BIMCO

International Chamber of Shipping

Shaping the Future of Shipping

INTERCARGO

International Association of Dry Cargo Shipowners

INTERTANKO

2020 FUEL OIL QUALITY AND SAFETY SURVEY

Contents

2020 Fuel Oil Quality and Safety Survey

Executive summary

On 24 February 2020 BIMCO, The International Chamber of Shipping (ICS), INTERCARGO and INTERTANKO launched The Fuel Oil Quality and Safety Survey with the aim to get a greater understanding of the quality of the new fuel oils and possible safety implications of the IMO 2020 sulphur regulation.

The survey, which ran from 24 February until 6 May 2020, was targeted at shore-based personnel not the ships' crews. Consequently, the three most frequent respondents were from technical departments (52.6%), operational functions, such as fleet and vessel management (21.9%), and bunker departments (8.3%). The dataset being analysed is based on 192 responses.

The intention of the survey was to conduct a wider industry survey, circulated to all members of BIMCO, ICS, INTERCARGO and INTERTANKO, rather than to collect data on a case-specific basis when a ship was faced with fuel quality and/or safety issues related to the fuel quality. Since the survey was addressed to individuals (e.g. Fleet Managers, Vessel Managers and Technical Superintendents) not companies nor specific ships, the questions had to be formulated in a more generic way. Respondents were guided to answer the questions to the best of their knowledge based on their personal experience with the ships, for which they are responsible. **Consequently, the distribution frequency of answers cannot be considered to represent the frequency of problems in the world fleet. However, it does give an indication of where the challenges may have been for the shipping industry on a global basis since 1 January 2020.**

14% of the respondents answered 'no' to all ten questions (Q2 to Q11) regarding off-spec and operational quality issues, which shows that some respondents had not experienced any problems at the time when responding to the survey.

The eight most selected characteristics or limits in accordance with ISO 8217 as experienced being off specifications (off-spec):

1. Sulphur
2. Total sediment
3. Aluminium plus silicon
4. Pour point
5. Ash
6. Flash point
7. Acid number
8. Viscosity

62% of the respondents have to some extent experienced increased sludge deposits in the fuel oil system including increased sludge discharge from the ship's separators.

32% of the respondents answered that they had experienced wax appearance in the fuel oil system e.g. in fuel oil tanks, filters etc.

31% of the respondents answered that they had experienced operational issues caused by increased wear and tear of cylinder liners, piston rings or other components, assessed to be due to increased amounts of catalytic fines (cat fines) in the fuel oil.

22% of the respondents answered that fuel oil had been de-bunkered as a consequence of fuel oil properties.

21% of the respondents answered that they had experienced problems with fuel injection, poor ignition or incomplete combustion of the fuel.

18% of the respondents answered that they had experienced fuel oil pumps seizures.

10% of the respondents answered that they had experienced loss of propulsion and/or black out as a consequence of fuel oil properties.

In addition to the yes or no questions, narrative answers to the open-ended questions can be found in the annexes.

The answers and comments provided by respondents suggest that the transition to IMO 2020 compliant fuel oil (0.5% sulphur) has not been without problems. As fuel oil properties are fluctuating, quality and safety problems will continue to be a challenge for the global shipping industry.

Introduction

The Fuel Oil Quality and Safety Survey was launched on 24 February 2020 and terminated 6 May 2020. During these 73 days, 201 responses were submitted.

The dataset was cleaned of nine responses based on discrepancy in answers to the two parts of question number two. See annex G.

The dataset being analysed consequently contains 192 responses.

Table 1: Respondents grouped based on their professional position and assigned department.

Position / Department	Count	Frequency (%)
Technical department	101	52.6
Operational functions incl. fleet and vessel management	42	21.9
Bunker department	16	8.3
Miscellaneous (e.g. owners' representative and project manager)	11	5.7
Fuel and energy efficiency department	6	3.1
Health, Safety, Environment and Quality (HSEQ) department	5	2.6
Top management (i.e. Vice President, Chief Operating Officer and Chief Technical Officer)	5	2.6
Chief engineers at sea	3	1.6
Marine engineers at sea	3	1.6
Total	192	100

The survey was designed to provide the participating associations with a general overview of the situation after the changeover to 0.50% sulphur compliant fuel oil. It was decided to target shore-based personnel as it was assessed that the response rate would be higher with a greater degree of validity.

Initially the collection of data on a case-specific basis when a ship was faced with fuel quality and/or safety issues related to the fuel quality was considered. However, the decision was taken to collect data initially through a broader survey circulated to all members of BIMCO, ICS, INTERCARGO and INTERTANKO. As a result the questions were worded more broadly, e.g.:

> *Q1. Please indicate which standard was used for the specifications of the latest compliant fuel oil ordered and delivered to one of your ships?*

The survey was not addressed to companies but to individual relevant employees (e.g. Fleet Managers, Vessel Managers and Technical Superintendents). This means that several employees from the same company may have submitted answers to the questionnaire. However, the introduction of the questionnaire emphasised that respondents should answer to the best of their knowledge and based on their personal experience with the ships, for which they are responsible. This also mean that the distribution frequency of answers cannot be considered to represent the frequency of problems in the world fleet.

Survey results

General observations

0 respondents answered ‘yes’ to all ten questions (Q2 to Q11) regarding off specifications (off-spec) and operational quality issues.

27 respondents (equivalent to 14% of all respondents) answered ‘no’ to all ten questions (Q2 to Q11) regarding off-spec and operational quality issues.

12 respondents (equivalent to 6% of all respondents) answered ‘yes’ to the question (Q2) whether any of the fuel oil analysis results indicated off-spec in accordance with the relevant version of ISO 8217 and answered ‘no’ to the subsequent nine questions (Q3 to Q11) regarding operational quality issues.

0 respondents answered ‘no’ to the question (Q2) whether any of the fuel oil analysis results indicated off-spec in accordance with the relevant version of ISO 8217 and answered ‘yes’ to the subsequent nine questions (Q3 to Q11) regarding operational quality issues.

Q1 – Standards used for the specifications of the latest compliant fuel oil ordered and delivered to one of your ships

Table 2: The three most common answers are:

ISO 8217:2010	81 respondents	42% of 192 respondents
ISO 8217:2017	49 respondents	25% of 192 respondents
ISO 8217:2005	35 respondents	18% of 192 respondents

It is observed that 3 respondents answered that the standard used for the specifications of bunker depended on the contract with the charter.

Furthermore, 3 respondents answered that the availability varies depending on the geographical area.

Q2 – Fuel oil analysis results indicated off specifications

55% of the respondents answered “yes” to whether any of the fuel oil analysis results had indicated off specifications (off-spec).

45% of the respondents answered “no” to whether any of the fuel oil analysis results had indicated off specifications (off-spec).

See a graphical presentation of the responses in annex C.

Table 3: The eight most selected characteristics or limits as off specs is:

Sulphur	56 respondents
Total sediment	54 respondents
Aluminium plus silicon	27 respondents
Pour point	26 respondents
Ash	16 respondents
Flash point	15 respondents
Acid number	15 respondents
Viscosity	13 respondents

The 56 respondents (equivalent to 29.2% of all respondents) does not mean that 29.2% of all ships are or have been non-compliant with the statutory MARPOL sulphur content requirement. It simply means that based on the ships, for which they are responsible, 56 respondents have experienced that one or more fuel oil analysis result(s) had indicated the sulphur content may be non-compliant.

Table 4: The five least selected characteristics or limits as off specs is:

Cloud point	3 respondents
Lubricity	2 respondents
Cetane index	1 respondent
Hydrogen sulphide	1 respondent
Oxidation stability	1 respondent

Q3 – Flash point

10% of the respondents answered “yes” to whether any of the fuel oil analysis results had indicated a flash point temperature below 60°C.

88% of the respondents answered “no” to whether any of the fuel oil analysis results had indicated a flash point temperature below 60°C.

2 % of the respondents answered that they did not know whether any of the fuel oil analysis results had indicated a flash point temperature below 60°C.

15 respondents selected ’flash point’ as one of the characteristics or limits that had been off specifications in question number two (Q2). The same 15 respondents also answered ’yes’ to the question (Q3) whether any of the fuel oil analysis results had indicated a flash point temperature below 60°C. However, a total of 20 respondents answered ’yes’ to the question (Q3) whether any of the fuel oil analysis results had indicated a flash point temperature below 60°C.

Q4 & Q5 – Sludge deposits and discharge

Q4 – Have you observed increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc?

53% of the respondents answered “yes” to observing increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc.

47% of the respondents answered “no” to observing increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc.

Q5 – Have you experienced increased sludge discharge from the ship’s separators?

55% of the respondents answered “yes” to experiencing increased sludge discharge from the ship’s separators.

45% of the respondents answered “no” to experiencing increased sludge discharge from the ship’s separators.

Cross-analysis between Q4 and Q5:

Table 5: Frequency distribution of answers related to sludge deposits and discharge.

Q4	Q5	Count	Frequency (%)
Yes	Yes	88	45.8
Yes	No	14	7.3
No	Yes	18	9.4
No	No	72	37.5
Total		192	100

46% answered ’yes’ to the question (Q4) about observing increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc. and answered ’yes’ to the question (Q5) about experiencing increased sludge discharge from the separators.

