IDWAL

Machinery and Machinery Spaces

Technical Guide - Ver 1.0

www.idwalmarine.com

Telephone +44 (0) 2920 446 644 | +86 21 6219 5047

Email surveyormanagement@idwalmarine.com

Carbon Neutral Organisation

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+44 (0)2920 446 644 | +86 21 6219 5047 operations@idwalmarine.com 1 Caspian Point, Caspian Way, Cardiff, CF10 4DQ, UK

Applying Idwal grade definitions in Idwal's Machinery and Machinery Spaces section

The following criteria should be used for assessing the condition of equipment and fittings in the Engine Room.

Description	Definition
Good	Either no issues or only minor issues found that do not materially impact any aspect of the vessel operation or impair the safety of the vessel, its machinery, personnel, or environment. Minor expected wear and tear is permitted, not requiring correction or repair.
Fair	Obvious wear and tear or deficiencies evident that require planned correction or repair.
Poor	Significant wear and tear or deficiencies evident that require immediate correction or repair.

Machinery and Machinery Spaces Questions

Were all Engine Room bulkheads and frames seen to be in good structural condition?

Engine Room bulkheads, frames and internal structures should be continuously assessed throughout for indentations, cracks, buckling and/or other damages.

It may be that the vessel has already been issued a Condition of Class for such a defect (should have been recorded under the applicable question in the Operational Data section). Details/further investigation can be replicated/recorded under this question.

Were the Engine Room fittings such as stairwells/ladders, handrails, floor plates and lighting found to be in good condition?

It should be ensured that all Engine Room fittings including stairwells/ladders, handrails and floor plates are in good order and properly secured. Any damaged/improperly secured items should be recorded here. Adequate levels of lighting and ventilation should also be assessed with any shortcomings recorded here. Alarm systems such as tower lights and horns should also be included. An example of poor fittings is shown below.

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Was the duct keel in good condition and free from any signs of ingress or internal leakages?

A superficial inspection of the vessel's duct keel, if applicable, should be requested. **Please note:** duct keels are enclosed spaces, and the relevant precautionary measures should be in place prior to entry.

The duct keel should be checked for adequate illumination, satisfactory condition of pipework and fittings, free from any leakages or internal/external ingress.

'***N/A***' is to be selected when the vessel is not fitted with a duct keel.

'***Not able to enter***' is to be selected when access is refused by the vessel or access is not possible for any other reason (inadequate enclosed space procedures, deemed to be unsafe etc.).

What equipment was seen running?

All machinery that was observed running in the machinery spaces should be recorded here.

Please use the '***Other'*** box to list any machinery that was seen running but is not included in the list. For example, if the steering gear was tested or the BWTS was seen in operation then recording it here is required.

Was the Engine Room free of any significant defects, either reported by crew or observed?

Significant defects include but are not limited to:

- major engine failure (main and auxiliary)
- other essential equipment that is out of order such as electrical distribution systems
- major damage of any main/auxiliary machinery
- missing essential equipment
- out of order electrical and/or monitoring systems

If there is any defective item that may impact the operational capabilities of the vessel – record it here.

What were the general levels of housekeeping and cleanliness in the Engine Room?

Answering this question negatively (Fair or Poor) is applicable in cases where the extent and/or volume of sub-standard housekeeping practices is deemed to be beyond the norm. Surveyor discretion and experience should be exercised in determining between Fair and Poor, noting that a Poor Engine Room is usually obvious and is typically very dirty and well below the expected standard.

Consider the overall cosmetic condition of the engine room including but not limited to:

- general standard of coatings and coating maintenance
- cleanliness of deck plating, machinery casings, bulkheads, bilges, and tank tops and other hard to reach areas
- dust, debris and/or residue build up.
- evidence of active leakages and/or instances of historic leakages that have not been adequately cleaned.
- any temporary collection/containment arrangements to stem leakages.
- standard of garbage disposal and segregation
- arrangement of tools, spares, and stores

With the above assessed, we request that any suspected contributing circumstances are also commented upon (examples below):

- was the vessel in dry dock at the time?
- was the vessel undergoing any major overhauls at the time?
- Had the vessel recently departed dry dock or recently completed any major overhauls?

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An example of a 'poor' level of housekeeping is shown below.

Were bilges and tank tops free of any significant oil and/or water?

Inspect all bilge wells and areas of the tank tops at various locations throughout the Engine Room. If any oil is noted in the bilges or on the tank tops, this should be recorded, noting the approximate volume (traces, oil film, notable, significant etc.). A small amount of water on the tank tops (mainly seen in the form of condensation) may be acceptable dependent on circumstances.

It is normal for bilge wells to contain a small amount of unpumpable water. The cleanliness of such water and the bilge well(s) itself should be assessed with any areas of dirtiness/mud accumulation etc. recorded.

Where the bilge well(s) contains a significant amount of water (at or above alarm level), this should be recorded.

As far as practical, the source of any significant oil and/or water accumulation should be ascertained. All supporting comments can be left in the Surveyor Comments box at the end of the Machinery and Machinery Spaces section.

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Were bilge alarms found to be fully operational during testing?

Request to test a selection of bilge alarms throughout the Engine Room and machinery spaces. Ensure that upon activation, all relevant audio and visual alarms are triggered, and the correct location is shown on the Alarm Monitoring System (AMS). Ensure that the alarm clears upon resetting.

'***Not able to test***' is to be selected when permission is not granted by the vessel or for any other applicable reason (time constraints, etc.).

Was the vessel equipped with adequate critical spares as recommended by the ship manager Safety Management System (SMS)?

Determination should be made by reviewing the vessel's critical spares list as per the SMS, and when time permits, random cross checking against actual stock ROB can be carried out.

If even one item is below the recommended ROB, then '***No***' should be selected and the relevant item(s) listed in the Surveyor Comments box at the end of the Machinery and Machinery Spaces section. If the vessel claims 'reconditioned' spares are carried, then it should be ensured that they are approved by manufacturer (e.g., honed liners).

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Storage List
(Critical Equipment)

08.12.2024

Ship :
Equipment : ENGINE \ Emergency Generator[01.38]

Equipment Name Item No. / Part No. / Drawing No. / Internal No.	Min. Stock	Max. Stock	Total Stock	Unit	Total Value (FIFO) [EUR]	Location Stock	Location Name [Code]
Filter L.O 01.38.001 / 65.05510-5020B / [none] / [none]	2.0	0.0	4.0	pcs		4.0	Emergency Gen. room
Filter fuel 01.38.002 / 65.12503-5025A / [none] / [none]	2.0	0.0	4.0	pcs		4.0	Emergency Gen. room
Gasket Cylinder head 01.38.003 / 51.03901-0348 / [none] / [none]	4.0	0.0	8.0	pcs		8.0	Emergency Gen. room
Gasket Cyl. Head cover 01.38.004 / 65.03905-0015B / [none] / [none]	4.0	0.0	8.0	pcs		8.0	Emergency Gen. room
Starting motor 01.38.005 / 860698GB / [none] / [none]	1.0	0.0	1.0	pcs		1.0	Emergency Gen. room
					0.00	EUR	

Were spares neatly stowed and correctly secured?

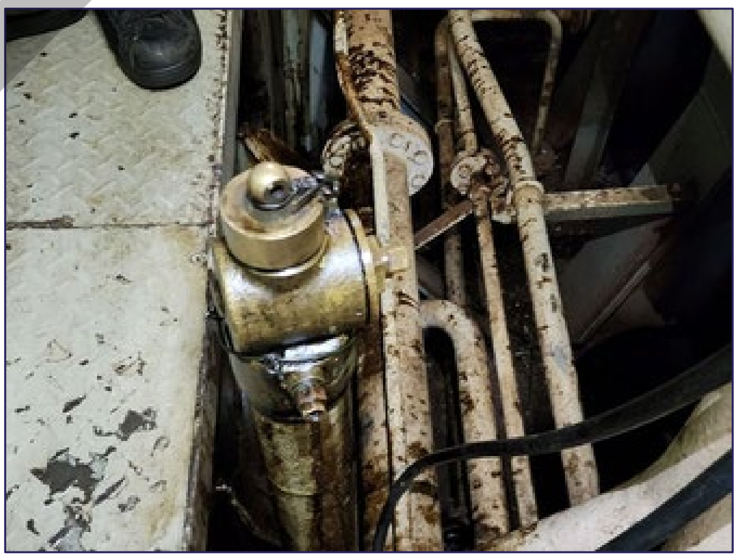
All storerooms should be checked for correct segregation of spares and general tidiness, ensuring that spares are easily accessible and stored at a suitable height, adequate guard rails in place, etc.

Additionally, all major spares such as main engine cylinder liners, pistons, etc. should be checked for general condition, adequate protection (anti-corrosive grease/shrink wrap) and properly fastened securing fittings.

Were all self-closing devices (sounding pipes, tank level gauge glasses etc.) in good working order?

As many sounding pipes as possible should be inspected and tested. Ensure that all mechanisms are working, caps secured and no unauthorised 'hold-open' devices are fitted. Please note that the scavenge air drain tank sounding pipe should not be opened if the main engine is in operation at the time of inspection (due to the tank being pressurised).

The same should be applied for gauge glasses - noting that a common deficiency found is the cylinder oil day tank push buttons held open (by cable ties or similar).



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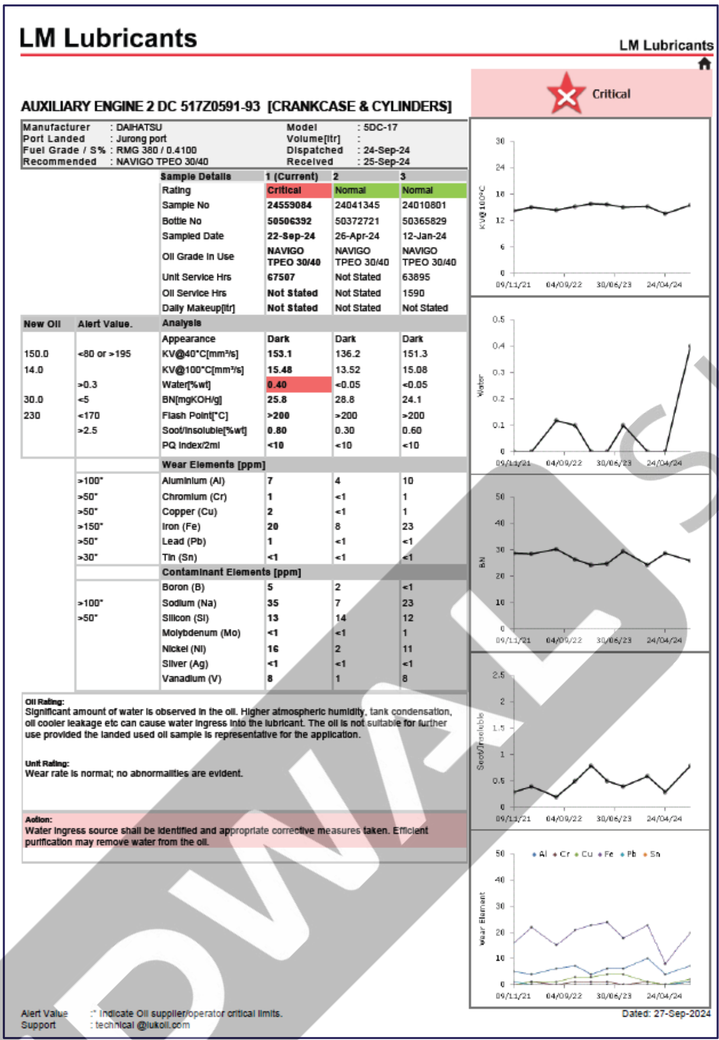
Were any caution (amber) or action (red) alerts seen on the supplied lube oil analysis reports?

Ideally, lube oil samples should be sent ashore for analysis by the vessel every 3-6 months (depending on the machinery/equipment). Please ensure to check the sampling date on the reports; these can sometimes be vastly different to the date of the report. Any notable date discrepancies or evidence of lack of regular testing should be recorded.



