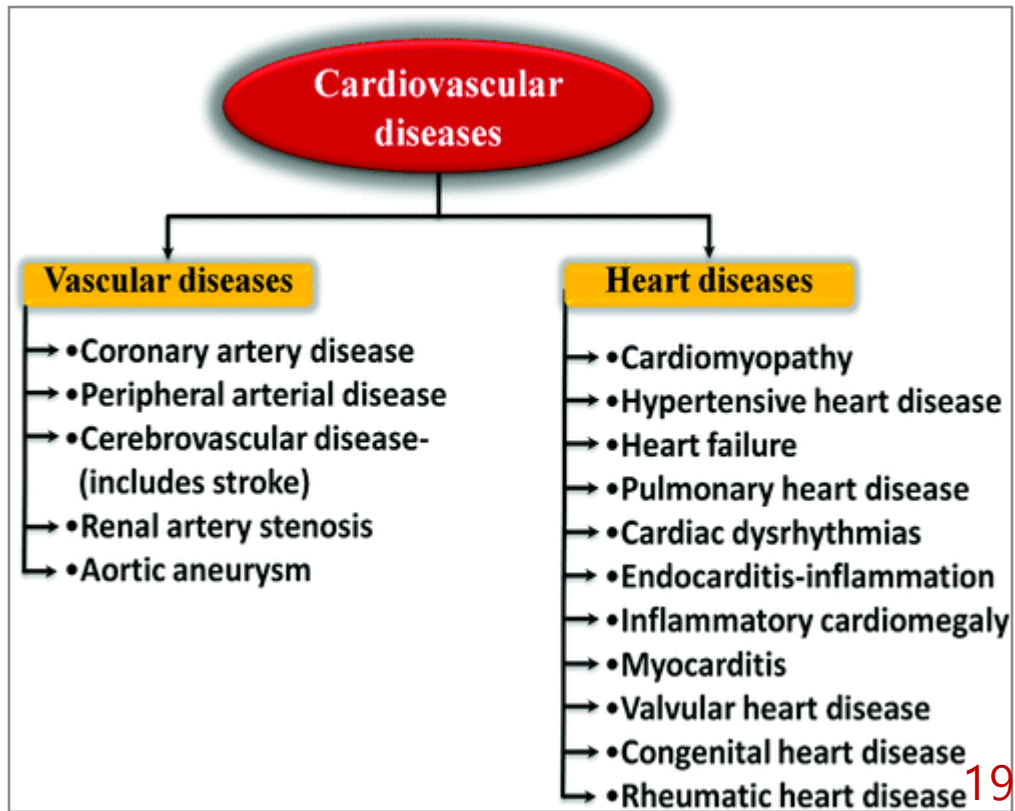


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Chest Pain

Diseases

Cardiovascular Diseases



19: <https://www.liebertpub.com/doi/10.1089/met.2019.0073>

20: <https://www.news-medical.net/news/20220511/Association-between-physical-activity-paradox-and-risk-variables-for-cardiovascular-disease.aspx>