7% answered ’yes’ to the question (Q4) about observing increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc. and answered ’no’ to the question (Q5) about experiencing increased sludge discharge from the separators.

9% answered ’no’ to the question (Q4) about observing increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc. and answered ’yes’ to the question (Q5) about experiencing increased sludge discharge from the separators.

38% answered ’no’ to the question (Q4) about observing increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction

filters etc. and answered ’no’ to the question (Q5) about experiencing increased sludge discharge from the separators.

Summing up, 62% of the respondents has to some extent experienced increased sludge deposits by answering ‘yes’ to question number 4 and/or question number 5. While 38% of the respondents has indicated that they have not experienced increased sludge deposits.

Q6 – Fuel oil pumps seizures

18% of the respondents answered “yes” to experiencing fuel oil pumps seizures.

82% of the respondents answered “no” to experiencing fuel oil pumps seizures.

Q7 – Problems with fuel injection, poor ignition or incomplete combustion

21% of the respondents answered “yes” to experiencing problems with fuel injection, poor ignition or incomplete combustion of the fuel.

79% of the respondents answered “no” to experiencing problems with fuel injection, poor ignition or incomplete combustion of the fuel.

Q8 – Wax appearance

32% of the respondents answered “yes” to experiencing wax appearance in the fuel oil system e.g. fuel oil tanks, filters etc.

68% of the respondents answered “no” to experiencing wax appearance in the fuel oil system e.g. fuel oil tanks, filters etc.

Q9 – Wear and tear due to catalytic fines

31% of the respondents answered “yes” to experiencing operational issues caused by increased wear and tear of cylinder liners, piston rings or other components, assessed to be due to increased amounts of catalytic fines (cat fines) in the fuel oil.

57% of the respondents answered “no” to experiencing operational issues caused by increased wear and tear of cylinder liners, piston rings or other components, assessed to be due to increased amounts of catalytic fines (cat fines) in the fuel oil.

12% of the respondents answered “I don’t know” to experiencing operational issues caused by increased wear and tear of cylinder liners, piston rings or other components, assessed to be due to increased amounts of catalytic fines (cat fines) in the fuel oil.

Q10 – Loss of propulsion and/or black out

10% of the respondents answered “yes” to experiencing loss of propulsion and/or black out as a consequence of fuel oil properties.

89% of the respondents answered “no” to experiencing loss of propulsion and/or black out as a consequence of fuel oil properties.

1% of the respondents answered “I don’t know” to experiencing loss of propulsion and/or black out as a consequence of fuel oil properties.

Q11 – De-bunkering

22% of the respondents answered “yes” to fuel oil being de-bunkered as a consequence of fuel oil properties.

77% of the respondents answered “no” to fuel oil being de-bunkered as a consequence of fuel oil properties.

1% of the respondents answered “I don’t know” to fuel oil being de-bunkered as a consequence of fuel oil properties.

Q12 – Descriptions of any other problems faced by your ships caused by fuel oil properties since changing over to compliant fuel oil and any mitigating actions taken

124 comments were received concerning problems faced due to fuel oil properties since changing over to compliant fuel oil.

Table 6: Comments grouped into the 14 most frequent problems faced:

Most frequent problems mentioned	Number of comments
Increased sludge or unstable VLSFO	43
No problems or only minor problems has been experienced	23
Increased wear and tear leading to engine damage, such as broken piston rings and/or accelerated cylinder liner scuffing	22
High pour point as a problem for onboard fuel management	12
Varying or low viscosity as a problem for onboard fuel management	12
Sulphur content indicated or confirmed as being non-compliant with 0.50%-limit	9
Wax appearance	8
Damage to equipment in fuel oil system, such as fuel pumps or separators	6
Compatibility is restricting the ship’s operations	6
Engines not performing optimal, such as fuel rack stuck	5
Fuel oil system performance not optimal, such as not able to maintain purifier inlet temperature	5
De-bunkering has been necessary	4
Insufficient heating in tanks when sailing in cold climate	4
Increased workload for ship's crew	3

Q13 – Comments received regarding the procurement, availability, or bunkering of VLSFO or ULSFO

73 comments were received concerning procurement, availability, or bunkering of VLSFO or ULSFO.

Table 7: Comments grouped into the 5 most frequently addressed subjects:

Most frequent comments	Number of comments
No problems or very few problems experienced in relation to availability of VLSFO and/or ULSFO	20
Problems experienced in relation to the availability of VLSFO and/or ULSFO	12
The importance of Certificate of Quality (CoQ) emphasised or commented on problems with obtaining a CoQ from the bunker suppliers	6
Problems arising in connection with disputes when stakeholders cannot agree on where the commercial sample should be drawn	4
The need for ISO 8217 to be amended to ensure less variation in the properties of VLSFO	4

The total number of ships operated by the respondent's company

Table 8: The six largest groups of respondents based on the number of ships operated by their company:

1 – 50 ships	106 respondents	55% of 192 respondents
51 – 100 ships	39 respondents	20% of 192 respondents
501 – 550 ships	16 respondents	8% of 192 respondents
101 – 150 ships	9 respondents	5% of 192 respondents
More than 700 ships	5 respondents	3% of 192 respondents
601 – 650 ships	4 respondents	2% of 192 respondents

Table 9: Respondents grouped into three groups based on the number of ships operated by their company:

	Count	Frequency (%)
1 - 50	106	55.2
51 - 100	39	20.3
More than 100 ships	47	24.5
Total	192	100

Conclusion

While yes or no questions allow respondents to answer in a more concise way, open-ended questions will lead them to describe their situations in their own words and offer valuable perspectives that such questions could not embrace. Annex D and Annex E contain narrative descriptions of how respondents experienced the implementation in their own fields.

The answers and comments provided by respondents suggest that the transition to IMO 2020 compliant fuel oil (0.5% sulphur) has not been without problems. As fuel oil properties are fluctuating, quality and safety problems will continue to be a challenge for the global shipping industry.

Annex A – Fuel oil quality and safety survey

Dear BIMCO, ICS, INTERCARGO and INTERTANKO member

The purpose of this survey is to collect and collate information on your company's experiences with fuel oil quality since changing over to 0.50% sulphur compliant fuel oil.

The four conductors of this survey are: BIMCO, the International Chamber of Shipping (ICS), INTERCARGO and INTERTANKO. We are interested in assessing any fuel oil quality and safety issues related to the new sulphur-compliant fuel oils (max. 0.50% sulphur content). Depending on the outcome of the survey, general information and observations, including any possible trends, from the survey may be submitted to the International Maritime Organization (IMO) for further consideration.

A statistical analysis of the survey result will ensure complete anonymity.

The questionnaire contains 13 questions and should only take about 5 minutes to complete.

When you have completed the questionnaire, just click the SUBMIT button to send it. By doing so you allow us to use the information as stated in the confidentiality and data protection management statement below.

Confidentiality and data protection management of information

- We will use the information you provide for the purposes mentioned above
- We will not pass on your personal information to third parties.
- As soon as a statistical analysis of the survey result is finalized, we will delete all personal information collected

By completing and submitting this questionnaire, you have given us your consent to keep and use your personal information in accordance with this notice and BIMCO's Privacy Policy.

BIMCO's Privacy Policy: https://www.bimco.org/web/privacy-and-cookies

Thank you for participating.

Should you need assistance in completing the questionnaire, please contact marinesurveys@bimco.org

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Who is this questionnaire relevant to?

This questionnaire is relevant to shore-based personnel such as Fleet Managers, Vessel Managers and Technical Superintendents.

What does regulation 14 of MARPOL Annex VI say?

From 1 January 2020, the sulphur content of any fuel oil used on board ships shall not exceed 0.50% m/m. And while ships are operating within a Sulphur Emission Control Area (SECA), the sulphur content of fuel oil used on board shall not exceed 0.10% m/m. (*The limit within SECA's has been in force since 1 January 2015*)

Furthermore, from 1 March 2020 the carriage ban enters into force meaning that, the sulphur content of fuel oil used or carried for use on board a ship shall not exceed 0.50% m/m.

What is VLSFO and ULSFO?

VLSFO stands for Very Low Sulphur Fuel Oil either of distillate properties or of residual properties with a sulphur content not exceeding 0.50% m/m.

ULSFO stands for Ultra Low Sulphur Fuel Oil either of distillate properties or of residual properties with a sulphur content not exceeding 0.10% m/m.

What are fuel oil quality issues?

"Fuel quality issues" are the problematic properties of fuel oil that may lead to, among others, increased sludge discharge, clogging of fuel pipes, clogging of preheaters, clogging of fuel separators, clogging of fuel filters, fuel pumps getting stuck, problems with fuel injection, poor ignition of fuel oil, incomplete combustion, wax appearance, increased wear and tear of cylinder liners, that may, in worst cases, result in loss of propulsion and/or black out.

Questionnaire

The questions below refers to ships that have changed from HFO to "compliant fuel oil" referring to both VLSFO and ULSFO. Please do not reply, if your ships are still using HFO with a sulphur content exceeding 0.50% m/m e.g. in combination with scrubbers.

Employees answering the questions should answer to the best of their knowledge, based on their personal experience with the ships they are responsible for.