LM Lubricants

LM Lubricants

Critical

AUXILIARY ENGINE 2 DC 517Z0591-93 [CRANKCASE & CYLINDERS]

Manufacturer : DAIHATSU
Port Landed : Jurong port
Fuel Grade / S% : RMG 380 / 0.4100
Recommended : NAVIGO TPEO 30/40
Model : 5DC-17
Volume[ltr] :
Dispatched : 24-Sep-24
Received : 25-Sep-24

New Oil	Alert Value.	Sample Details	1 (Current)	2	3
		Rating	Critical	Normal	Normal
		Sample No	24559084	24041345	24010801
		Bottle No	50506392	50372721	50365829
		Sampled Date	22-Sep-24	26-Apr-24	12-Jan-24
		Oil Grade In Use	NAVIGO TPEO 30/40	NAVIGO TPEO 30/40	NAVIGO TPEO 30/40
		Unit Service Hrs	67507	Not Stated	63895
		Oil Service Hrs	Not Stated	Not Stated	1590
		Daily Makeup[ltr]	Not Stated	Not Stated	Not Stated
		Analysis			
		Appearance	Dark	Dark	Dark
150.0	<80 or >195	KV@40°C[mm²/s]	153.1	136.2	151.3
14.0		KV@100°C[mm²/s]	15.48	13.52	15.08
	>0.3	Water[%wt]	0.40	<0.05	<0.05
30.0	<5	BN[mgKOH/g]	25.8	28.8	24.1
230	<170	Flash Point[°C]	>200	>200	>200
	>2.5	Soot/Insoluble[%wt]	0.80	0.30	0.60
		PQ Index/2ml	<10	<10	<10
		Wear Elements [ppm]			
	>100*	Aluminium (Al)	7	4	10
	>50*	Chromium (Cr)	1	<1	1
	>50*	Copper (Cu)	2	<1	1
	>150*	Iron (Fe)	20	8	23
	>50*	Lead (Pb)	1	<1	<1
	>30*	Tin (Sn)	<1	<1	<1
		Contaminant Elements [ppm]			
		Boron (B)	5	2	<1
	>100*	Sodium (Na)	35	7	23
	>50*	Silicon (Si)	13	14	12
		Molybdenum (Mo)	<1	<1	1
		Nickel (Ni)	16	2	11
		Silver (Ag)	<1	<1	<1
		Vanadium (V)	8	1	8

Oil Rating:
Significant amount of water is observed in the oil. Higher atmospheric humidity, tank condensation, oil cooler leakage etc can cause water ingress into the lubricant. The oil is not suitable for further use provided the landed used oil sample is representative for the application.

Unit Rating:
Wear rate is normal; no abnormalities are evident.

Action:
Water ingress source shall be identified and appropriate corrective measures taken. Efficient purification may remove water from the oil.

Alert Value : * indicate Oil supplier/operator critical limits.
Support : technical @lukoil.com

Dated: 27-Sep-2024

Also, be wary of lube oil analysis reports that are not from reputable sources or look like they have been tampered with. Further investigation will be required in this case. Again, this should be recorded.

Reports should be reviewed, and comment(s) made on all areas flagged as caution (amber) or alert (red) stating which system the oil is for and what the given cause is. An example is shown opposite. The Chief Engineer / Engine Room crew should be asked about any cautions or alerts and whether they have been resolved or what the plan is to rectify the reported issues.

Please select '***Not available***' if the document was not provided.

We are also occasionally provided with on board oil testing reports (example below). Standard practice is that critical oil systems are tested monthly. Receiving such reports tends to show that the vessel is following proper monitoring procedures.

On board testing for viscosity, Total Base Number (TBN) and water-in-oil are common and will give early warnings of oil deterioration or potential signs of water ingress. As a rule, the TBN for 4 stroke engine oil will decrease as the oil ages and deteriorates. The oil should normally be replaced if this figure reaches less than 50% of the original TBN. Conversely, 2 stroke engine system oil TBN often increases due to contamination from higher TBN cylinder oil (due to leaking stuffing box seals etc.).

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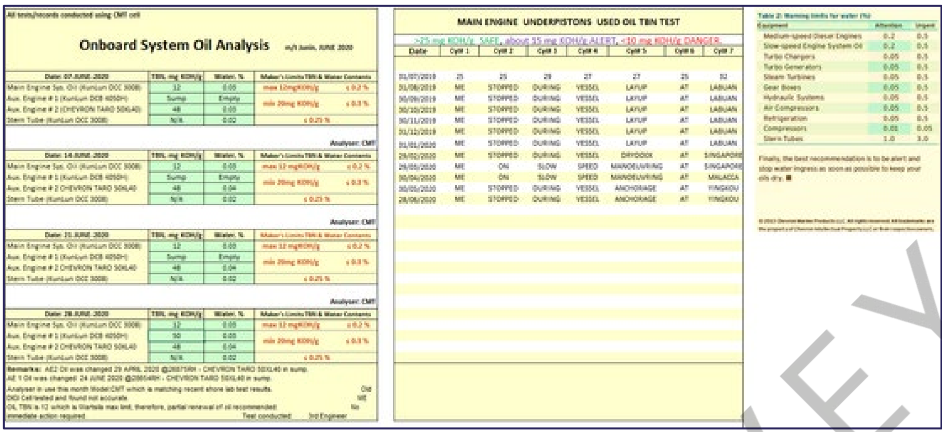


Above: An example of an onboard oil analysis record form.

Were any alerts or abnormal findings seen on the supplied fuel oil analysis reports?

Ensure the supplied reports are from reputable providers (VPS being the most commonly seen) and free from any obvious tampering or modifications.

The vessel normally receives these reports in email format, but customary practice is for them to be printed and clearly displayed in the ECR together with the applicable Bunker Delivery Note (BDN). Analysis reports should be provided for every bunker stemmed.

Any out of spec parameters are normally indicated in **amber** or **red** but can also be in plain text, normally at the top or bottom of the sheet. These should be detailed in the Idwal report if present. These reports often prescribe correct measures to reduce the impact of any out of spec parameters (fuel oil purifiers to be run in parallel is a common one sighted). These can also be recorded in the Idwal report if deemed necessary.

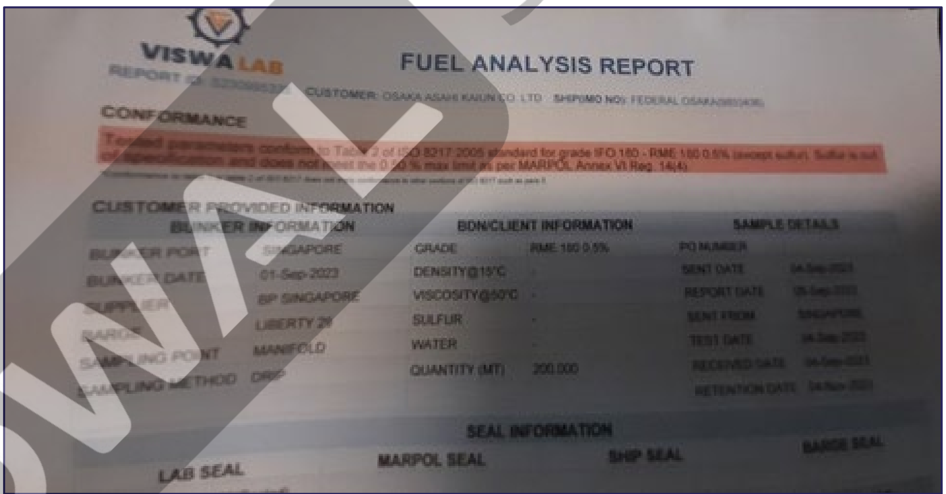
Please select '***Not available***' if the document was not provided.

According to IMO 2020 Regulations, most vessels that Idwal inspect operate on Very Low Sulfur Fuel Oil (VLSFO), containing less than 0.5% sulfur content. VLSFO is a blended fuel and commonly has issues with:

- **Instability:** The inability of a fuel to keep asphaltenes in suspension, causing increased sludge formation inside filters and separators) In extreme scenarios, this can lead to loss of power and propulsion.
- **Compatibility:** The suitability of two different fuels for mixing without leading to adverse effects. Two stable but incompatible fuels, even if compliant with the Global Sulphur Cap and ISO 8217, when mixed may also result in increased sludge formation inside filters and separators. The components used for developing blended fuel oils are so diverse that compliant fuel grades having the same sulphur content, but bunkered at different geographical locations, may not be compatible, even if ordered from the same bunker supplier.

Not exclusive to VLSFO, other common deficiencies we often see with fuel oil analysis reports include:

- **High Sulphur Content:** For example, >0.5% without EGCS fitted, >3.5% with EGCS fitted. This fuel should not be used as it is out of compliance. Additionally, to note, the Sulphur content of a fuel oil dictates the quantity and quality of cylinder lubrication that is required to optimally neutralise corrosive oxides produced as a result of combustion.
- **Water Content:** High water content (maximum allowable is 0.5%) results in improper combustion that can lead to cylinder liner corrosion, damage to pistons/rings and issues with fuel injection systems.
- **high Catalytic Fines:** These are often referred to as cat fines for short, are very hard microscopic particles which can embed in softer metal surfaces such as piston rings, cylinder liners and fuel injection equipment such as pumps and injectors. This can cause high wear rates, resultant damage to components and eventually premature failure. The maximum permissible level of cat fines in marine residual fuels is 60 parts per million (ppm) as per the ISO 8217:2017 Fuel Standard. However, engine manufacturers recommend a maximum of 15 ppm for fuel entering the engines.
- **Low Flashpoint:** The minimum allowable flashpoint is 60°C.
- **High Pour Point:** Pour point is a measure of the lowest temperature at which the fuel will no longer flow and is determined by the amount of petroleum wax in the oil. As the temperature drops, the wax in the fuel crystallizes and separates out, which can cause the fuel to thicken and solidify. This can cause clogged filters, separators, and other issues with fuel transfer.



Was the NOx Technical file kept up to date?

This should be inspected and the most recent date of entry recorded in the inspeciton checklist. The Nox Technical file should include details such as changes to engine running parameters and records of critical components, such as fuel injection nozzles, fuel pumps, pistons, con rods, cylinder heads, camshaft, charge air cooler and turbochargers.

The NOx Technical Code specifies the requirements for the testing, survey, and certification of marine diesel engines in order to ensure they comply with the Nitrogen Oxide (NOx) emission limits of regulation 13 of Annex VI of MARPOL. The code applies to all diesel engines with a power output of more than 130 kW which are installed, or are designed and intended for installation, on board any ship subject to Annex VI and to which regulation 13 applies. For each NOx certified diesel engine there must be onboard an approved Technical File.

https://www.imo.org/en/OurWork/Environment/Pages/Nitrogen-oxides-(NOx)-%E2%80%93-Regulation-13.aspx

Was the Engine Room Logbook up to date, correctly filled in and without any obvious abnormalities recorded?

This should be checked to ensure that there are no obvious errors, omissions or adverse findings including but not limited to the following:

- completed daily.
- correct date format used (dd/mm/yyyy)
- unusual/abnormal records (parameters should be within expected limits and allowable deviations, no defects recorded etc.)
- incomplete/partial records (limited data contained)
- absence/omission of records
- signed by Duty Engineer and countersigned by Chief Engineer

The extent of scrutiny is at the surveyor's discretion and is subject to crew co-operation, time constraints and any observed discrepancies (when one discrepancy is found it is likely that others are present, prompting further investigation).

Were Chief Engineer Standing Orders clearly posted and signed by all engineers?

Standing orders should be sighted and checked for signatures of all engineering staff in conjunction with an up-to-date crew list, description of personnel's duties and working schedules (at sea and in port).

A night order book and UMS alarm log should also be maintained and briefly checked to ensure that records are up to date, satisfactory and countersigned.

Were all machinery special tools provided and in good condition?

Special tools are normally carried for various machinery/equipment including but not limited to the following:

- Main Engine

- Auxiliary Engines
- Purifiers

Often these tools are kept on a 'shadow board' with the special tools outlined near to the machinery itself.

Any defective or missing special tools identified or reported by crew should be detailed in the report in the Surveyor Comments box at the end of the engine room section. These can often be costly items to replace.

Equipment for performance testing (e.g., Icon-Doctor) should also be confirmed to be available onboard and in operational condition. Examples of special tools are shown below.

Were all machinery and equipment manuals reported to be available onboard?

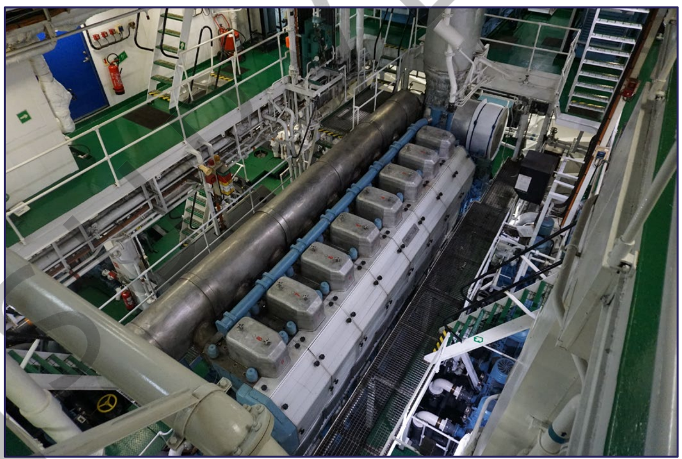
The Chief Engineer (or their representative) should be asked if all machinery and equipment manuals are available onboard.