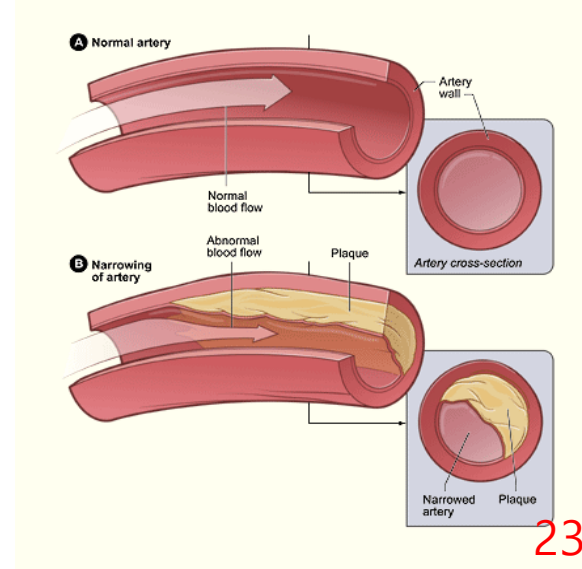
Diseases - Cardiovascular Diseases



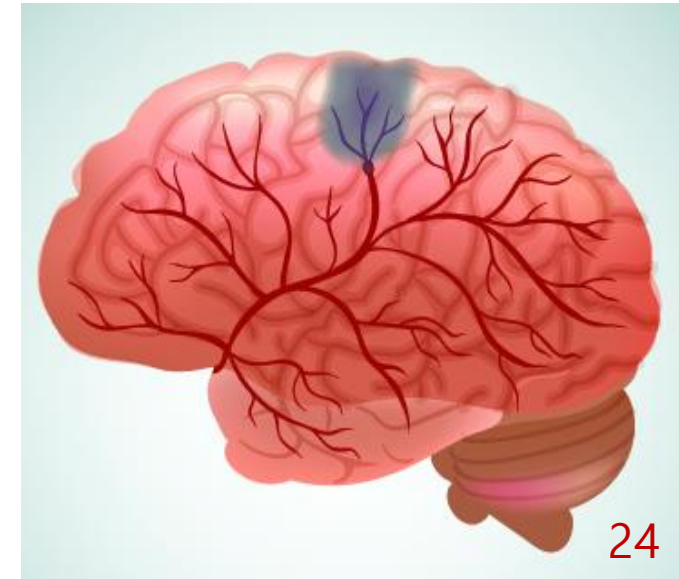
High Blood Pressure



Myocardial Infarction



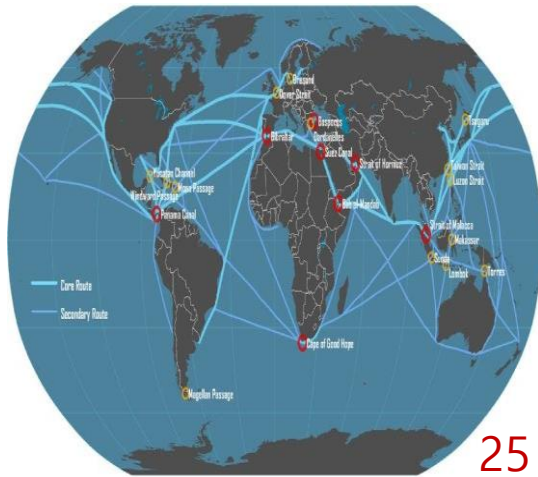
Arteriosclerosis



Cerebrovascular and Brain disease

Lack on Supervision

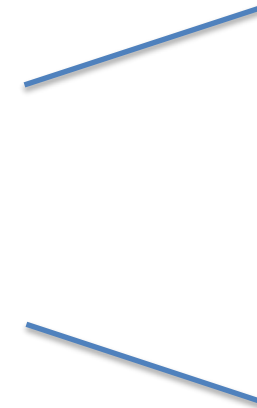
Shipping route



Limited Network



Accuracy Error





Solutions

Part 01 Standards & Regulation

Part 02 How to supervise

Part 03 Where to install

Standards

pollutant		criteria
Particulate Matter ($\mu\text{g}/\text{m}^3$)	PM_{10}	45
	$PM_{2.5}$	15
Carbon monoxide ($\mu\text{g}/\text{m}^3$)		4
Carbon dioxide ($\mu\text{g}/\text{m}^3$)		1000
TVOC ($\mu\text{g}/\text{m}^3$)		400
Formaldehyde ($\mu\text{g}/\text{m}^3$)		80