Q1. Please indicate which standard was used for the specifications of the latest compliant fuel oil ordered and delivered to one of your ships? Please select *

- ○ ISO 8217:2005
- ○ ISO 8217:2010
- ○ ISO 8217:2010/Corr 1:2011
- ○ ISO 8217:2012
- ○ ISO 8217:2017
- ○ I don't know
- ○ Other, please specify

Q2. Has any of the fuel oil analysis results indicated off specifications (off-spec) in accordance with the relevant version of ISO 8217? Please select *

- ○ Yes
- ○ No
- ○ I don't know

If yes, please select the characteristics or limits off specification:

- ☐ Deleterious materials
- ☐ Viscosity
- ☐ Density
- ☐ Cetane index
- ☐ Sulphur
- ☐ Flash point
- ☐ Hydrogen sulphide
- ☐ Acid number
- ☐ Total sediment
- ☐ Oxidation stability
- ☐ Fatty acid methyl ester (FAME)
- ☐ Carbon residues
- ☐ Cloud point
- ☐ Cold filter plugging point
- ☐ Pour point
- ☐ Appearance
- ☐ Water
- ☐ Ash
- ☐ Lubricity
- ☐ Calculated Carbon Aromaticity Index (CCAI)
- ☐ Vanadium
- ☐ Sodium
- ☐ Aluminium plus silicon
- ☐ Used lubricating oil (Calcium and Zinc / Calcium and Phosphorus)

Q3. Has any of the fuel oil analysis results indicated a flash point temperature below 60°C? Please select *

- ◯ Yes
- ◯ No
- ◯ I don't know

Q4. Have you observed increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc.? Please select *

- ◯ Yes
- ◯ No

Q5. Have you experienced increased sludge discharge from the ship's separators? Please select *

- ◯ Yes
- ◯ No

Q6. Have you experienced fuel oil pumps seizures? Please select *

- ◯ Yes
- ◯ No

Q7. Have you experienced problems with fuel injection, poor ignition or incomplete combustion of the fuel? Please select *

- ◯ Yes
- ◯ No

Q8. Have you experienced wax appearance in the fuel oil system e.g. fuel oil tanks, filters etc.? Please select *

- ◯ Yes
- ◯ No

Q9. Have you experienced operational issues caused by increased wear and tear of cylinder liners, piston rings or other components, assessed to be due to increased amounts of catalytic fines (cat fines) in the fuel oil? Please select *

- ◯ Yes
- ◯ No
- ◯ I don't know

Q10. Have you experienced loss of propulsion and/or black out as a consequence of fuel oil properties? Please select *

- ◯ Yes
- ◯ No
- ◯ I don't know

Q11. Has fuel oil been de-bunkered as a consequence of fuel oil properties? Please select *

- ◯ Yes
- ◯ No
- ◯ I don't know

Q12. Please describe any other problems faced by your ships caused by fuel oil properties since changing over to compliant fuel oil and any mitigating actions taken:

Q13. Do you have any comments you want to share regarding the procurement, availability or bunkering of VLSFO or ULSFO?

Finally, what is the name of your company? *

What is your position in the company? *

Please indicate the total number of ships operated by your company: *

Do you have other comments you want to share?

Feel free do add general question to the entire questionnaire

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Thank you for sharing your valuable experience.

Submit Clear Form

Annex B – Frequency distribution tables

Q1. Please indicate which standard was used for the specifications of the latest compliant fuel oil ordered and delivered to one of your ships?

	Count	Frequency (%)
ISO 8217:2005	35	18.2
ISO 8217:2010	81	42.2
ISO 8217:2010/Corr 1:2011	3	1.6
ISO 8217:2012	9	4.7
ISO 8217:2017	49	25.5
I don't know	5	2.6
Other answers	10	5.2
Total	192	100

Other answers:

1. IFO80-RMD80 0.5%

2. We purchase as per the latest ISO 8217 revision (2017) or if not available as per the revision available in the port of supply.

3. Fuel is order on a number of the agreed standards depending on contracts with charterers .

4. Various revisions: 2005, 2010, 2012 or 2017

5. We aim for ISO 8217:2017, but in some ports this is not possible.

6. It varies as per area of supply.

7. Fuel is not supplied by us. Different charterers use different ISO standards.

8. PAS 23263

9. ISO 8217:2017 as amended by ISO/PAS23263:2019

10. Depending on charter party

Q2-1. Has any of the fuel oil analysis results indicated off specifications (off-spec) in accordance with the relevant version of ISO 8217?

	Count	Frequency (%)
Yes	106	55.2
No	86	44.8
I don't know	0	0.0
Total	192	100

Q2-2. If yes, please select the characteristics or limits off specification:

	Count	Frequency (%) out of 192 total respondents
Deleterious materials	9	4.7
Viscosity	13	6.8
Density	7	3.6
Cetane index	1	0.5
Sulphur	56	29.2
Flash point	15	7.8
Hydrogen sulphide	1	0.5
Acid number	15	7.8
Total sediment	54	28.1
Oxidation stability	1	0.5
FAME	6	3.1
Carbon residues	7	3.6
Cloud point	3	1.6
Cold filter plugging point	4	2.1
Pour point	26	13.5
Appearance	5	2.6
Water	12	6.3
Ash	16	8.3
Lubricity	2	1.0
CCAI	5	2.6
Vanadium	4	2.1
Sodium	5	2.6
Aluminium plus silicon	27	14.1
Used lubricating oil	5	2.6
Total	299	

Q3. Has any of the fuel oil analysis results indicated a flash point temperature below 60°C?

	Count	Frequency (%)
Yes	20	10.4
No	169	88.0
I don't know	3	1.6
Total	192	100

Q4. Have you observed increased sludge deposits in fuel oil tanks, and/or clogging fuel pipes, separators, preheaters, fuel oil transfer pump suction filters etc.?

	Count	Frequency (%)
Yes	102	53.1
No	90	46.9
Total	192	100

Q5. Have you experienced increased sludge discharge from the ship's separators?

	Count	Frequency (%)
Yes	106	55.2
No	86	44.8
Total	192	100

Q6. Have you experienced fuel oil pumps seizures?

	Count	Frequency (%)
Yes	34	17.7
No	158	82.3
Total	192	100

Q7. Have you experienced problems with fuel injection, poor ignition or incomplete combustion of the fuel?

	Count	Frequency (%)
Yes	41	21.4
No	151	78.6
Total	192	100

Q8. Have you experienced wax appearance in the fuel oil system e.g. fuel oil tanks, filters etc.?

	Count	Frequency (%)
Yes	62	32.3
No	130	67.7

Total	192	100

Q9. Have you experienced operational issues caused by increased wear and tear of cylinder liners, piston rings or other components, assessed to be due to increased amounts of catalytic fines (cat fines) in the fuel oil?

	Count	Frequency (%)
Yes	59	30.7
No	109	56.8
I don't know	24	12.5
Total	192	100

Q10. Have you experienced loss of propulsion and/or black out as a consequence of fuel oil properties?

	Count	Frequency (%)
Yes	19	9.9
No	171	89.1
I don't know	2	1.0
Total	192	100

Q11. Has fuel oil been de-bunkered as a consequence of fuel oil properties?

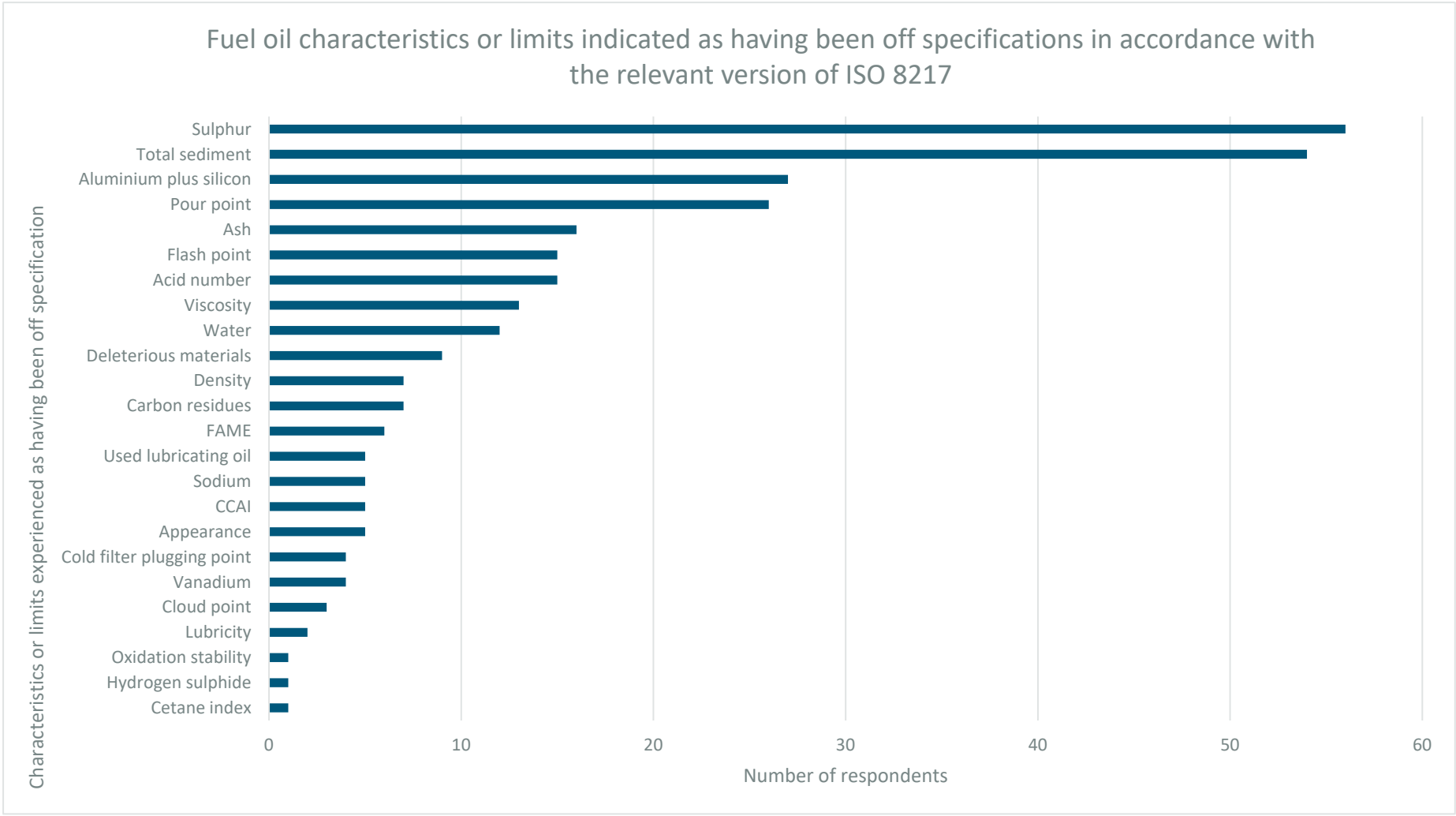
	Count	Frequency (%)
Yes	43	22.4
No	147	76.6
I don't know	2	1.0
Total	192	100