Was the main engine in good working condition?

What this question is essentially asking is, '*can the main engine be started, stopped, used to transit the vessel to its intended destination and is it fully manoeuvrable (all functions including speeding up, slowing down and reversing, if applicable, are operational?)*'

If the main engine is not seen in operation, then this should be ascertained by asking the Chief Engineer and engine room crew. Any major issues such as full inoperability, disabled units or major damage should be noted here.

In any cases where only limited Main Engine operation is available (e.g. circumstances such as control only available from ECR/local manoeuvring stand etc.) then this can be recorded under this question.



If the main engine is undergoing overhaul, please do not mark it as 'non-operational.' Instead, please tick 'Overhaul in progress' and describe in detail what maintenance was being undertaken in the Surveyor Comments box at the end of the Engine Room section. Please also include whether the maintenance was routine or unplanned.

Please note that some defects such as leakages may not necessarily impede the operational capability of the main engine and should be recorded under the next question *'In what condition was the Main Engine?'*

In what condition was the Main Engine?

Answering this question negatively (Fair or Poor) is applicable in cases where the Main Engine is operational, but defects are present. Surveyor discretion and experience should be exercised in determining between Fair and Poor, considering the volume, nature and severity of the identified deficiencies.

These include but are not limited to the following:

- Fuel oil leaks (normally on/around injectors, fuel pumps and piping)
- Lube oil leaks (normally seen around hydraulic actuators and accumulators)
- Exhaust gas leaks (normally seen around exhaust manifold flanges and turbocharger casings)

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- Compressed air leaks (normally seen/heard around starting air valves and solenoids)
- Cooling water leaks (normally seen around cylinder liners and their cooling jacket seals)
- Signs of significant historic staining seen around the engine entablature
- Evidence of abnormal noise/vibration during running
- Cracks sighted around the engine casing
- Exposed/damaged sensors and electrical connections
- Any other defects detailed in any supplied documentation or reported by crew

Were any defects or abnormal findings seen on the supplied scavenge space inspection reports?

Ideally, these inspections and associated reports should be conducted monthly but may be bound by operational limitations (long voyages, refusal by the port for main engine immobilisation etc.)

Any notable deficiencies should be recorded in the report, stating the nature of the defect(s) and the affected unit(s).

Supplied reports are normally provided with a key on the left-hand side and are generally in a standardised format with consistent terminology. The keys are normally easily identifiable in the table to diagnose deficiencies.

Any provided photographs should also be assessed to ensure the recorded findings match those photographed.

Unit running hours since last overhaul are often also included to help clarify/verify engine running hours.

Common defects include:

- Broken/collapsed piston rings (can lead to rapid cylinder liner wear and scavenge fires due to exhaust gas blow-by)
- Seized/sticking piston rings (leads to reduced efficiency and as per above)
- Heavy/excessive sludge deposits (increases risk of scavenge space fires and subsequent risk of crank case explosion)
- Immovable/damaged air intake flaps and non-return valves
- Scuffing and/or cold corrosion of cylinder liner (reduces efficiency and can lead to premature failure - can be caused by insufficient lubrication)

Please select '***N/A***' if the main engine/propulsion unit is not fitted with a scavenge space (e.g. 4 stroke main engine or diesel electric propulsion).

Please select '***Not available***' if the document was not provided.

Were all maximum cylinder liner wear measurements seen to be within maker limits?

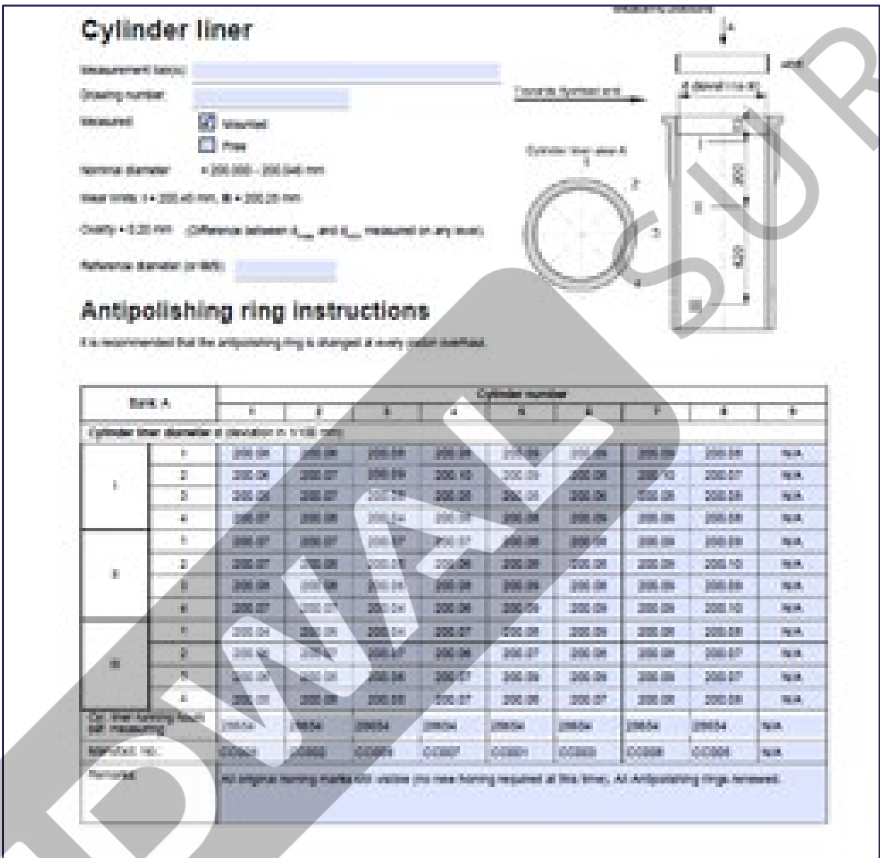
As cylinder liners age, the measured diameter will increase (due to wear). There is a maximum permissible amount of wear before the cylinder liner needs to be replaced. Liners worn beyond their maximum allowable wear will operate at notably reduced efficiency and can lead to failure of other components.

In addition to maximum wear, these reports also provide an indication of 'ovality' of the cylinder liner - this gives an indication of uneven wear, another contributing factor to reduced performance/efficiency of the engine and potentially symptomatic of issues with the piston, piston rings or cylinder lubrication system.

Measurements are normally taken during individual unit(s) overhauls and/or major overhauls. These may be provided as separate reports or may be incorporated within a larger overhaul report. They are also normally measured and recorded prior to dry docking for planning purposes.

It should be verified that all readings are within allowable limits. The reports normally specify the maximum cylinder liner diameter or directly state the maximum allowable wear. Where the reports do not explicitly state this, information should be requested from the Chief Engineer.

It is important to accurately assess these 'big ticket' items as they have high replacement costs ($40k+ each) and therefore must be detailed across all inspection types.



For the purpose of the Idwal inspection checklist, any cylinder liners worn beyond the maximum limit must be recorded. For any cylinder liners still within acceptable limits but worn close to the maximum wear, a comment can be inserted in the comments box at the end of the engine room section at the surveyor's discretion/if deemed necessary.

Please select '***Not available***' if the document was not provided.

Were all main engine safeties reported to be fully operational? (e.g., oil mist detectors, bearing temperature sensors, low lube oil pressure trip etc.)

This is to be asked to the engineering staff and proof of operability should be able to be provided upon request. These tests are often carried out monthly/quarterly.

Evidence of testing may be provided as a separate document, included as a routine PMS job or included in the safety routines folder (or a combination of all).

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A quick and easy test would be to request witnessing a test of the fuel leakage alarm.

Were the main engine turning gear and flywheel in good condition?

Carry out a visual inspection of the main engine turning gear and flywheel, recording any areas of damage, worn gear teeth, inadequate greasing/lubrication etc.

Witnessing the turning gear in operation is preferable but may be bound by operational constraints and terminal permission must often be sought by the vessel if alongside. Where this is not possible, engine crew should be asked if the turning gear is operational - proof of which should be available in the engine room logbook (or pre-departure checklist) from the date/time of last pre-departure.

Were the supplied main engine performance reports seen to be satisfactory?

The report(s) provided should be from tests conducted in the previous 3 months. If reports older than 3 months are provided, then this should be commented upon ('***No***' selected). Reasons such as lay-up, prolonged stays at anchorage or periods of extended slow steaming may restrict the vessel's ability to conduct effective performance monitoring. Any such reasons can also be commented upon in the report.

Ideally, the performance tests should be conducted at a load above 70% to be able to conduct an effective performance review.

However, consideration should be given where vessels have undergone Engine Power Limiter (EPL) / Shaft Power Limiter (ShaPoLi) installation. Updated software to incorporate the new maximum continuous rating (MCRlim) is often at an uneconomical and large expense to ship owner/operators and is therefore very rare to see.

Where EPL installation has been confirmed, we are more interested in ensuring exhaust temperatures, Pcomp and Pmax (amongst other clear parameters) are within expected limits and allowable deviations.

Where the vessel is not fitted with an EPL, a comment should be made if the performance test was conducted below 70% load.

Regardless of circumstance, any abnormally high/low exhaust gas/pressure readings (or large deviations from the mean) should be commented upon.

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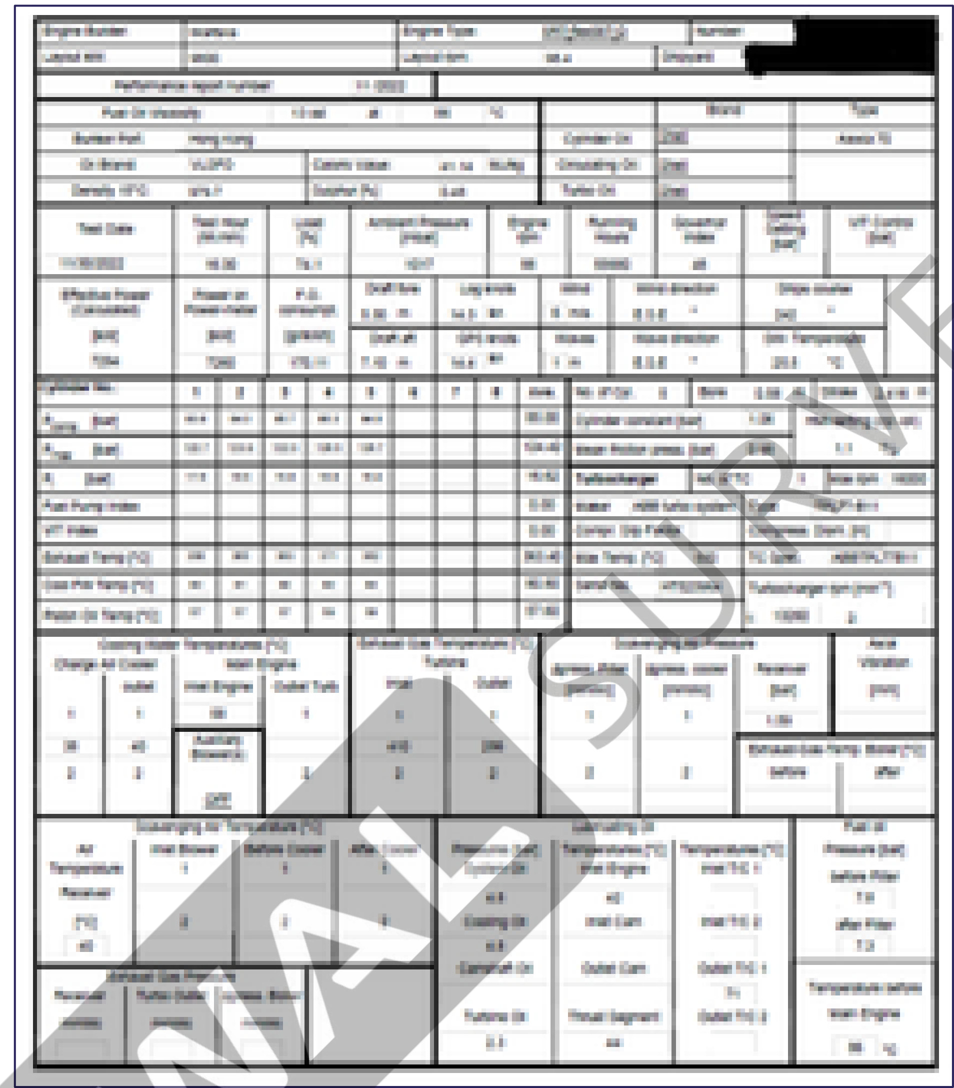
Please select '***Not available***' if the document was not provided.



In the above example, you can see that the engine load was 74.1% (in this case it was confirmed not fitted with an EPL), above the Idwal minimum requirement of 70%.