Determined by WHO & IMO members' country

Regulation

SD	PI Index	PI Name
SD 1 Improve implementation	PI 1.1	# of references in audit findings per instrument (article and regulation)
	PI 1.2	% of audit findings and observations with corrective actions implemented according to the target completion dates
	PI 1.3	% of deficiencies and detentions per ship type
	PI 1.4	# of deficiencies per category of deficiency
	PI 1.5	# of Member States that have ratified each IMO instrument, including those yet to enter into force
	PI 1.6	% of the world's merchant shipping (tonnage) covered by each IMO instrument, including those yet to enter into force
	PI 1.7	# of Member States requesting technical cooperation to implement corrective actions to address audit findings and observations
	PI 1.8	# of Member States receiving technical cooperation to implement corrective actions to address audit findings and observations
	PI 1.9	% of technical cooperation activities directed towards the implementation of IMO instruments with effective results for the receiving Member States

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Regulation 7

Atmosphere testing instrument for enclosed spaces

SEE INTERPRETATION 1

Every ship to which chapter I applies shall carry an appropriate portable atmosphere testing instrument or instruments[†]. As a minimum, these shall be capable of measuring concentrations of oxygen, flammable gases or vapours, hydrogen sulphide and carbon monoxide prior to entry into enclosed spaces[‡]. Instruments carried under other requirements may satisfy this regulation. Suitable means shall be provided for the calibration of all such instruments.

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Atmosphere testing instrument for ship

All ships to which Chapter I applies shall be equipped with appropriate atmosphere testing instrument or instruments. At a minimum, there shall be a measuring instrument in the bedroom, hallway, dining room, engine room, and steering room and the concentration of oxygen, combustible gas or steam, hydrogen sulfide, carbon monoxide, particulate matter, carbon dioxide, formaldehyde, and TVOC. Instruments carried under other requirements may satisfy this regulation. Suitable means shall be provided for the calibration of all such instruments.

How to supervise

Install of measuring instrument



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Send data on dock



dock

30

Where to install?

Place where people eat, sleep,
work



<Dining room>



<Bed room>



<Engine room>

Additional spaces : Semina room, Kitchen, etc...

In Conclusion

Arouse attention of IAQ
By Checking on eye



QNA

Thank you :)

Source

- 1: <https://www.dohle-yachts.com/wp-content/uploads/2021/05/ISM-Code-2018.pdf>
 - 2: <https://www.isiaq.org/docs/papers/490.pdf>
 - 3: <https://www.sciencedirect.com/science/article/pii/S1001074222002261#bib0032>
 - 4: SOLAS
 - 5: <https://www.simplyemma.co.uk/royal-yacht-britannia-wheelchair-accessible-tour/>
 - 6: <https://www.healthline.com/health/mens-health-doctors>
 - 7: <https://m.blog.naver.com/vitajk/222066820438>
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 - 10: <https://www.itap365.com/index.php/board/view/3066/105953>
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 - 24: <https://icloudhospital.com/specialties/cerebrovascular-diseases>
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 - 26: <https://www.pinterest.co.kr/pin/397090892152298703/>
 - 27: IMO
 - 28: SOLAS
 - 29: <http://allhomeitem.com/%EA%B0%80%EC%84%B1%EB%B9%84-%EC%B5%9C%EA%B3%A0-co2%EC%B8%A1%EC%A0%95%EA%B8%B0-%EC%8B%A4%EB%82%B4-%EA%B3%B5%EA%B8%B0%EC%A7%88-%EC%B8%A1%EC%A0%95%EA%B8%B0-%EC%9D%B4%EC%82%B0%ED%99%94%ED%83%84%EC%86%8C/>
 - 30: https://www.google.com/imgres?imgurl=https%3A%2F%2Fwww.epnnews.com%2Fnews%2Fphoto%2F201906%2F1718_1776_4452.jpg&imgrefurl=https%3A%2F%2Fwww.epnnews.com%2Fnews%2FarticleView.html%3Fidxno%3D1718&tbid=Ldf3tpTExN-LeM&vet=1&docid=yL2WyBE0POemM&w=600&h=400&hl=ko&source=sh%2Ffx%2Fim
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- pictures with no comment : Pexels.com