Please indicate the total number of ships operated by your company:

	Count	Frequency (%)	Cumulative Frequency
1 - 50	106	55.2	55.2
51 - 100	39	20.3	75.5
101 - 150	9	4.7	80.2
151 - 200	2	1.0	81.3
201 - 250	2	1.0	82.3
251 - 300	2	1.0	83.3
301 - 350	0	0.0	83.3
351 - 400	1	0.5	83.9
401 - 450	0	0.0	83.9
451 - 500	2	1.0	84.9
501 - 550	16	8.3	93.2
551 - 600	2	1.0	94.3
601 - 650	4	2.1	96.4
651 - 700	2	1.0	97.4
more than 700	5	2.6	100.0
Total	192	100	

	Count	Frequency (%)	Cumulative Frequency
1 - 50	106	55.2	55.2
51 - 100	39	20.3	75.5
More than 100 ships	47	24.5	100.0
Total	192	100	

Annex C – (Q2-2) Fuel oil characteristics or limits indicated as having been off specifications in accordance with the relevant version of ISO 8217



Annex D – Answers to question number twelve

Answers have been proofread and edited to be more readable without deleting any sentences or changing the meaning of the text. Furthermore, names of for instance ports, external laboratories and providers of additive has been removed.

Q12. Please describe any other problems faced by your ships caused by fuel oil properties since changing over to compliant fuel oil and any mitigating actions taken:

Answers submitted:

1. Vessel experienced problem with VLSFO fuel and FO separator sludge formation, FO auto-back flush filters getting choked, but not with all VLSFO fuels supplied.

2. Loss of cylinder liner and loss of exhaust valve seat/spindle. Mitigating actions: regular scavenge inspections, increased frequency of onboard scrap down analysis test, intermittent use of cylinder oil of higher BN (70 or 100) basis sulphur percentage and scavenge inspection report.

3. Excessive sludge generation and clogging of sludge outlet pipe noted during purification resulting in both separator vertical assembly getting damaged after frequent opening of separators every 6-8 hours. Subsequently, vessel had to change over to distillate fuel and fuel further used after high dosing with fuel additive (in ratio 4 litre additive to 55 metric ton fuel) and recirculation of fuel. Additional test was carried out by [external] laboratory and result indicated that fuel was unstable (result 3 on a scale of 1-5, where 1 indicates fuel to be stable). Fuel onboard was finally consumed.

4. Most ships have not faced quality related issues. However, some of the ships have faced and are facing increased sludge generation in fuel oil purifiers and chocking of fuel oil system requiring repeated opening up and manual cleaning of purifiers.

5. Purifier de-sludge line is getting choked up. De-sludge line is thus being cleared regularly. Purification temperature is kept higher than recommended to prevent wax formation.

6. Wax deposit at purifier sludge outlet. Consequently, frequent draining to settling tank. Lowered purifier auto desludging timer and adjusted the purifier inlet temperature to match with engine injection temperature.

7. Auxiliary engine fuel rack is getting stuck very frequently. Fuel rack has been dismantled and cleaned. Lubrication frequency for fuel racks has been increased.

8. Vessel faced increase in sludge generation to an extent that need to clean filters and purifier every day. Sludge deposited inside the sludge tank is getting solidify very quickly and transfer of sludge to waste oil incinerator tank was not possible.

9. Excessive wax sludge formation in the purifier at recommended temperature. Initial recommended purification temperature is 50°C. The separation temperature was increased to 70°C. Most of the wax present in the oil melted between 65 to 70°C.

10. High cylinder liner wall temperature observed for 2 cylinders. Upon disassembly, liner wear was noticed to be over limit. Liner replacement carried out. Piston overhauled. Cylinder lubrication increased.

11. Main Engine Unit#2, 2nd and 3rd piston found collapsed in the groove. Unit overhaul was not due. Excessive carbon deposits in the ring grooves. Cylinder lubrication increased for the concerned unit. Unit#2 overhaul carried out.

12. Spalling of the top piston ring chromium ceramic (CC) coating observed in main engine unit#7. Unit overhauled and piston ring renewed.

13. Purifiers were getting completely clogging up with sludge at every 2-3 hours.

14. Increase wear and tear at piston ring need to renew piston rings more frequently.

15. Excessive sludge which is like wax being formed in the purifier sludge outlet. The amount is such that outlet port gets choked frequently. This got resolved by raising the temp of purification. But in believe that with increased temperature all wax is going to the engine. Another point is that excessive sludge in settling and service tanks. This is leading to choking of outlet pipe of settling and service tanks. This happened after few days of using VLSFO fuel.

16. Our vessel has faced severe issues related to one grade of VLSO fuel received at [port]. It led to heavy fouling of HFO purifiers. The purifiers fouled frequently with maximum 11 running hours before cleaning was needed again. Purifiers had to be opened every two hours. Sludge was very very hard; it damaged all sealing rings. The fuel system filters get dirty frequently. Even with other grades we still face the following issues:

    - The viscosity had huge variations. Viscosity goes as low as 40 cSt at 50°C and goes up to more than 300 cSt.

    - This variation in viscosity has implications on the purifiers. The purifiers have huge span in operational temperatures (40°C to 98°C). We are not sure of operational efficiency of purifiers with so varying temperatures.

    - Most of the VLSO fuel now are unstable on PNA based stability index.

- Finding high level of contaminants through gas chromatography-mass spectrometry (GCMS) screening.

- High sediment potential.

- High total accelerated sediment.

17. Excessive cylinder liner wear, scuffing of piston rings, carbon deposit on piston landing surfaces.

18. We have faced an isolated report of increased sludge from purifiers.

19. We did not experience any problems since changing over to compliant fuel. All fleet vessels operation and fuel bunker properties has been observed 'normal' since change over to compliant bunker.

20. Main engine fuel pumps and injectors external leaks observed more often due to varying fuel densities and fuel working/injecting temperatures. Cylinder lubrication oil feed rate has been increased in order to control cylinder liner/piston and piston rings wear. Due to higher pour point (up to 30°C) fuel in storage tanks onboard require additional fuel consumption in winter season to keep fuel preheated. New VLSFO density at 15°C differs from each batch ranging from 915 kg/m3 to 986 kg/m3; even lower result based on analysis. Vessel should pay attention to correct gravity disk and correct temperature during purification to obtain optimal result.

    - Compatibility test result can be good but due to different density of different batches if commingle two different batches of VLSFO it can result in unstable purification and the need to find compatible gravity disk with correct temperature. Note that the recommended purification temperature can range from 50°C to 90°C depending on the result of oil analysis.

    - Generally speaking, there is no unusual problem caused due to VLSFO or ULSFO. However, there are some common problem after change over to ULSGO as it has very low viscosity and leaky compared to HFO. This leads to minor leaks from fuel system.

    - VLSFO and specially ULSFO (< 0.1%S) have lower density that is to be taken into account before bunkering due to tanks maximum capacity. Preventively main engine start settings are adjusted to "heavy start" from first attempt to avoid start failure. In shallow waters and with strong current when using MGO, fuel leaks accumulate in overflow tank a little faster and it is difficult to return it back to service in SECA due to ULSMGO contaminated with VLSFO previously used and drained to overflow tank.

    - Common new fuels are more convenient due to lower temperature at 13 cSt (60-70°C) and for SECA entering as there is much less difference between 0,5% and 0,1% sulphur and between 70°C and 30/40°C and also time required for changing

over is shorter.