The compression pressures (Pcomp) have been recorded for each cylinder and can be compared to the average; there is an approximate 1-2% deviation from the average for each cylinder. If there is a deviation of more than 10%, this should be recorded in the report, as it could indicate potential problems with the engine, such as damaged piston rings or worn cylinder liners.

The maximum/peak pressures (Pmax) have also been recorded which also show an approximate 1-2% deviation from the average. If there is a deviation of more than 10% this should be recorded in the report as, again, this could be an indicator of potential defects with liners, pistons or fuel injection equipment.

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The exhaust temperatures should also be assessed and should not exceed a deviation of +/- 50°C from average. Reference to sea trial results can be made to ascertain in what range the exhaust temperatures should be expected to be in however, for a slow-speed 2 stroke engine, they would normally be anticipated to be in the region of 350°C.

Main Engine Maintenance (Operational Data Section)

Preferably, all quoted component running hours and overhaul intervals should be obtained from the vessels PMS. Excel format 'tracking' sheets should ideally only be used to confirm/verify PMS running hours. It should be also confirmed that the supplied running hours are up to date (normally provided from the end of the previous month).

Note: If 'cylinder covers' are not listed then use exhaust valve figures (the term cylinder cover may not be used for a 2-stroke engine).

Instead of scheduled service intervals, some vessels use a Condition Based Monitoring (CBM) maintenance strategy. CBM is a maintenance strategy that monitors the real-time condition of machinery and equipment to determine what maintenance needs to be performed. Unlike service intervals that are scheduled by a certain time period or by how many running hours the machinery has completed, CBM dictates that maintenance should only be carried out when real-time indicators show irregularities or signs of decreasing performance. For example, vibration analysis can be used to detect fluctuations in vibration levels that may indicate wear of components, improper calibration or potential damage.

Please ensure to verify if the Main Engine(s) and/or Auxiliary Engines components are subject to CBM or not. This can be verified onboard by:

- Confirming with the crew – by asking the engine room crew, it may be able to be confirmed what machinery and equipment is subject to CBM onboard.
- Is it noted in the Pre-Inspection Details (PID)? – the crew may have recorded in the Pre-Inspection Details that the main engine(s) and/or the auxiliary engines may be subject to CBM; this, however, should be verified onboard.
- Is it recorded on the provided copy of the onboard running hour documentation? – sometimes, it will be recorded on the provided running hour documentation that some components and machinery are subject to CBM; this may be a quick way to confirm.
- Ask to see maintenance records and/or the PMS for the machinery that is suspected to be on CBM – these may or may not be able to confirm if the machinery is on CBM.
- Ask to see evidence of Continuous Survey Records (CSR) – these can be signed off by Class or the Chief Engineer and may indicate if any machinery and components are subject to CBM.

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Please ensure to compare the running hours in the Pre-Inspection Details to the provided copies of the onboard running hour documentation, as sometimes there can be discrepancies. The provided copy of the onboard running hours usually lists most of, if not all, components of the engine(s) and may indicate overdue maintenance that has not been included on the Pre-Inspection Details. It is therefore preferred that any hours input to the PDF checklist are verified onboard and regurgitated from the PID.

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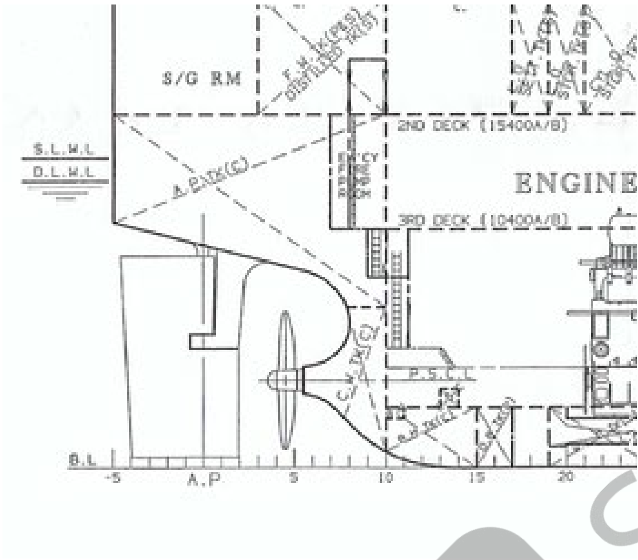
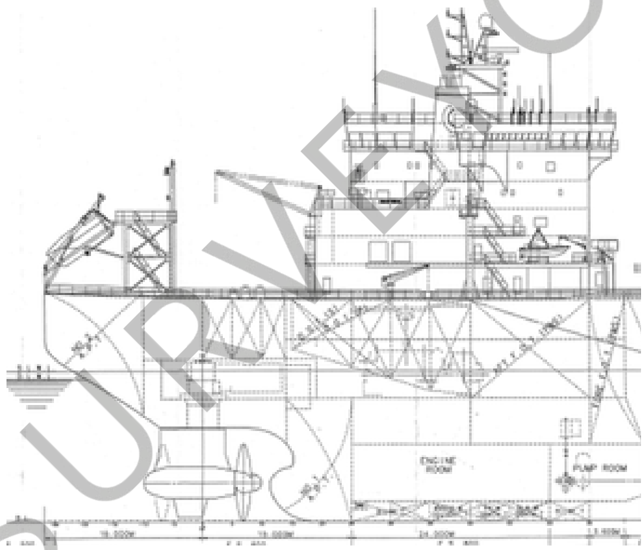
What type of propulsion does the vessel have?

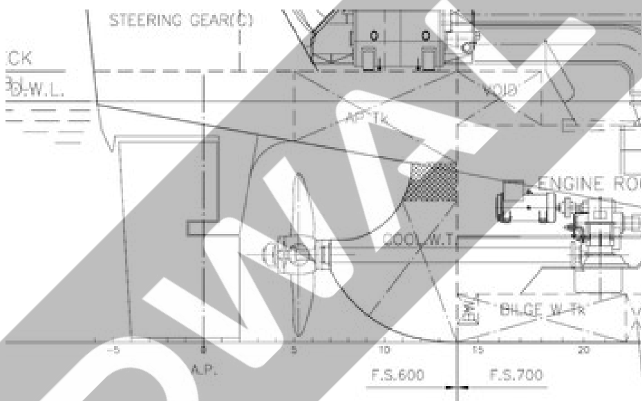
Determine the type of main propulsion system the vessel has. This can be done by checking the supplied GA Plan, Vessel Particulars or by confirming with vessel staff. Common examples are shown below.



Conventional ‘fixed pitch’ arrangement



Azipod propulsion



Controllable Pitch Propellor

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Were the Propulsion systems, including shafts, gearing and electric motors, if relevant, in good working condition?

If the vessel is underway at the time of inspection, this can be ascertained by visual inspection of the following (list is not exhaustive):

- Shaft
- Stern Tube sealing arrangements
- Intermediate Shaft Bearing(s) including oil level
- Gearbox (if fitted)

The absence of any abnormal noise, smell or vibration should also be confirmed.

If the vessel is not underway at the time of inspection, this should be obtained by discussion with the Engineering Officers on board. A visual inspection should still also be carried out. It will likely be obvious if there are issues with the propulsion systems.

What type of thruster systems does the vessel have?

Does the vessel have a Bow Thruster, Stern Thruster or both? This information can be confirmed from the General Arrangement Plan, Vessel Particulars or inspection of all required spaces onboard.

Were the thruster(s) in good working condition?

If the unit(s) is not seen in operation, then this can be confirmed through discussion with the Engineering Officers on board. It will likely be obvious if there are issues with the propulsion systems.

It is important to note that we often see de-commissioned thrusters onboard inspected vessels, of which documentary evidence should be able to be provided (often a letter from Class or recorded in the supplied Class Status Report as a Memo).

Do not confuse an out-of-order thruster with a de-commissioned one - clarification should be sought onboard. An out-of-order thruster should normally be recorded as a Condition of Class with a due date (not only a Memo).

In what condition was the thruster(s)?

Answering this question negatively (Fair or Poor) is applicable in cases where the Thruster(s) is operational, but defects are present. Surveyor discretion and experience should be exercised in determining between Fair and Poor, considering the volume, nature and severity of the identified deficiencies.

These include but are not limited to the following:

- Lube oil leakages
- Water leakages
- Exposed electrical connections
- Damaged electrical motor
- Any other defects detailed in any supplied documentation or reported by crew (broken/missing blades etc.)

If the unit is seen in operation, then noise, smell and vibration should also be assessed with any abnormal findings recorded under this question.

How many Auxiliary Engines does the vessel have?

This can be confirmed through visual inspection, communication with crew and as stated on the International Air Pollution Prevention Certificate (IAPP) supplement. The emergency generator should not be included in the total figure.

Were the auxiliary engines in good working condition?

What this question is essentially asking is, can the auxiliary engines be started, stopped and operated at full design load. Any non-operational engines or engines only capable of low-load operation should be recorded here. Any other abnormal running conditions can also be detailed under this question.

If any auxiliary engine is not seen in operation, then this should be ascertained by asking the Chief Engineer and engine room crew. Evidence of satisfactory operation should be available in the engine room logbook if falsified statements are suspected.

If any auxiliary engine is undergoing overhaul at the time of inspection, '***No***' can be selected but please describe in detail the extent of works being undertaken and the reasons for those works (routine planned maintenance, unplanned maintenance because of breakdown etc).

Please note that some defects such as leakages may not necessarily impede the operational capability of the auxiliary engines and should be recorded under the next question 'In what condition were the Auxiliary Engines?'

In what condition were the Auxiliary Engines?

Answering this question negatively (Fair or Poor) is applicable in cases where the Auxiliary Engine(s) is operational, but defects are present. Defects associated to the attached alternator should also be considered. Surveyor discretion and experience should be exercised in determining between Fair and Poor, considering the volume, nature and severity of the identified deficiencies.

Common deficiencies include:

- Fuel oil leaks (normally on/around high-pressure fuel pumps and piping with particular attention to be paid inside the 'hot box' area)
- Lube oil leaks (normally seen around filters, pumps and the crankcase seal at the flywheel end)
- Exhaust gas and charge air leaks (normally seen/heard around exhaust manifold flanges, air intake manifold flanges and turbocharger casings)
- Compressed air leaks (normally seen/heard around the starting air motor and associated fittings and pipework)
- Cooling water leaks (normally seen around engine driven cooling pumps and associated pipework and valves)
- Signs of significant historic staining seen around the engine entablature (typically sighted near fuel oil filters)
- Damaged/missing pressure/temperature gauges
- Evidence of abnormal noise/vibration during running
- Cracks sighted around the engine casing
- Exposed/damaged sensors and electrical connections
- Low sump oil level (when dipped using the dip stick)
- Low shaft bearing oil level (as per the sight glass)
- Heavily fouled alternator air intake filter cloth (if air cooled)

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- Any other defects detailed in any supplied documentation or reported by crew

Were all auxiliary engine safeties reported to be fully operational? (low lube oil pressure, overspeed, high HT temperature etc.)

This is to be asked to the engineering staff and proof of operability should be able to be provided upon request. These tests are often carried out monthly/quarterly.

Evidence of testing may be provided as a separate document, included as a routine PMS job or included in the safety routines folder (or a combination of all).

A quick and easy test would be to request witnessing a test of the fuel leakage alarm.

Were the supplied auxiliary engine performance reports seen to be satisfactory?

The report(s) provided should be from tests conducted in the previous 3 months. If reports older than 3 months are provided, then this should be commented upon ('***No***' selected). They should also be conducted at a load above 70% in order to be able to conduct an effective performance review. If the load is below 70% this should be commented on.

Again, similarly to the main engine, particular attention should be paid to compression pressures, maximum (firing) pressures and exhaust temperatures and subsequent unit deviations.

To note, for older and smaller model auxiliary engines detailed performance testing may not be possible due to the absence of required fittings. This should be confirmed onboard if suspected/reported to be the case.

Please select '***Not available***' if the document was not provided (inclusive of the above when performance testing is not carried out due to engine model).

Auxiliary Engine Maintenance (Operational Data Section)

Preferably, all quoted component running hours and overhaul intervals should be obtained from the vessels PMS. Excel format 'tracking' sheets (example below) should ideally only be used to confirm/verify PMS running hours. It should be also confirmed that the supplied running hours are up to date (normally provided from the end of the previous month).