- Black out during and immediately after change over from ULSFO to ULSGO and difficulties to start the auxiliary engine on ULSGO. Most probably because of low viscosity of ULSGO and wear of the auxiliary engine's fuels pump. The starting index on auxiliary engine's governor has been adjusted. No serious issues have been noticed concerning wear and tear of cylinder liners, piston rings or other components.

21. No, VLSFO is supplied in perfect quality in most of ports worldwide.

22. Excessive sludge discharge from the purifiers has been noted while using VLSFO. Also experiencing piston ring breakages, liner scuffing while using 40BN cylinder lubricating oil with VLSFO on 80 and 90 mm bore engines. We believe 40BN lubricating oil lacks sufficient detergency and therefore have been interspersing 70BN and 40BN lubricating oils supplanted by frequent under-piston inspections, onboard iron and reserve BN monitoring.

23. Two ship had higher abrasion on the liner surfaces. The lubricating oil feed rate was increased slightly higher than minimum and problem was solved. The vessel uses low TBN cylinder lubricating oil while burning VLSFO. However, if the feed rate is not optimum or the detergent properties of the lubricating oil is not good, it may lead to higher wear rate of the liner.

24. Fuel pump getting stuck during vessel idling. Had to replace the worn plunger & barrel in the fuel pump.

25. Most of the fuels are instable and generates lot of sludge especially in case of longer storage time after bunkering. Another problem faced is that pour point is very high sometime even up to 30°C which is very abnormal.

26. Even pour point are in specification as 30°C ie. 20-24°C. When vessel trade in cold sea area we have trouble in heating fuel, and thus transferring fuel to settling and service tanks. If we don't enough fuel margin, then vessel may unable to safe reach destination or port of deviation for stem addn bunkers.

27. Cylinder oil feed rate adjustments based on liner and piston ring inspection. In some cases we have raised feed rate to 1.2 gm/kWH.

28. Piston ring breakage and liner wear were accelerated.

29. In early September 2019, I had issues of finding VLSFO in [port], resulting purchase of around 680 Mt of LSMGO; whilst using HSFO before on around 15 Dec 2019, and changeover to 600 Mt of LSMGO (0.1% sulphur) in the last 3 weeks in December 2019 and early January 2020.

30. No other problems experienced so far.

31. Some of the fuel oil received are very unstable, which is not discover by initial and standard analysis. It can be discovered only by additional test.

32. Prior to January 2020, our standard practice was to never commingle unless it was necessary and the only option. But today, with the increased varieties of fuel blends that are accepted as VLSFO, it is even more critical to avoid commingling and therefore makes it a more strategical task to plan future bunker stems. Our business mostly allows for accurate quantity bunker plans 2 stems out, but this must be extremely stressful on tramp shipping.

33. Main concern is a good housekeeping (to avoid fuel mixing), good fuel management on board, temperature is a key point.

34. VLSFO are blended fuel at many ports, hence purifier not able to operate at optimum efficiency due to purifier inlet temperature not able to maintain.

35. Clogging of strainers. Being steam ship we don't have fuel oil separators, but excessive clogging of strainers happened due to ULSHFO fuel for one vessel. Plus, the viscosity difference is very high between different ports of supply. So, maintaining right viscosity at burners is important which at times can get difficult due to vast range depending on what is the amount of blending done in the fuel to achieve sulphur percentage.

36. No other problems experienced so far.

37. No other problems experienced so far.

38. VLSFO are blended fuel at many ports, hence purifier not able to operate at optimum efficiency due to purifier inlet temperature not able to maintain.

39. Random and abnormally high wear rate of cylinder liners. Piston rings break or wear.

40. No problems faced until now.

41. First fuel sourced proved to be poor quality so have had to switch suppliers. Using multiple short contracts until the market settles.

42. Sludge deposits in storage tanks.

43. Necessity to dismantle and clean fuel oil purifiers almost daily because of unstable VLSFO.

44. 1200 man-hours spend by vessel crews on handling problematic fuels. The additional onboard workload affected the vessels normal maintenance time-schedule. 55 extra analysis (additional to the standard) preventively carried out. Mainly FTIR/GCMS, confirmation analysis, purification efficiency analysis etc. to ensure vessels safety.

45. 10-micron filter tends to get choked during change of fuel grades. Increase in sludge generation in purifiers, vessel had to open purifiers 3-4 times in 24 hours for bowl cleaning. Transfer pump, purifier and auto backwash filter clogging frequently.

46. We have experienced accelerated liner wear and piston ring breakages on some vessels. Further, these have been only noted in some units of the main engine i.e. not all the units are equally affected

47. Availability of VLSFO is a challenge in the [geographical area] & very frequently, our vessels have to either run on LSMGO or have to wait for supply of VLSFO. Too many times, we had to change-over between LSMGO & VLSFO - which is not good for the Engine.

48. Lowering of sulphur has resulted in lowering of BN number. However, the specific cylinder oil remains same. This results in increased deposits and sticking piston rings and related problems. If BN is reduced, then specific cylinder oil consumption should be increased.

49. In case of our charged vessels, we did not meet any problem from using of compliant fuel oil.

50. Mainly sludge accumulation trouble has occurred on fuel purification and filtering system. Heavy sludge accumulation occurred when low viscosity oil (roughly below 40cSt) supplied. Case of Sulphur contents being over the limit (0.5%) still happen. More than 10 cases after January 2020.

51. Stuck puncture valves, increased leakages due to low viscosity.

52. Pour point on some occasions was relatively high around 20°C. Variation in density and viscosity of the fuels, necessitating adjustment in the purifiers for better purification. Cat fines mostly within Engine maker's limits. Sulphur content marginal above limit on few occasions.

53. Non-organic acids; Phenol content; High unknown chemicals; suspect they are added in order to keep VLSFO stable/compatible but lead to high sludge amount and clogging of separators.

54. On only one case so far separators were to clean every 4 hours due to sticky residues remaining in the separator bowl. However, combustion of the machinery was always in normal range.

55. Damage of inserts butterfly valves in fuel oil transfer system.

56. Clogged drain oil pipes of settling and service tanks. Open the drain more frequently to avoid wax formation in drainpipes. Limited compatibility between different VLSFOs = Increased sludging during change over from one VLSFO to the next. Empty settling

tank completely and service tank as much as safely possible, before starting to fill settling tank with new fuel.

57. Filter clogging and sludge formation in separator. Increasing the pre-heating temperature solved most challenges.

58. We have received the following from a ship: “This is to inform you of what we had observed and encounter about the fuel oil sludge being produced of ISO 8217:2005 IFO 380-RMG 380 0.5%S we received during last bunkering in [port].”

    As per external laboratory analysis results density @15°C is 941.9 kg/m3, viscosity @50°C is only 30 cSt, 0.2 water %vol, 0.5 sulphur %mass, 0.03 total sediment pot. %mass, 16 ppm vanadium, 16 ppm al + si , 10 ppm calcium, 2 ppm zinc, 4 ppm phosphorous, 7 ppm sodium, 9 ppm iron, 3 ppm lead, 7 ppm nickel, 4 ppm magnesium, 3 ppm potassium, API Gravity 18.65, Net specific energy 41.64 Mj/kg, Gross specific energy 44.14 Mj/kg and CCAI IS 836, viscosity @100°C is 7.0 cSt. Temperature at injection (for 13cSt) is 75°C.

    We had replaced the gravity disc of the fuel oil purifier from 64 to 68.5 diameter. Inlet temp. of the purifier is maintained to 98°C. During desludging we observed that the sludge produced by the purifier going to sludge tank was of waxy type and have difficulty in cleaning the suction filter. Regular transferring from sludge tank to waste oil settling tank had been carried out since the use this fuel, no problem yet observed during every transfer. After cleaning of no. 2 starboard tank, the remnants of HSFO was transferred manually to bilge oil separator tank and also coming from Fuel oil overflow tank. The transferring to waste oil settling tank was taken from bilge oil separator tank for a few days as we need to empty and incinerate first the remains of HSFO. During the time to transfer from sludge tank to waste oil settling tank, we found out that it cannot take suction, open suction strainer of the sludge pump and found out that the filter is having a hardened waxy sludge. After the cleaning, still cannot do the transfer. We removed each sections of the suction pipeline from sludge pump to sludge tank and observed that the pipes are blocked with hardened type of sludge. The sludge tank had been heated but the suction pipelines is without heat tracing and had not been used for few days found totally blocked. Removal of hardened waxy type of sludge being carried out. At present we have approx. about 45.8MT left of this fuel oil. We had overhauled also the sludge pump, changing with new spare of stator and rotor as we noticed that it doesn’t take any suction anymore. The level of the sludge tank now is about 88% already, still we cannot get a suction, what we are suspecting is that the waxy sludge that came from fuel purifier is in the lower portion of the sludge tank and covers the suction portion going to the sludge pump.

59. High pour point of VLSFO, 28°C. Limit is 30°C. Required extra heating of storage tanks and flushing of bunker lines. Slight accumulation of sludge in the fuel oil heaters experienced initially upon change over to VLSFO. One ship with total sediments 0.09 (limit is 0.10) reported serious problem with sludge formation in purifiers.