MONTHLY MACHINERY RUNNING HOURS REPORT

VESSEL NAME: ____________ CHIEF ENGINEER: ____________ Month (Month/Year): ____________

MAIN ENGINE		NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	Routines
M/E Unit Overhauls	Date Last Done	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23			18000
	Running Hrs When Done	0	0	0	0	0	0			
	Run Hrs Since Last O'Haul	2507	2507	2507	2507	2507	2507			
Exhaust Valve	Date Last Done	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23			18000
	Running Hrs When Done	0	0	0	0	0	0			
	Run Hrs Since Last O'Haul	2507	2507	2507	2507	2507	2507			
Air Start Valves Overhauled	Date Last Done	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23			12000
	Running Hrs When Done	0	0	0	0	0	0			
	Run Hrs Since Last O'Haul	2507	2507	2507	2507	2507	2507			
Fuel Pump O'Haul / Timing	Date Last Done	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23			18000
	Running Hrs When Done	0	0	0	0	0	0			
	Run Hrs Since Last O'Haul	2507	2507	2507	2507	2507	2507			
Fuel Valves O'Haul	Date Last Done	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23	25-May-23			12000
	Running Hrs When Done	0	0	0	0	0	0			
	Run Hrs Since Last O'Haul	2507	2507	2507	2507	2507	2507			
Scav Manifold/ U/Piston Cleaning / Insp	Done Date	22-Sep-23								Monthly
Date - Running Gear Inspected		22-Sep-23								Monthly
Date - Crankshaft Deflection Checked/Recorded		25-May-23								6 Monthly
Date - Bearing Clearances Checked/Recorded		25-May-23								6 Monthly

M/E Turbor Charger / Air Cooler	NO. 1			NO. 2			NO. 3		
	Date Last Done	*Run Hrs When Done*	*Run Hrs Since Last O'Haul*	*Date Last Done*	*Run Hrs When Done*	*Run Hrs Since Last O'Haul*	*Date Last Done*	*Run Hrs When Done*	*Run Hrs Since Last O'Haul*
Date - Run Hrs Complete Overhaul - 36000 Hrs	25-May-23	0	2507						
Date - Run Hrs Renewal - Bearings/Sleeves - 36000 Hrs	25-May-23	0	2507						
Date - Run Hrs Air Coolers Chemical Cleaned - 3 Monthly	25-May-23	0	2507						

AUXILIARY ENGINES	NO. 1			NO. 2			NO. 3		
	Date Last Done	*Run Hrs When Done*	*Run Hrs Since Last O'Haul*	*Date Last Done*	*Run Hrs When Done*	*Run Hrs Since Last O'Haul*	*Date Last Done*	*Run Hrs When Done*	*Run Hrs Since Last O'Haul*
Date - Run Hrs Last De Carbonised - 12000 Hrs	25-May-23	0	1753	25-May-23	0	2242	25-May-23	0	1512
Date - Run Hrs Cyl Heads O'Hauled - 6000 Hrs	25-May-23	0	1753	25-May-23	0	2242	25-May-23	0	1512

Does the vessel have a shaft generator?

A shaft generator is driven from the main engine, often via a reduction gearbox. This can be identified on the General Arrangement Plan and by visual inspection. It should also be mentioned in the vessels EEDI/EEXI technical file and Vessel Particulars.

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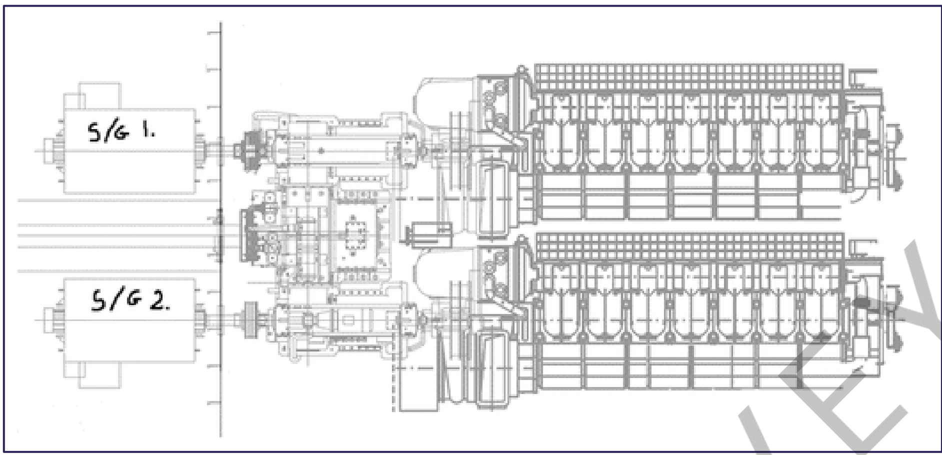

GA plan extract showing shaft generator set up

Shaft generator installation on board

Was the shaft generator unit fully operational and in good condition?

What this question is essentially asking is, can the shaft generator be started, stopped and operated at full design load. Any symptoms or reports of non-operability and/or only low-load operation should be recorded here. Any other abnormal running conditions can also be detailed under this question.

Unlike the formatting/layout of other questions in our new engine room section, this question also requires the assessment of the shaft generator condition. In short, if the shaft generator is inoperable <u>or</u> in Fair/Poor condition, please select '***No***' and provide your supporting reasoning.

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Common deficiencies include:

- Low shaft bearing oil level (as per the sight glass)
- Heavily fouled air intake filter cloth (if air cooled)
- Blistering paint as a result of overheating
- Unusual active alarms present
- Any other defects detailed in any supplied documentation or reported by crew

Does the vessel have a shaft motor (Power Take-In)?

This is converse to a Shaft Generator (Power Take-Out mode) and is a system whereby stored electrical power can be fed back to the propulsion plant, therefore boosting the output power. Any such system is normally detailed in the vessels EEDI/EEXI Technical file.

In PTI mode, the shaft generator acts as a synchronous motor, using electrical power from the ship's auxiliary diesel generators. It can also be used as emergency backup machinery to propel the ship to the nearest shore if the main engine goes out of operation, thereby increasing redundancy. This mode is also known as shaft motor mode.

The shaft motor doesn't need to be able to start itself because it's usually already spinning as an alternator before switching to motor mode.

Does the vessel have an Auxiliary Boiler?

This is a yes or no question - most ocean-going vessels have one or more auxiliary boiler fitted for the purpose of providing a heating medium for essential onboard systems such as fuel oil treatment, cargo heating and accommodation temperature regulation.

What type of boiler is fitted?

Steam Boiler

A steam boiler is a steel pressure vessel in which water under pressure is converted into steam by the application of heat resulting from combustion (normally diesel oil or fuel oil). These are easily identifiable, normally in a vertical orientation with the presence of water gauge glasses and a main steam valve (amongst many other distinguishing features). There are two main types of steam boiler:

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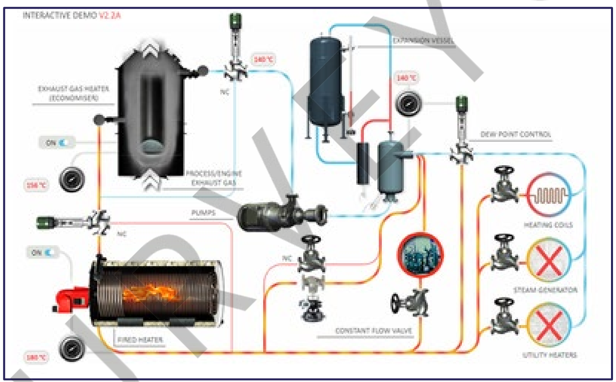
Steam Boiler Type	Description	Example
Water tube	The most common type of steam boiler. This is self-explanatory in name whereby the internal tubes are filled with water and the combustion chamber (furnace) is heated by a diesel oil/fuel oil burner. The subsequent heat is transferred into the water (via heat transfer across the tube surfaces), eventually turning the water into steam.	
Fire / Flame tube	This type of boiler operates conversely to a water tube boiler whereby the internal components are essentially reversed (fire inside the tubes, water outside the tubes).	

Thermal Oil Boiler

Thermal oil boilers are typically seen on smaller commercial vessels and passenger ships. They themselves are normally of a smaller stature to that of a steam boiler of comparable capacity due to increased efficiency and are often mounted horizontally (as opposed to the typical vertical mounting of a steam boiler). They also have the added benefit of longer expected lifespan due to the significant reduction in corrosion associated problems often found in steam boilers.

The thermal oil boiler burns diesel oil or fuel oil to heat the thermal oil to a given temperature. This heated oil is then circulated around the system by circulating pump(s), passing through heat exchangers to provide heating for essential systems. Due to the process of heat transfer, the thermal oil cools down so are then recirculated back to the thermal oil boiler for the process to restart.

Similarly to a steam boiler, these systems are often also benefitted with the option of circulating the thermal oil through an economiser (when the main engine is in operation) to improve vessel efficiency.



Was the boiler(s) in good working condition?

Can the boiler(s) be started, stopped and operated in fully automatic mode and/or as designed. Any symptoms or reports of inoperability, low load running or other abnormal running conditions (manual/emergency mode operation, failure of automation etc.) should be detailed under this question.

If the boiler(s) is not seen in operation, then this should be ascertained by asking the Chief Engineer and engine room crew. Evidence of satisfactory operation should be available in the engine room logbook if falsified statements are suspected.

If any boiler is undergoing overhaul at the time of inspection, '***No***' can be selected but please describe in detail the extent of works being undertaken and the reasons for those works (routine planned maintenance, unplanned maintenance because of breakdown etc).

Please note that some defects such as leakages may not necessarily impede the operational capability of the boiler(s) and should be recorded under the next question 'In what condition was the boiler(s)?'

In what condition was the boiler(s)?

Answering this question negatively (Fair or Poor) is applicable in cases where the boiler(s) is operational, but defects are present. Surveyor discretion and experience should be exercised in determining between Fair and Poor, considering the volume, nature and severity of the identified deficiencies.

Common deficiencies include:

- Steam/condensate leakages (from valve glands, piping flanges or expansion joints)
- Water leakages (from gauges glasses)
- Fuel oil leakages (from burner piping/connections)
- Exhaust gas leakages or soot staining (normally seen around bellows and inspection/manhole covers)
- Unusual active alarms present
- Crew reporting that any safeties (e.g. low-low water level, high-high steam pressure shutdowns) are out of order

Were boiler safety valves in satisfactory condition?

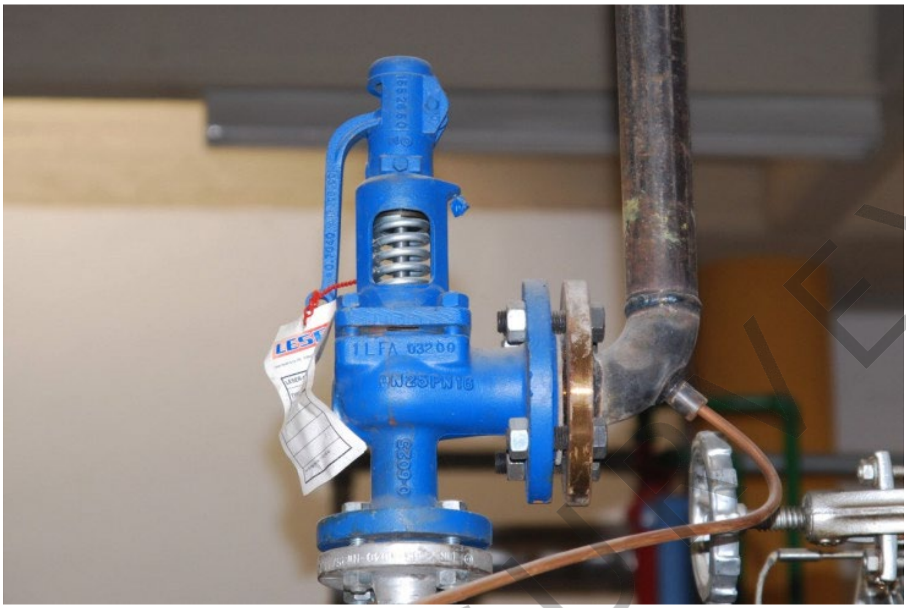
Each boiler should have more than one safety valve installed (for emergency release of any inadvertent excess steam pressure build up).

Valves should also be tagged with their calibration date and set operating pressure (although common practice is often for this to be posted somewhere on the ECR operating panel).

Particular attention should be paid for:

- Signs of inoperability
- No proof of calibration or testing available onboard
- Set operating pressures are not posted or known by crew
- Excess corrosion or signs of damage
- Steam/condensate leakages from glands and flanges
- Valve passing - escape piping should not be excessively hot to the touch (take extra care if checking)
- Condition of drain line (ensuring absence of plugging and tampering)

- Presence and condition of easing gear (wire and pulley arrangement for remote manual opening/testing of the valve - this should be connected to the operating lever)



Was it reported that any boiler tubes had been plugged? (including Economiser/EGB)

Boiler tubes can be plugged for several reasons including damage or leakage. Permanent repairs/replacement of the tube will likely be required in future; therefore, it is essential that any plugged tubes are adequately documented and known by crew.

The plugging of boiler tubes leads to reduced heat generating capacity and efficiency of the boiler. The more tubes plugged, the greater the adverse effect.