60. One ship is in process of de bunkering, not yet commenced.

61. Fractured fuel pump barrels on LSMGO operation.

62. Care must be taken on temperatures when using this fuel as this can have a big impact on the fuel and sludging.

63. We are managing high sludge content which is meaning frequent cleaning of centrifuges and filter cleaning. This is just allowing us to provide fuel of sufficient quality to the engines. Filter clogging is very significant though. Also, on 0.1% products we are seeing the presence of VOCs that should not be found in fuel. They have only been detected via extended testing over and above the ISO standard. Fumes are a safety issue.

64. High sulphur content on a couple of vessels - fuel had to be de-bunkered.

65. We have had increased wear of liners and piston ring breakages predominantly on the VLCCs after changing over to VLSFOs and 40 TBN cylinder lubrication oil from 100 / 70 BN cylinder lubrication oils. The cat fines in the fuel are ok - fuel analysis report as per todays standard are ok. We are getting the engines health checked by makers service engineers - checking the water mist catcher functioning, cylinder lubrication system, fuel injectors and scavenge drain systems.

66. CCAI comes up periodically, but we have not had any combustion issues when using the fuel.

67. We have had issues with filters when switching from VLSFO to MGO as even small remnants of VLSFO generates a lot of problem.

68. Excess generation of sludge has been observed during the purification process of a fuel oil batch that was tested and found marginally within the specifications. Frequent cleaning of the purifier and transfer filters was deemed as necessary.

69. We have seen an increase in issues upon initial change over due to incompatibility of the fuel in the fuel system. We have also seen an increase in the amount of sediment and sludge from certain fuels.

70. Clogging of strainers and separators. Deposition on piston crowns with wiping of lubrication oil film. Rapid wear, severe scuffing, micro-seizures, cat fine embedding in liner surfaces.

71. Additional workload in sampling, testing, re-testing, arguing test results and in collecting evidence and documenting the complete process.

72. In few of our managed vessels the total sediment content was found higher than specified. In a few other vessels the sulphur content on analysis was found higher than 0.53% though Bunker Delivery Note mentioned the fuel to be having less than 0.5% S. Fuel had to be de-bunkered.

73. High amount of sediments and increased wear rates.

74. No issues faced till now. Sulphur has been a bit high (0.51% - 0.53%) noted during analysis in some cases. Regulation has just come in and everyone is on heightened alert. But it is just a matter, before contamination with waste refinery streams and poor blending, to cut costs, starts. However, speaking to colleagues, it appears problems with high pour point, sedimentation, high cat fines have already started.

75. New fuels are having strong acidic chemicals. Sludge produced is difficult to handle onboard. Filters are getting choked frequently and sludge cannot be burnt. While burning thick black smoke is noted. On two occasions fuel oil supplied has a strong odour and was highly incompatible.

76. Increased leakages from fuel oil filters and high-pressure fuel oil pumps as overflow of purifiers due to low viscosity.

77. Unable to perform voyage speed due to filter blockage.

78. Having very low viscosity and high pour point. Engineers need to control the temperature to ensure min 2cSt at engine inlet, while not getting filters clogged.

79. Operational issues caused by increased wear and tear of cylinder liners, piston rings but not attributed to cat-fines. Issues recently appeared upon using VLSFO and in conjunction with the cylinder lubrication basis on makers recommendations for using low BN cylinder lubrication oils.

80. Increased wear and tear of piston rings and cylinder liners. However, with the received bunkers the level of cat fines were very less (less than 25 ppm).

81. No other issues, main problem is sediment.

82. No problems faced until now.

83. High cat fines although just within (borderline) the specifications limits and couples by problems with purifiers has cause rapid liner and piston rings wear.

84. Compatibility between last 3,5% and first 0,5% fuel checked before changing over. Compatibility between any previous 0,5% and any subsequent 0,5% ascertained by external laboratory prior of usage of any subsequent 0,5%. All vessel has been supplied with a testing equipment.

85. Some of the vessels under the management are suffering with excessive sludges and filter clogging mainly from fuel bunkered at European ports. From the same locations, the FAME quantity is increased but still within specification. Other ports have issues with high pour point (higher than 24°C) which is causing heating requirements in the storage tanks which in turn are contradicting with possible sensitive cargoes in the

holds that are in some occasions baked if constant and close monitoring is not achieved. All fuels are treated with additives though that are compensating possible fuel abnormalities while there is a strict policy of not comingling fuels from different suppliers even if they are of the same grade.

86. High wear and tear on liners and piston rings, assumed by cat fines. Filter system changed from 25 micron to 10-micron.

87. Some vessel designs have no heating coils throughout fuel oil storage tanks (only around bell mouth) and oil heating is done by shifter pump via settling tank. An issue is raised for fuel mixing/compatibility in settling tank. This is creating an issue in oil heating in cold climates.

88. Up to now no problem face with the new compliant VLSFO.

89. Minor leakages in case of low viscosity compliant fuel

90. No issues experienced yet

91. Treating the fuel with the correct storage temperature depending on the pour point very increased off specification analyses.

92. We are using last 4 years ULSFO and VLSFO last 2 months in our fleet vessels. We never mixed the fuel in the tanks. We did not face any problem. Also, we reduced maintenance time of fuel equipment like fuel pumps and nozzle valves.

93. Excessive worn down and lead the drop of capacity of fuel burning pumps for main propulsion steaming boilers after the changing fuel from ITF380 to LSMGO.

94. Due to increased sediment, observed huge sludge generation in purifiers and filters. Observed an increase in off-specification or near to the limits of relevant ISO in total acid numbers, with additional analysis required to determine the suitability of fuels.

95. So far, the main issue is excessive sludges discharged by fuel oil purifier, blockage of fuel oil purifier, extra maintenance required for fuel oil purifier.

96. Excessive sludge, pyrolysis oil in the fuel (stinking, irritating to skin, abrasive in separators).

97. The VLSFO 0,5% is much better than the previous HSFO 3,5%, almost no cat fines, TSP levels is on the high side but cause no problems. We just reached delivery number 1.000 for the VLSFO 0,5% and only had the sulphur off-specifications. You pay 1-2 dollars more and you get the good products.

98. Difficulty in incineration of sludge when water is evaporated, due to high temperature waxing.

99. Some of the engines retrofitted with cermet coated piston rings. Fuel vale seat lubricators to take care of lubrication issues.

100. Most of the quality problems are related to %S, which finally within repeatability/reproducibility.

101. All VLSFOs received onboard our fleet were found within specifications. In general, from the fuel oil analysis received we have noticed the following:
    a. Low viscosity fuels.
    b. Increased level of cat fines.
    c. Increased pour point.

102. One of our vessel's has sailed from [port A] in loaded condition towards [port X] for discharging her cargo. As the fuel available on board during the sailing time from [port A] was not enough for vessel to reach safely [port C], which was the main bunkering port, it was arranged to stop vessel in [port B] in order to receive a small quantity of compliant fuel oil. Vessel was bunkered with approximately 297 tons of fuel oil having sulphur content of 0.50% as per the BDN. The standard procedure as per MARPOL was followed and bunker samples were collected during the operation from ship's manifold. The sample was dispatched to external laboratory for performing analysis. Nevertheless, due to the custom regulations and logistics issues in [county of port B] the sample reach the laboratory only **17th February**, while bunker operation in [port B] was carried out on **3rd February**. Analysis results of this bunker samples was made available to us only on **18th February** afternoon. In the meantime, vessel has arrived in [port C] on **17th February** before midnight having consumed almost half of the fuel oil received in [port B] and the rest remained on board. On **18th February,** the PSC authority boarded the vessel and during the inspection had also tested the fuel in use with portable analysis equipment. The results obtained on board were showing that the fuel in use had sulphur 0.58%. The PSC obtained another sample and landed to local laboratory for analysis. Same time we have obtained samples from fuel in use from settling tank and at inlet to main engine and landed the fuel oil samples for analysis to external laboratory in [port C].

    Basis on the analysis results from external laboratory of fuel samples landed in [port C] the sulphur content is 0.57 – 0.58% and same time PSC analysis shows 0.59%. In the meantime, the results from laboratory of the sample taken in [port B] showed sulphur content of 0.57%. This indicates that the vessel staff has carried out due diligence and the bunker supplied at [port B] has disparity of sulphur content with BDN and actual fuel supplied onboard. Vessel has changed to LSMGO immediately after the results were known in order to comply with the current sulphur limit.

    Further to above we wish to inform that vessel was bunkered with VLSFO – 1800.647 MT on **21st Dec 2019** at [port Z] and sulphur content stated in BDN was 0.48%. The bunker sample analysis result also confirmed 0.48%. All bunker tanks on board were cleaned before bunkering VLSFO. We wish to confirm that there were no high sulphur bunkers on-board since **27th Dec 2019**.

The IMO regulation was followed by the vessel and informed the agent in [port B] to put on notice the barge and fuel supplier. Nevertheless, the specific case of non-compliant fuel is a strong indication that "problem" remain on the vessel/managers to find a solution even if the violation was done by the supplier. Under these circumstances, suppliers will not have any liability and cases like the one above will continue to appear every day.