The presence of plugged tubes can be ascertained by asking the engineering officers and upon review of the vessels PMS. Notices are also sometimes posted local to the boiler.

Was the Hot Well/Cascade Tank seen to be in good order and free from contaminants?

Common deficiencies include:

- Oil seen in the observation glass (normally a result of leaking heating coils or heat exchangers). Please note that a very thin film/sheen is normally acceptable
- Inspection lamp out of order/unlit
- Notable corrosion/damage to the tank casing/insulation
- Notable corrosion and/or leakages from the attached atmospheric condenser (if fitted)
- Reports of plugged atmospheric condenser cooling water tubes (relatively common on sea water cooled condensers)

- Low temperature - the tank should typically be maintained at 85-95 degrees C. Below 85 degrees will encourage excess oxygen build-up in the boiler water, leading to accelerated corrosion of boiler components (however if cargo tank heating/deck steam is in use at the time of inspection the temperature will be lower - this should still be recorded and detailed). Above 95 degrees causes bubbling of the water which can lead to cavitation in the feed pumps, along with excess water consumption through steam losses via the tank vent
- Low or high-water level and/or poor condition of the level gauge glass
- Auto-filling system not operational (if fitted)
- Out of order alarms (e.g. high/low level, oil in water etc)

Were any abnormal findings observed on the supplied boiler and cooling water analysis reports?

Ensure the supplied reports are from reputable providers (with the likes of Drew Marine and Unitor probably being the most commonly seen) and free from any obvious tampering or modifications.

Most tests should be completed and recorded daily (with some others conducted weekly). Results are recorded either via computer software or excel sheet (with the same input in the engine room logbook). The completed reports are submitted to the analysis provider at the end of each month, with their observations/recommendations then received back normally by the middle of the following month. The returned reports are normally in PDF format - it is these provider reports that we are most interested in.

To note - in cases where the vessel is fitted with a thermal oil boiler, boiler water analysis results are not applicable (thermal oil analysis should be included in the provided lube oil analysis reports).

Please select '***Not available***' if the document(s) was not provided.

Boiler Water

Normally conducted daily. Common tests include:

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Test Methodology	Explanation
Chloride	Essentially a test for the presence of salt/sea water in the boiler system. This is very important as elevated chloride levels cause increased conductivity between the boiler metal and its water, which accelerates oxidation/corrosion. Chloride levels above 50 ppm may indicate that the boiler needs to be blown down. The maximum chloride level for low-medium pressure boilers is generally taken as 100 ppm. Sudden/repeated increases of chlorides may suggest a leaking sea water cooled steam condenser or issues with the Fresh Water Generator (which provides the boiler feedwater system). Where high chlorides are present, increased blowdown frequency is advised, and the source of chloride ingress identified and rectified promptly.
Hydrazine	An oxygen scavenging chemical, often referred to by its trade name 'Amerzine.' This test confirms adequate levels of the chemical in the system, necessary for the control of oxygen content to minimise corrosion rates. This should typically be in the range of 0.03-0.10ppm for low-medium pressure boilers but does depend on the characteristics of the specific system. When results are indicated as too high/low, hydrazine dosage should be adjusted accordingly.
Hydrate Alkalinity	Boiler water should be maintained in an alkaline state to avoid any issues with accelerated wear because of acidic attack. The recommended pH level is between 9.0 and 10.5. However, hydrate alkalinity is measured in parts per million (ppm) and is an indicator that the pH level is correct, without also having to specifically test for pH. The presence of hydrate alkalinity in boiler water also ensures that any calcium hardness in the presence of phosphate, magnesium and silica will be in a form that is easily removed by blowdown. However, if levels are maintained too high, this can result in foaming and caustic corrosion of boiler steel. Values should typically be between 30-65ppm for low-medium pressure boilers but does depend on the characteristics of the specific system. Where results are indicated as too high/low, Drewplex AT (or equivalent) dosage should be adjusted accordingly.
Phosphate	Used in boiler water to prevent scale build-up and corrosion, and to buffer the water's pH. Phosphates react with calcium and magnesium in the boiler water to form a soft sludge that can be removed from the boiler by blowdowns. However, when the concentration of phosphate in the boiler water is too high, phosphate will react with boiler scale and can form a solid layer on the hot boiler tubes - reducing efficiency and leading to other issues. Values should typically be between 10-80ppm for low-medium pressure boilers but does depend on the characteristics of the specific system. Where results are indicated as too high/low, Drewplex AT (or equivalent) dosage should be adjusted accordingly.

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Test Methodology	Explanation
Neutralised Conductivity	This test is important as it is a direct measure of the total ionizable (dissolved) solids in the water. This gives an indication of the internal condition of the boiler tubes and highlights any symptoms of accelerated wear. High conductivity also causes foaming and increases the volume of the boiling water which produces low quality, 'wet' steam. This in turn increases the risk of water carry over in steam which can damage downstream equipment, especially turbines, if fitted. Values should typically be less than 800 microsiemens per centimetre for low-medium pressure boilers but does depend on the characteristics of the specific system. High conductivity can be controlled with increased frequency of top and bottom blowdowns.
Hardness	On most vessels, boiler feedwater is provided in the form of distilled water from the FWG via a Boiler Water Storage Tank. It is very important that when filling this tank, the mineralizer/re-hardening filter is bypassed. Hard water can cause limescale to build up on boiler tubes, which can lead to reduced efficiency, circulation issues, premature corrosion, overheating and eventual tube collapse/failure. The recommended hardness of boiler water is less than 1ppm (of calcium and magnesium). The maximum allowable hardness is usually around 3–5ppm but does depend on the characteristics of the specific system.

It is important to reiterate that the above values are generic examples only and acceptable limits may differ dependent upon the characteristics of the specific system. Any issues, observations or recommendations for a specific system are normally very clear on the supplied provider analysis report.

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Cooling Water (HT and LT)

Normally conducted weekly. Common tests include:

Test Methodology	Explanation
CWT Titrets	Determines cooling water treatment levels. Where results are indicated as too high/low, LiquidEWT (or equivalent nitrite-based, multi-functional corrosion inhibitor) dosage should be adjusted accordingly. The acceptable content range will be stated on the supplied reports, as this varies dependent upon the capacity of the specific system.
Chlorides (System and make up)	Similar to above, this gives an indication of potential sea water ingress to the cooling water system, possibly via a leaking central cooler or similar. Most engine manufacturers recommend a maximum of 50 parts per million (ppm) chlorides. The source of high chlorides should be identified and rectified promptly.
Make up Water Hardness	Any tanks used for topping up the LT/HT systems should be tested for hardness, again undesirable due to potential loss of cooling efficiency because of scale build-up. Hardness presence should be negligible but is sometimes bound by limitations of the test kit used (the result may read '<20ppm' as an example).

What was the condition of the following equipment?

Where equipment is fully operational and in good condition, ensure that both boxes ('Yes' and 'Good') are ticked.

Answering '***No***' is applicable where objective evidence of inoperability is provided - either in the form of visual defects, PMS records, sighted C/E defects list, declared in the Pre-Inspection Details or from crew reports. It is possible that an item is reported as out of order due to an internal/unsighted defect with no other deficiencies observed. In which case, it is acceptable to state 'No' and 'Good' as a combination. Where the machinery is not operational and also not in good condition for other reasons, '***No***' then '***Fair***' or '***Poor***' should be selected as a combination. Such defects can range from minor leakages/staining to significant visible damage or disassembly. Surveyor discretion and experience should be exercised in determining between Fair and Poor, taking into account the volume, nature and severity of the identified deficiencies.

Answering '***Yes***', followed by 'Fair' or 'Poor' is applicable in cases where the machinery/equipment is operational, but visual/reported defects are present. Such defects can range from minor leakages/staining to abnormal running conditions such as excessive vibration. Surveyor discretion and experience should be exercised in determining between Fair and Poor, taking into account the volume, nature and severity of the identified deficiencies.

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Where any machinery/equipment is not fitted onboard, please select '***N/A***.'

When any items have been answered negatively (No, Fair or Poor), all relevant details should be inserted in the comment box that appears below the table. This should include the nature of the defect(s), any plans for rectification as stated by the crew and the status/availability of the required spare parts.

What was the condition of the following equipment?

Equipment	Fully operational?		Condition		
Purifiers	☑ Yes	☐ No	☑ Good	☐ Fair	☐ Poor
Pumps	☑ Yes	☐ No	☑ Good	☐ Fair	☐ Poor
Coolers	☑ Yes	☐ No	☑ Good	☐ Fair	☐ Poor
Air compressors	☐ Yes	☑ No	☐ Good	☑ Fair	☐ Poor
Fresh Water Generator	☑ Yes	☐ No	☑ Good	☐ Fair	☐ Poor
Filters	☑ Yes	☐ No	☑ Good	☐ Fair	☐ Poor
Fans	☑ Yes	☐ No	☑ Good	☐ Fair	☐ Poor
Refrigeration Systems	☑ Yes	☐ No	☑ Good	☐ Fair	☐ Poor

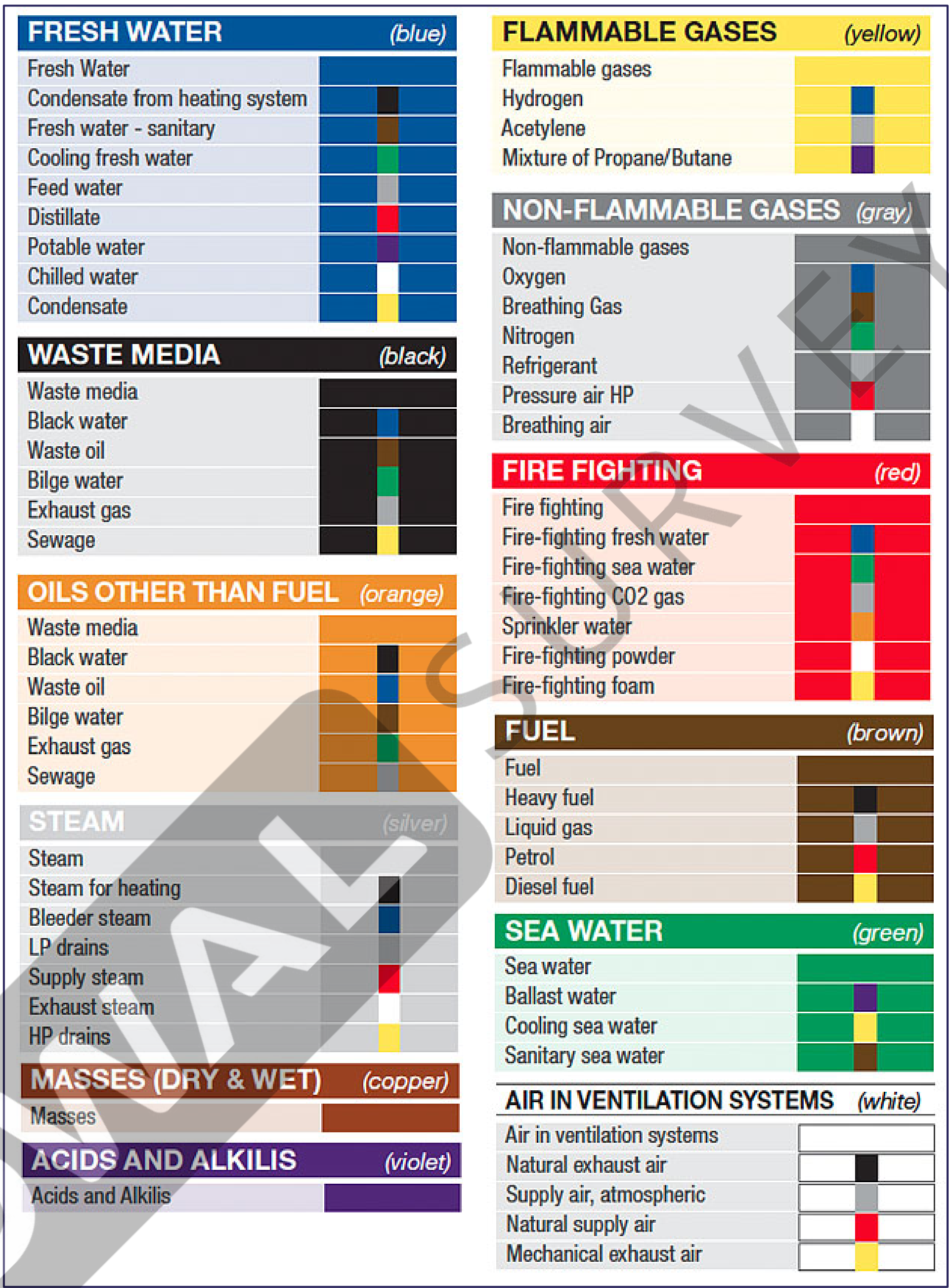
Why was 'No', 'Fair' or 'Poor' selected above?

Air Compressor No. 2 was reported to have been out of order due to a damaged HP pistion. The Chief Engineer advised that spares to rectify the fault were on order and due to be delivered to the vessel's next port of call. Air Compression No. 1 was reported to have been fully operational.

Was all Engine Room pipework free of significant corrosion?

Any areas of notable pipework corrosion should be listed here including the severity and type of corrosion observed as well as the location and associated system the pipework is part of. Affected valves can also be included.

The below may assist in determining the system(s) affected if unclear:



https://gb.creativesafetysupply.com/articles/guide-to-pipe-marking-standards/

Was all Engine Room pipework free of leakages?

Any clearly observed active leakages, evidence of leakages (staining, weeping) or instances of temporary containment/collection arrangements should be listed here including the severity, fluid type, location and associated system the pipework is part of. Affected valves can also be included. Further details should also be sought regarding any plans for repair.

Was all pipework free of temporary repairs including soft patches?

Any obvious or suspected temporary repairs or soft patches should be listed here, detailing the nature of the repair, location and associated system the pipework is part of. Affected valves can also be included. Temporary repairs are to be considered 'weak points' and should be closely monitored for further deterioration by vessel staff until permanent repairs are carried out.

Further details should also be sought such as:

- crews' awareness/knowledge of the temporary repair
- any plans for permanent repairs to be including the time frame, downtime of the plant etc.

Such repairs are most commonly seen on sections of sea water piping, mainly around the central coolers and FWG (if fitted). Surveyor discretion and experience should be exercised in determining whether or not the temporary repair is attributed to the associated pipework (record under this

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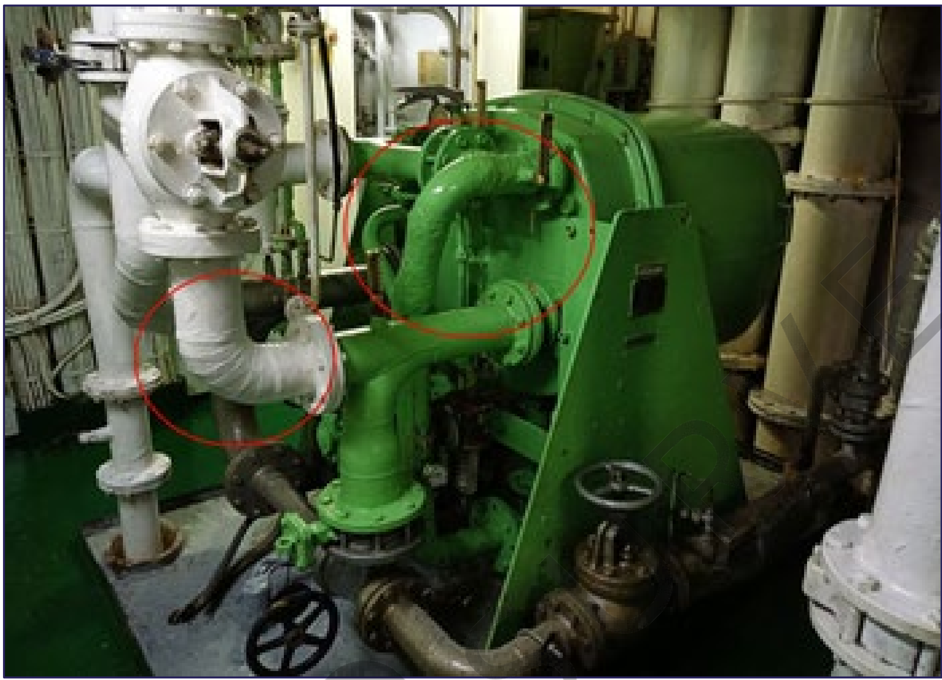
question) or a piece of auxiliary/ancillary equipment itself (in which case can be recorded under the 'What was the condition of the following equipment?' question).



What condition was pipework insulation lagging in?

Answering this question positively 'all clean and intact' is considered relatively rare and is intended for use on newbuild vessels and/or in exceptionally well-maintained engine rooms.

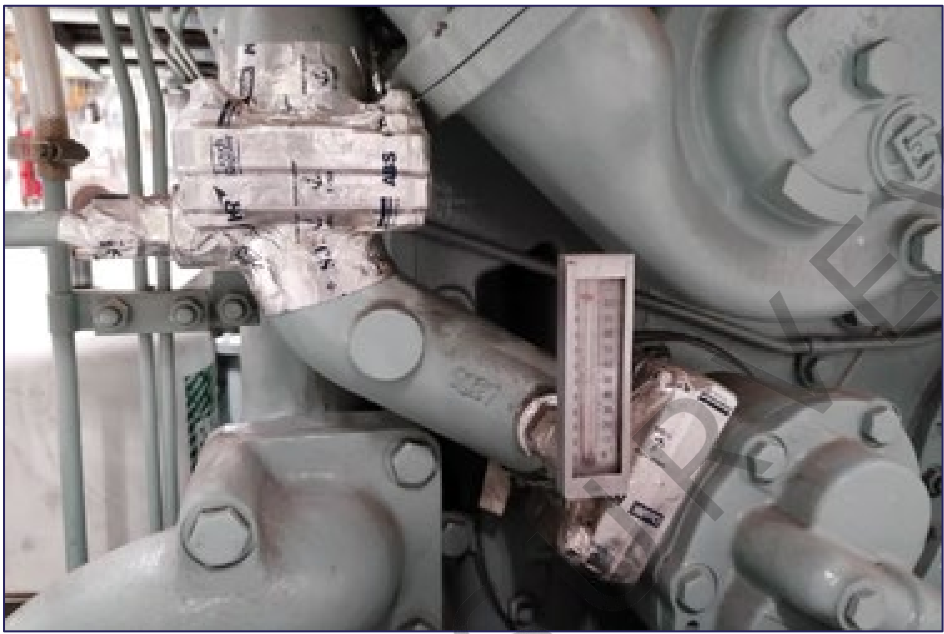
Answering this question negatively 'some areas of deterioration and staining' or 'severely deteriorated and dirty' is applicable in cases where sections of insulation lagging are worn, dirty or missing. Surveyor discretion and experience should be exercised in determining between the two, taking into account the volume, nature and severity of the identified deficiencies.

Photographic evidence showing examples should be taken and uploaded.

Was all anti-splash tape seen to be in place at the required Engine Room pipe connections?

Main Engine fuel pumps, fuel injectors and other associated fittings, connections and pipe flanges should be provided with anti-splash tape or clamp like insulation pieces. Various other fuel oil and lube oil systems in the engine room should also be provided. This is to reduce the possibility of fuel/oil jets causing injury or fire. Any areas of missing anti-splash tape should be recorded here.

Where they are fitted, they should be stain free, properly secured and in otherwise good visual condition.



Was the steering gear in good working condition?

What this question is essentially asking is, can the steering gear be operated throughout its full range of movement, within the allotted timeframe, and is it fully operational in all available operating modes (auto-pilot, manual, non-follow up, one pump, two pumps, emergency etc). Any major issues such as full inoperability or restricted operability (one pump out of order, failure of remote control etc) should be noted here.

Testing of the steering gear can be requested but may be bound by time and/or operational constraints. Terminal permission must often be sought by the vessel if alongside. If tested, any abnormalities such as excessive noise, smell or vibration should be recorded here. The operating times taken should also be monitored, with any discrepancies also recorded here.

If the steering gear is not seen in operation, then this should be ascertained by asking the Chief Engineer and engine room crew. Evidence of satisfactory operation and testing should be available in the form of engine room records such as the engine room logbook and pre arrival/departure checklists.

Please note that some defects such as leakages may not necessarily impede the operational capability of the steering gear and should be recorded under the next question 'Was the steering gear free of leakages?'

Was the steering gear free of leakages?

Steering gear are high-pressure hydraulic systems, with fine tolerances. As they are often located in a separate compartment, the oil gets cold when in port which can alter the viscosity of the oil as well as the clearances of the ram seals etc. Subsequently it is common to see small amounts of oil or weeping from areas such as ram seals which need not be recorded negatively.

However, if any leakages above and beyond these levels are observed they should be recorded here, with supporting photographic evidence provided.

Was the emergency steering communication equipment and gyro repeater working as required?

Crew can be asked to test the communication equipment in conjunction with the bridge team; there should be a sound powered telephone and/or talkback system fitted. The reading on the gyro repeater should be compared to the reading on the Bridge in order to ensure its accuracy.

Were emergency steering instructions posted nearby?

Emergency steering instructions should be clearly posted nearby in the working language of the ship.

Was the Engine workshop clean and tidy?

Ensure that all tools and equipment are stored correctly and properly secured. Housekeeping and general cleanliness should be of a generally good standard, taking into account any recent maintenance activities that may have been carried out. In cases where engine workshop housekeeping and/or cleanliness is found to be unsatisfactory at the time of inspection, further details can be provided in the Surveyor Comments box at the end of the Machinery and Machinery Spaces section.

Was all welding equipment including gas bottles, flame arrestors and associated fittings in good order and properly secured?

Please confirm the following:

- general condition and proper securing of cylinders
- identification and markings of cylinders (gas contained, full, empty etc)
- general condition of hoses, pipes and fittings (including satisfactory colour coding)
- condition of regulators and flame arrestors
- system isolated and lockers locked whilst in port
- presence of any other related deficiencies

Was the Engine Control Room clean and tidy?

Housekeeping and general cleanliness should be of a generally good standard with stores and documentation well sorted and readily accessible. Ensure furniture and outfitting's are in good order. Satisfactory hygiene standards should also be assessed. Areas behind switchboards should be clear and not used for storage.

Were all Engine Control Room automation and monitoring systems fully operational?

The following should be checked and any adverse findings recorded here:

- AMS screens (including any integrated functionality such as starting/stopping of machinery, opening/closing of remote valves etc)
- Main Engine telegraph

- All other ECR monitoring panels (Boiler, Main Engine MOP, revolution counter, shaft power meter, viscometer read-out, navigation/environmental repeater screen etc)
- ECR panel gauges
- ECR panel controls/buttons (start/stop of compressors, soot blowers, selector switches etc)
- Alarm and Log printers
- PCs

Was the Engine Control and Alarm system free of any serious active alarms?

The vessel crew should be asked to show you the list of active alarms. It is not unusual to see certain active alarms depending on the vessel's operational circumstances, however, the crew should be able to provide clear reasoning and rationale behind any such alarms.

Any abnormal, serious, suspect or unexplained (including unsatisfactory explanation) active alarms should be recorded here with photographic evidence also uploaded. The alarm history should also be checked for the past few days, again paying attention for anything considered abnormal or repetitive. Additionally, you can record any alarms of concern that were activated during your inspection.

Were any concerning Engine Room control system alarms seen to be manually blocked/disabled?

Here, we are concerned with instances where the vessel's crew have manually overridden the Alarm Monitoring System to prohibit the activation of certain alarms. Depending on the system installed, there are various terms used for this including blocked, disabled, off-scan, masked and isolated.

Care should be taken not to confuse this with alarms automatically blocked by the AMS when certain machinery is not in operation - this is often defined as 'Inhibit' or similar. Specific system terminology should be clarified on board.

Crew should be asked to see the list of manually masked/offscan alarms on the AMS panel. It is not unusual to see certain alarms masked/offscan depending on the vessel's operational circumstances, however crew should be able to provide clear reasoning and rationale behind any such masked/offscan alarms.

Any abnormal, serious, suspect or unexplained (including unsatisfactory explanation) masked/offscan alarms should be recorded here with photographic evidence also uploaded.

It is also standard practice that at the time of offscanning an alarm, Chief Engineer approval should be sought and relevant records kept - normally in the form of a booklet titled 'Request for change of parameter' or similar. This record, if kept, should also be checked to ensure consistency with the AMS. Any deficiencies with this can also be recorded here.

If the vessel has a UMS Class notation, does the machinery space operate in UMS mode?

The presence of UMS Class notation can be verified from the supplied Class certificate. Please select '***N/A***' if the vessel does not have a UMS Class notation.

Class Society	Notation
ABS – American Bureau of Shipping	ACCU
BV – Bureau Veritas	AUT-UMS
CSS – China Classification Society	AUT-0
DNV – Det Norske Veritas	AUT / E0
GL – Germanischer Lloyd	AUT / E0
IRS – Indian Register of Shipping	SYJ
KR – Korean Register	UMA
LR – Lloyds Register	UMS
Class NK – Nippon Kaiji Kyokai	M0
RINA – Registro Italiano Navale	AUT-UMS

If a vessel has UMS Class notation, this does not necessarily mean that the vessel operates in UMS mode. A vessel that has UMS Class notation but is manned at all times can be due to a variety of reasons; commonly due to company policy or other factors affecting the vessel, such as a defect that would render it unable to go into UMS mode (e.g. auxiliary boiler only able to be controlled manually). Regardless of reason, if a vessel has the notation but is not regularly being operated in this mode whilst at sea then this should be mentioned in the report. This can be ascertained by asking the crew onboard, specifically the engineering officers.