103. Not faced any problems so far however mostly bunkered gas oil so far only limited use of VLSFO.

104. Known off specifications VLSFO is on board not used in the engines. After laboratory tests, purifier tests also carried out to see the results. Awaiting sellers for de-bunkering.

105. No other problems - few cases with wear and tear in the fuel system still under investigation with the engine makers.

106. High pour point (although below the maximum permissible limit) in one VLSFO supply for a vessel which proceeded to [country on the northern hemisphere], which required significant extra steam consumption to reduce the risk of wax deposits and/or solidification.

107. A part of the challenges to treat some fuel batches through purifiers due to excessive sludge, we have noticed increased issues with piston rings failures (seizures, wear out, breakage), accelerated wear of cylinder liners, lacquering, scuffing etc.

108. Higher Pour Point (15-25 Deg C) of the VLSFO require it to be kept heated up to 25-35 deg C in the bunker tank. During cold weather storage and transfer is an issue.

109. The pour point to be recommended more lower than iso 8217 (especially for blended oil) as many cases of bunker supply in [port] the pour point almost close to 30°C that would cause oil became wax in cold area.

110. Facing issues with cylinder liner excessive wear with use of VLSFO and corresponding TBN 40 cylinder Lube oil.

111. Found in [region] that TSP are on the high side and over limit which caused more sludge on process.

112. We are unable to find any abnormality in the fuel by the standard tests as per ISO 8217 parameters, GC/MS and FCA (Fuel combustion analysis) but the circumstantial evidence suggests there is something in VLSFO which is causing substantial damage to engines, leading to major financial losses for owners.

113. Initial experience with VLSFO is very bad. Cat-fines appear in fuel and totally damaged cylinder unit on main engine. All piston rings were damaged. Cylinder liner was

completely polished. On FO analyses showing very high content of Aluminium + Silicon.

114. The standards for fuel require a lot of improvement, we are receiving fuels with viscosities ranging from 13 to 330 cSt which all meet VLSFO standards. Suppliers should be asked to ensure that the fuel grades supplied refer to an ISO standard, not VLSFO, LSMGO, ULSMGO, etc.

115. Lab analysis reports are not able to find out chemical used in the processing of fuel. Same is causing issues with high acidity in the cylinders. The wax formation, crystallization, and incompatibility are the major concerns. Suppliers to provide the detailed pre-analysis reports and same to be verified against ships drip sampling lab results. Industry to be educated for the processes and chemicals utilized in reducing sulfur content. Testing labs to take note and test fuel for any unwanted additives.

116. For VLSFO, Sometimes the Pour point is high whereas viscosity is low. So, heating of bunker tanks had to be done carefully.

117. The specifications of the grades as ordered does not always coincide the actual products since the ISO 8217 specification allows a very wide range of individual characteristics. For example, the order is for RMG 380 and the actual bunkered fuel can have a kinematic viscosity of 45cSt. This means that every fuel bunkered will need different treatment and handling onboard thus making the whole process more complicated for the crew and office personnel follow up.

118. Sludge is generated even though TSP is within the specified value.

119. Mostly fuel with sulphur content 0.49% stated on BDN have lab analysis report showing test results of sulphur greater than 0.50%. Hence while procurement of compliant fuel it should be considered for ordering 0.47% and below for fuel sulphur percentage. this will help in resolving such matters.

120. For now, we have no issues. But routine monitoring has been increased as effects would show up in few months.

121. The problems being encountered with VLSFOs seem to be mainly related to VLSFOs having low viscosity (say, 50 and below).

122. We did extensive and planned cleaning, inspection of all bunker tanks before taking (receiving) compliant bunker 0.5 % S. Our preparation and tanks readiness were quite good for the storage of 0.5 % S fuel. While taking new bunker, we did not commingle / mix two bunkers. While C/O we arranged in such a way to have mixing as min as possible. So far, we have not experienced any difficulties, stoppage or breakdown due to use of 0.5 % S fuel (compliant bunker).

123. As for any increase of wear and tear none has been detected so far but may be expected.

124. VLSFO has more sludge generation tendency than conventional HSFO.

Annex E – Answers to question number thirteen

Answers have been proofread and edited to be more readable without deleting any sentences or changing the meaning of the text. Furthermore, names of for instance ports, external laboratories and providers of additive has been removed.

Q13. Do you have any comments you want to share regarding the procurement, availability or bunkering of VLSFO or ULSFO?

Answers submitted:

1. Pre, post Blended/non-blended oil at refinery and vessel's bunker oil specification history to be recorded by common Fuel analysis laboratory organization, in order to track down the deviation of fuel specification if any. Regular use of lubricity improver additives and sludge conditioner.

2. With high wax and also with high Carbon Residue should be rejected from market.

3. The cost difference between LSMGO and VLSFO is very less so it is not worth buying VLSFO.

4. At present Charterers are supplying fuel as per present Charter party which designate ISO 8217:2005 or ISO 8217:2010 Standards. These standards have huge range of specifications, present available VLSO fuel varies in properties with lot of unpredictability like Viscosity. Owners have to get the advanced fuel testing like as below:

    - GCMS Screening
    - Stability Tests
    - Compatibility Tests
    - Sediment Potential Tests
    - Even though these tests shows bad results for the fuel supplied, they are still not Off Spec as per ISO 8217 standards hence vessel has no option but to consume this fuel posing risk of machinery breakdown and operational hazards.
    - We want ISO standards to provide more narrow and stringent guidelines/specifications for VLSO Fuel.

5. Bunker is arranged from the Charterer side, however we have not experienced difficulty in delivery / receiving of Bunkers to our Vessels. So, believe that availability of VLSFO (0.5% S fuel) has not any issue.

6. On our fleet (12 oil/chemical tankers + 2 barges), bunkers are managed by time charterers ; however, on 2 of oil/chemical tankers specially trading in [sea area], almost of the bunkering ports propose VLSFO.

7. You have to lobby with IMO to stop scrubber applications. Like cars you say burn this and market provide product as per regulations, it must be very simple one type for all with no exceptions (like scrubber) it was actually proposed by INTERTANKO in 2010 "all ships must burn diesel" which would be best of best solution but industry lost 10 years for nothing and still spending money for strange mechanisms onboard (like scrubber and its parts) we have to go simple one type oil for ships VLSFO and/or gasoil full stop, any other alternative makes shipping unreliable.

8. Current fuel available in the market are unstable and we expect issued with engine components in the near future like breakdowns / high wear.

9. The potential problem will be cylinder lubrication oil TBN. Oil makers should be made to inform customers about appropriate or correct TBN for new oil.

10. Many regular bunkering ports still do not have VLSFO leaving Owners to use expensive ULSFO available there.

11. Buy the bunkers from reputable supplier. To carry out test the bunker prior supply to the vessels. Enhanced testing regime is important to ensure fuel are handle properly onboard.

12. ULSFO is still in limited supply.

13. We never faced any issue with procurement or bunkering of above fuel.

14. BIMCO 2018 Clause 9(b)(i) needs to be reinforced and supported as many suppliers still have (14) day limits for quality time bar and bunker traders are reluctant to fill the gap and increase their liability. Even if the Owner has had the time to obtain the standard fuel analysis after receiving bunkers, the latent fuel issues will not surface until machinery is already damaged as we have experienced with the Houston fuel issue of 2018. The quality time bar needs to be 30 days.

15. Avails are there, specific energy of the fuel is by far better compared to HSFO, hence burns well in engine. Specific attention by Chief Engineer on cold flow properties depending on trading areas, purifiers set up.

    - Difficult from a purchasing perspective to know what we buy from Sellers (paraffinic or aromatic fuel oil) and transparency over the supply chain. Importance of receiving a COQ prior purchase.

- Stability from shore to engine inlet is key, so do homogeneity of the delivered product. Proper sampling methods are of utmost importance too.

- It is not recommended to store VLSFO more than 3 to 4 months having no knowledge yet if product does age well or not, with possible stability deterioration over time.

16. Suppliers continue not accepting ship's manifold samples on BDN making quality claims impossible.

17. ULSHFO we have seen is difficult to procure at times. Vessel ran short of supply around Europe to Africa run and had to consume LSMGO instead.

18. So far, we have stemmed 5 times VLSFO in [four different ports] every time there has been no issue with availability. Also, quality has been good for all stems so far.

19. 0.5% is fine and now the new HFO. 0.1% is difficult to source as demand is low and the differential between that and MGO negligible. using 0.1% for now but may revert to MGO in SECA areas.

20. Don't go for the cheapest.

21. Fuel additives are being used to eliminate the above problems. Commingling is not being made during bunkering.

22. There were availability problems early January, now the fuel has been available.

23. Surprisingly despite media expectations there has been no real issues with regards to bunker availability of either VLSFO or ULSFO to date.

24. Despite requesting COQ the actual quality of the VLSFO is sometimes worse than specified and/or expected.

25. Availability in main ports is presently normal. At none main ports, there were cases were ULSMGO had to be procured. In the beginning of the year, cases with availability and backlog experienced.

26. Because of the sludging issues we have been looking at LSG only stems.

27. Given the possibility of incompatibility of these bunkers as well as change in characteristics during storage (especially for blended VLSFO), Charterers must consider bunkering quantities without mixing as far as possible.