Suspension or removal of UMS notation is often sometimes detailed within an open Condition of Class or Class Memo. Details of this can also be recorded here.

Note: if an inspection is conducted with the vessel alongside, many vessels keep the engine room manned - this does not need to be mentioned. We are looking for extended/regular periods of manned operation at sea.

Were the engine room deadman and engineer call alarms found fully operational during testing?

Testing of the deadman and engineer call alarms should be requested - ensuring all audio and visual alarms are functioning.

Please note that the deadman system should be fitted with a pre-alarm, giving the crew members in the space time to reset the timer prior to the automation activating the full alarm. This pre-alarm normally consists of flashing lights in the Engine Room and an audio alarm in the ECR. This pre-alarm system should also be checked for satisfactory operation. '***Not able to test***' is to be selected when permission is not granted by the vessel or for any other applicable reason (time constraints etc.).

'***N/A***' is to be selected if the vessel is not fitted with such systems.

Were all package air conditioning units operational and in good condition? (e.g., ECR, Bridge, galley, electrical rooms)

All package air conditioning units around the vessel should be checked for satisfactory operation. Assessment of their condition should also be made, taking into consideration any abnormal noise or vibration, excess corrosion or leakages. Any deficiencies should be recorded here.

If any units are not in use at the time of inspection, crew should be asked to confirm their operational status. Assessment of their condition can still be made and commented upon.

Were all Electrical distribution systems in good working condition?

A good way to verify this is to ask the Engineering Officers if there are any faults with the electrical distribution system. Where operations permit, requesting the starting and paralleling of an extra generator is also a good indicator of full operability. Additionally, checking of the standby start function for redundant pumps can be used to assess satisfactory operation.

Pay particular attention for any warning notices, 'Out of Order' notices or breakers that have been locked and tagged out. These should be queried with crew if found. Any defects should be recorded here.

Were Main and Emergency Switchboard Insulation readings adequate?

This can be ascertained by checking the insulation meters for the main 230V and 440V panels and emergency 230V and 440V panels. Most earth faults we see onboard are caused by water ingress to external lights during adverse weather (which are fed by the 230V systems). Once the light has warmed up, the water normally evaporates and the fault clears. Naturally, 440V earth faults should be treated more seriously as they normally relate to electrical motors, some of which operate at high load, which can be dangerous to the machinery and personnel.

In both cases, prompt actions should be taken by crew to identify and rectify the source of any low insulation readings.

Please ensure to press the test button in order to check that the meter is functioning.

In a normal state without defects, the indicator will read 'infinity'; the symbol for which is ∞. The insulation meter will normally have a range that has been highlighted in red; when in this range, this will normally activate the relevant earth fault alarm.

As a quick and general rule, ideal insulation resistance readings should be more than 1 megaohm, although 1000 ohms per volt can also be used. Surveyor discretion and experience should be exercised in whether or not marginally low insulation readings are recorded in the report.

Were any abnormal findings observed as per the latest Megger Test reports?

A Megger test, also known as an insulation resistance (IR) test, is an electrical test that measures the condition of insulation in an electrical system. In simple terms, 'insulation' refers to the cable sheathing (a type of electrical insulator in which electric current does not flow freely - acting as a grounding barrier between conductive parts). A Megger, or insulation tester, applies a high voltage to the circuit and measures the amount of current that flows through the insulation. The test verifies the condition of the insulation, which can degrade over time due to environmental conditions like temperature, humidity, and moisture. It also helps determine if cables are suitable to perform a particular function.

A breakdown of insulation can lead to the following risks:

- Electric shock from exposed/unprotected wiring
- Fire as a result of overheating due to short circuiting
- Machinery/equipment damage, malfunction and shutdown

Therefore, Megger testing is often used as a preventative maintenance action to detect symptoms of insulation breakdown - and is completed on a routine/rotational basis onboard. Essentially, they are used to indicate the health of the electrical machinery onboard. Megger testing is also used when investigating the location/source of any low insulation alarms. Megger test reports may be provided as separate reports (with all motors/electrical equipment inventoried) or included in the vessels PMS.

These reports can be reviewed on board without the necessity for collection - however, where adverse findings are present, it is required that photographic evidence is provided. If deemed necessary, the reports can be collected for further review.

Adverse findings and observations are normally clearly detailed and displayed in the report, normally next to the relevant electrical equipment. As a quick and general rule, insulation resistance should be approximately one megohm for every 1,000 volts of operating voltage, with a minimum value of one megohm - however, ideally insulation readings should be as high as possible.

Were distribution and switchboard panels protected with approved rubber matting?

Approved rubber matting should be placed on the deck in front of all distribution and switchboard panels (this applies throughout the entire Engine Room - not only the ECR). Where any mats are missing, in poor condition or inadequately rated for their application, this should be answered negatively.

Was evidence of regular safety equipment testing available? (i.e., weekly, monthly, and quarterly tests of bilge alarms, dampers, emergency machinery etc.)

On most vessels we inspect, evidence of regular safety equipment testing is available in the form of a 'Safety Routines' folder or similar. This normally includes items such as bilge alarms, fire dampers, lifeboat, rescue boat, quick closing valves, emergency air compressor, engine and boiler alarms and trips etc. Tests are normally completed weekly, monthly and quarterly (depending on the equipment) and recorded in this folder. The same is often included in the vessels PMS (cross checking of records can be done if any abnormalities are found).

Where evidence of regular safety equipment testing is not provided, this should be recorded negatively. Additionally, where any records are missing or partially incomplete, this should also be recorded negatively. Photographic evidence should be provided in such cases.

Maintaining this file is a standard practice and is considered a routine inspection item in the industry and gives a good indication as to the safety culture onboard. This should be reviewed onboard and there is no necessity for collection.

Was the Emergency Generator tested during the inspection?

Testing of the emergency generator should be requested - but may be bound by operational constraints (time, terminal restriction etc). There should be at least two different methods to start the emergency generator (e.g. battery, spring, hydraulic etc) and it is recommended that both starting methods are tested.

Was the Emergency Generator in working order?

Can the emergency generator be started by all available means and used to supply the emergency switchboard with the rated/required power? Failure to start when tested should be recorded here. Any sighted or reported issues that impact the engines operation or any issues with low output power should also be recorded here.

If the emergency generator is not tested, then this should be ascertained by asking the Chief Engineer and engine room crew. Evidence of recent operation/testing should be available in the Safety Routines folder and/or PMS mentioned above.

Please note that some defects such as leakages may not necessarily impede the operational capability of the emergency generator and should be recorded under the question '*What was the condition of the Emergency Generator?*'

Were Emergency Generator Starting instructions clearly posted?

Starting instructions should be clearly posted nearby in the working language of the ship, detailing starting procedures by all available means and how to supply power to the emergency switchboard once the engine is running.

What was the condition of the Emergency Generator?

Answering this question negatively (Fair or Poor) is applicable in cases where the emergency generator is operational, but defects are present. Defects associated to the attached alternator should also be considered. Surveyor discretion and experience should be exercised in determining between Fair and Poor, taking into account the volume, nature and severity of the identified deficiencies.

Common deficiencies include:

- Fuel oil leaks (normally on/around fuel pumps, filters, valves and the fuel tank)
- Lube oil leaks (normally seen around filters and sump/crankcase covers)
- Exhaust gas and charge air leaks (normally seen/heard around exhaust manifold flanges, air intake manifold flanges and turbocharger casings)
- Coolant leaks (normally seen on/near the radiator)
- Signs of significant historic staining seen around the engine entablature (typically sighted near fuel oil and lube oil filters)
- Damaged/missing pressure/temperature gauges

- Parameters out-of-spec during running (speed, frequency, lube oil pressure, coolant temperature etc)
- Evidence of abnormal noise/vibration during running
- Cracks sighted around the engine casing
- Exposed/damaged sensors and electrical connections
- Low sump oil level (when dipped using the dip stick)
- Low battery charge level
- Low coolant level (normally sighted via the radiator header gauge)
- Heavily fouled alternator or turbocharger air intake filter cloth
- Any other defects detailed in any supplied documentation or reported by crew (e.g. overdue maintenance as per PMS or overdue oil/filter change - often written on/near the components)

Was the "18 hour" fuel level marked on the emergency generator fuel tank?

As per SOLAS Chapter II-1 Regulation 42 and 43, the emergency source of electrical power on cargo ships should be capable of running on load for 18 continuous hours and passenger ships for 36 continuous hours. The emergency source of power should therefore be provided with sufficient fuel for 18 or 36 hours of operation. The fuel oil supply tank should also be provided with a low-level alarm, arranged at a level ensuring sufficient fuel oil capacity for emergency consumers for the period of time as required by SOLAS.

The applicable marking should be clearly posted/stencilled on the tank.

What date was the EGCS last used?

This can be ascertained from crew statements, the monitoring system history and from Engine Room/EGCS logbook entries.

Were all critical EGCS parameters recorded daily in the Engine Room and/or EGCS logbook?

Any missing, incorrect or suspect entries should be recorded here. Critical parameters should be recorded daily when the system is use. These parameters include but are not limited to:

- output SO_2/CO_2
- scrubbing water pressure and temperature
- wash water pH
- wash water polycyclic aromatic hydrocarbons (PAH)
- wash water turbidity

Was the EGCS reported to be fully operational in all available operating modes (e.g., 0.5% and 0.1%)?

Without seeing the system in operation, it may be hard to accurately assess this. The most reliable way in determining full operational capability is by asking crew, and cross checking their statements against all necessary recorded parameters. Checking of the recent alarm history may also assist in your assessment.

Did the EGCS alarm log history show any concerning alarms?

As above, any concerning alarms may indicate operational issues with the plant. The most concerning alarms would typically be related to failure of the system or individual components (sensor failure alarms are commonly sighted), or prolonged periods of the system running out-with compliance (e.g. high SO_2/CO_2 readings).

Consideration/exception should be given to any active alarms associated with the system being shut down/not in use at the time of inspection.

In what condition were the major components such as pumps, fans, scrubber tower etc.?

Answering this question negatively (Fair or Poor) is applicable in cases where the system is operational, but defects are present. Surveyor discretion and experience should be exercised in determining between Fair and Poor, taking into account the volume, nature and severity of the identified deficiencies.

Common deficiencies include:

- notable corrosion of structure, fittings and components including pipework and tanks (residue tank, sludge tank etc)

- leakages from scrubber tower inspection/manhole covers
- leakages from pumps (scrubber pumps, sludge pumps, wash-water pumps etc)
- leakages from filters (automatic back-wash filter etc)
- pumps/fans running with abnormal noise/vibration
- compressed air leaks from solenoid valves
- any overdue maintenance/inspection as per PMS

In what condition was the overboard pipework?

Answering this question negatively (Fair or Poor) is applicable in cases where wear and tear of overboard EGCS pipework exceeds expected levels. Surveyor discretion and experience should be exercised in determining between Fair and Poor, taking into account the volume, nature and severity of the identified deficiencies.

Deficiencies would typically include significant corrosion, temporary repairs, leakages or physical damage. Affected valves can also be included.

Was any history of issues with the EGCS reported by crew or reported in the vessel's logbooks?

This should include a brief check of more historical records, extending further back in time. The vessels PMS and/or service technician attendance reports can also be consulted for more details. It should be made clear that this question is looking for notable or repetitive issues over time, not issues currently being experienced (any such issues should have been recorded under the applicable previous questions).

Were the EGCS remote control systems fully operational (e.g., valves, gauging etc.)?

Such systems are normally fitted with a significant amount of automation. This includes but is not limited to:

- changeover valves for exhaust gas flow (to atmosphere or to scrubber)
- inlet/outlet valves for scrubbing water (which normally close automatically when the system is stopped)
- variable speed drives for scrubber pumps (which adjust automatically based on the operating mode selected and output SO_2/CO_2 readings)

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Any deficiencies related to remote control and automation systems should be recorded here.

Were all sensors and alarms operational (e.g., SOx, PAH, temperature, and turbidity) including compliance monitor?

Similarly to as mentioned above, sensor failures are relatively common on these systems, but they are critical in ensuring the system is operating within compliance. Any reported or sighted issues should be recorded here. Where any deficiencies are found, plans for rectification should be requested from vessel crew.

The main compliance monitor (normally located in the ECR), along with all other remote repeater panels (commonly found in the steering gear room, funnel, scrubber room and bridge) should also be checked, ensuring full functionality (often touch screen) and with bright, legible displays.