28. Buy fuel above min pour point of near 10°C.

29. Availability of VLSFO in the [region] has been a challenge. Very frequently, our vessels have to either run on LSMGO or have to wait for supply of VLSFO. Too many times, we had to change-over between LSMGO & VLSFO - which is not good for the engine.

30. Decrease in BN number of cylinder oil should result in increased specific cylinder oil consumption.

31. Purchasing team of our company had contracted local suppliers for VLSFO and then procurement, availability or bunkering of VLSFO had been smoothly progressed now.

32. It is suggested to check that the Tan Number is below the standard value before supplying ULSFO.

33. Most of case, Sulphur contents in VLSFO in 0.46 ~ 0.48% and there is very less margin to upper limit. We strongly request to make fix more strict quality standard by ISO as soon as possible.

34. Increased lifting of MGO due to non-availability of VLSHFO during Q1.

35. When ship's sample shows off spec then second sample from barge is tested as per supply contract which is always on spec which means that barge sample is not true reflection of the fuel given to vessel as vessel is having problem with the fuel e.g. too much sludge etc which means fuel is not stable. There it should be made mandatory to take barge sample from ship's manifold as well.

36. There was shortage of VLSFO. It was compensated by MGO. Whole changeover process to 0.5% fuels was made unnecessary complicated. Fuel grades change is very common and simple process, which all marine engineers are familiar with.

37. The last month an increased number of charters and suppliers are not prepared to accept ship manifold samples as binding.

38. According to our experience, the reason of off spec bunker is mostly depending on blending property/method. Blending of high volatile chemicals to conventional fuel during process of refining rising up non-conformance.

39. Very low and no availability at all still in some regions.

40. Always check the certificates of quality and sediment values. Find as much information about the fuel, i.e. which refinery it came from and if there have been any issues with fuels from there.

41. VLSFO – fine / ULSFO - we can get it, but quality is largely poor.

42. Availability: Abundant in [two regions] but scarce in other parts of the world. Quality still remains suspect and only time will tell if VLSFO can be mixed or not.

43. There were initial problems (real or created) with regards to availability of VLSFO (in fact it was for some time cheaper to buy MGO than VLSFO). The [trade sanctions] issue increased this problem and the lead time required but after the COVID 19, we are seeing a softening of the prices and adequate availability. Hope the VLSFO price comes down to acceptable market rates.

44. It is better to use VLSFO instead of HSFO with low viscosity and high specific energy. So, it is so easy to changeover to LSMGO where to need using before entering ECA.

45. The Sulphur content is just borderline at around 0.47 pct.

46. No problems have been encountered so far with the availability of VLSFO.

47. We are suffering availability in certain areas. At times we will reject a fuel based on its COQ however we are then subsequently told that there is no further availability and therefor have to accept thew said fuel.

48. The standards for fuel require a lot of improvement, we are receiving fuels with viscosities ranging from 13 to 330 cSt which all meet VLSFO standards. Suppliers should be asked to ensure that the fuel grades supplied refer to an ISO standard, not VLSFO, LSMGO, ULSMGO, etc.

49. Availability is ok., the timely bunkering - considering additional workloads and additional time needed for test results - is still not understood by all stakeholders.

50. In many ports, fuel oil as per ISO:8217:2017 is not available and ship has to accept ISO: 2005, or 2010 / 2012 fuel. In many ports also VLSFO/ ULSFO are not available and charterers end up giving LSMGO to vessel which has challenges like low viscosity. On some occasions limited capacity of LSMGO tank can lead to using Fuel oil tank for storage of LSMGO.

51. VLSFO is still not available on short notice or if it, then the cost is higher than MGO. Have a VLCC running on MGO for past 2 months now. As for ULSFO, the experience is bad - as long it is from an Oil Major the bunker is normally ok, however when it comes from a bunker broker/trader, problems can be expected.

52. Availability of VLSFO is not an issue yet. Availability of HSFO (for ships equipped with EGCS) is a big problem. This directly affects the proper operation of the engine as the appropriate grade of cylinder oil will not be available.

53. We use VLSFO, seems widely available.

54. VLSFO and ULSFO was not available in [ports in country] in Dec 2019 and January 2020.

55. Certain suppliers had refused to issue the full analysis prior of fixing and therefore the supply was not fixed with them.

56. Overall, we have found VLSFO to be available at major bunkering ports.

57. In general, it is a massive problem that the bunkers barge their own MARPOL sample and do not accept the drip sampler taken from the ship. this leads to problems with the fuel claim. a clear regulation worldwide would help a lot here. the ship's negotiating position on bunkering would thus be facilitated if there were clear rules.

58. Regarding the procurement, availability of VLSFO or ULSFO, the comment we have is that the buyers should plan to stem bunkers at least 10-15 days prior vessel's arrival at bunkering port, as a result to make it difficult for chartering dept for next employments.

59. Never mix both fuels in the tanks. Pay attention to fuel temperature. Do not use the new fuel until you get analysis report. To reduce the maintenance time of fuel equipment.

60. The fuel shall be well within Specifications. Lesser cat fines, Purchase from reputed suppliers. Certificate of Quality shall be obtained for review before purchase.

61. Countries should start legal actions against bunker suppliers delivering off-spec products.

62. There was some shortage in some ports before New Year 2020 but now is better.

63. Company fleet has been operating within SECA area (95%) since 2015, no low sulphur fuel of residual type has been consumed.

64. With proper proactivity no availability problems. It is all about planning.

65. Availability has been from time to time an issue in main bunkering ports because of availability of VLSFO and associated logistic.

66. Up today we have not faced any problems regarding availability or bunkering of VLSFO. Main trading area SECA-Asia.

67. Buy from known suppliers who you have experience with and request analysis before procurement.

68. Refinery products are very limited, mainly blend products are in the market. Buyers should pay much attention to Total sediment Potential (TSP) especially when bunker supplied at [region].

69. No Comments - however the quality control of the supplier is not clear comparing to previous old HFO - supplier is mainly concentrating on Sulphur level and nothing else.

70. Suppliers used to be very reticent in providing a certificate of quality for the VLSFO before supply, although recently this appears to be changing.

71. So far, we have not experienced any issue with regards to the availability of VLSFO.

72. We request ISO 8217 Standards to be amended for new VLSO fuel types, this can make the properties of VLSO fuel more predictable and reduce the variation.

73. All Bunkers should have Certificate of Quality (CoQ) which contains the TSP (not TSA or TSE) and provide to Buyers before the Bunkering.

Annex F – Comments shared by respondents

Comments have been proofread and edited to be more readable without deleting any sentences or changing the meaning of the text. Furthermore, names of for instance ports, external laboratories and providers of additive has been removed.

Do you have other comments you want to share?

Answers submitted:

1. Questions related to experience on compatibility between fuel oils may be included in future surveys.

2. Should ISO reduce max. pourpoint for VLSFO in order to minimise wax appearance.

3. Users should be more informed about right handling, purification, and usage temperature.

4. Viscosity range for ULSHFO fuel to be standardised as lot of burning equipment has a range of operation. Large difference in viscosity between fuel grades causes machinery to malfunction.

5. We are still observing closely on the bunker specifications being supplied in future.

6. We are seeing a potential narrowing of the price differential between ULSFO and MGO in [port].

7. ISO 8217 should include SN max. value.

8. We need urgently a clear interpretation for the industrial on 'fuel under dispute for high sulphur content vs. carriage ban'.

9. Application or modification of 10 microns of filtering devices is not the solution. Nowadays only solution seems as using chemical additives for avoiding wax composition.

10. We are seeing a potential narrowing of the price differential between ULSFO and MGO in [port].

11. Difficult to pin-point the source of the problem on the new fuels as such. Seems to be a combination of fuel oil, cylinder lubrication oil and other weaknesses in the engine which were in control with the previous types of fuels and cyl lube oils.

12. Circulating fuel from bunker tank to bunker tank helps in reducing sludge. Separation temp about 98°C.

13. Limited Availability of Cylinder Oil of BN 40 and Generator Oil.

14. We use Fuel additive in VLSFO bunker tanks. These suppress sludge precipitation, so tanks & filters and pipelines are kept clean.

15. Some fuel bunkered is of very good quality.

16. Countries should start legal actions against bunker suppliers delivering off-spec products.

17. Don't create panic - the product is fine, it’s just that the operator/owners need to work now...or the bunker purchaser need to work a bit more.

18. We are concerned of possible long-term effects and damages to fuel oil pumps and other engine components due to higher (although within limits) values of very low sulphur fuel oil than numbers.

Annex G – Cleaning of dataset

The dataset was cleaned of nine responses based on discrepancy in answers to the two parts of question number two:

> *Q2-1. Has any of the fuel oil analysis results indicated off specifications (off-spec) in accordance with the relevant version of ISO 8217?*
>
> *Q2-2. If yes, please select the characteristics or limits off specification:*

Eight responses contained the answer ‘no’ to whether or not any of the fuel oil analysis results indicated off specifications (off-spec) in accordance with the relevant version of ISO 8217 while at the same time one or more characteristics or limits had been selected as off specification in the second part of the question.

One response contained the answer ‘yes’ to whether any of the fuel oil analysis results indicated off specifications (off-spec) in accordance with the relevant version of ISO 8217 but no characteristics or limits had been selected as off specification.