

Summary Report for **BULK INDEPENDENCE [ 9374002 ]** dated **07-Oct-2023**

| Machine Name  | Oil Grade In Use | Oil Rating  | Action              | Rating |
|---|------------------|---|---------------------|--------|
| MAIN ENGINE<br>SULZER<br>6RT-flex50<br>SYSTEM (BEFORE PURIFIER) | NAVIGO 6 CO      | The oil is fit for further use provided the landed used oil sample is representative for the application. | No action required. |        |
| MAIN ENGINE<br>SULZER<br>6RT-flex50<br>SYSTEM (AFTER PURIFIER)  | NAVIGO 6 CO      | The oil is fit for further use provided the landed used oil sample is representative for the application. | No action required. |        |
| M/E L.O. SETTLING TANK<br>NOT APPLICABLE<br>N.A.<br>-           | NAVIGO 6 CO      | The oil is fit for further use provided the landed used oil sample is representative for the application. | No action required. |        |

Immediate Action Required

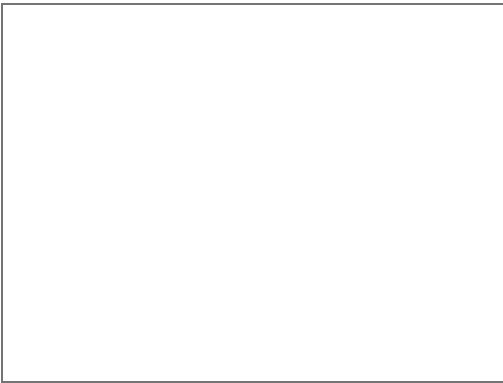
Can Continue

Normal

BULK INDEPENDENCE [9374002]

MAIN ENGINE DU-3708 [SYSTEM (BEFORE PURIFIER)]

|                                  |                     |                                    |                    |             |             |
|----------------------------------|---------------------|------------------------------------|--------------------|-------------|-------------|
| <b>Manufacturer</b> : SULZER     |                     | <b>Model</b> : 6RT-flex50          |                    |             |             |
| <b>Port Landed</b> : Netherlands |                     | <b>Volume[ltr]</b> :               |                    |             |             |
| <b>Fuel Grade / S%</b> :         |                     | <b>Dispatched</b> : 02-Oct-23      |                    |             |             |
| <b>Recommended</b> : NAVIGO 6 CO |                     | <b>Received</b> : 05-Oct-23        |                    |             |             |
|                                  |                     | <b>Sample Details</b>              | <b>1 (Current)</b> | <b>2</b>    | <b>3</b>    |
|                                  |                     | Rating                             | Normal             | Critical    | Caution     |
|                                  |                     | Sample No                          | 23098207           | 23085384    | 23064027    |
|                                  |                     | Bottle No                          | 50333164           | 50252623    | 70004909    |
|                                  |                     | Sampled Date                       | 26-Sep-23          | 21-Aug-23   | 07-Jun-23   |
|                                  |                     | Oil Grade In Use                   | NAVIGO 6 CO        | NAVIGO 6 CO | NAVIGO 6 CO |
|                                  |                     | Unit Service Hrs                   | 75148              | Not Stated  | 74181       |
|                                  |                     | Oil Service Hrs                    | Not Stated         | Not Stated  | Not Stated  |
|                                  |                     | Daily Makeup[ltr]                  | Not Stated         | Not Stated  | Not Stated  |
| <b>New Oil</b>                   | <b>Alert Value.</b> | <b>Analysis</b>                    |                    |             |             |
| 100                              | <85 or>150          | Appearance                         | Clear              | Dark        | Dark        |
| 11.5                             |                     | KV@40°C[mm²/s]                     | 112.5              | 122.5       | 124.1       |
| 6                                |                     | KV@100°C[mm²/s]                    | 12.35              | 12.42       | 12.78       |
|                                  | >15                 | BN[mgKOH/g]                        | 8.8                | 12.3        | 12.9        |
|                                  | <180                | Flash Point[°C]                    | >200               | >200        | >200        |
|                                  | >1                  | Soot/Insoluble[%wt]                | 0.10               | 0.20        | 0.20        |
|                                  | >0.3                | Water[%wt]                         | 0.12               | 0.50        | 0.06        |
|                                  |                     | PQ Index/2ml                       | <10                | <10         | <10         |
|                                  |                     | <b>Wear Elemental [ppm]</b>        |                    |             |             |
|                                  | >100                | Aluminium (Al)                     | 1                  | 3           | 2           |
|                                  | >50                 | Chromium (Cr)                      | <1                 | <1          | <1          |
|                                  | >100                | Copper (Cu)                        | 3                  | 4           | 5           |
|                                  | >200                | Iron (Fe)                          | 5                  | 14          | 16          |
|                                  | >100                | Lead (Pb)                          | <1                 | <1          | <1          |
|                                  | >100                | Tin (Sn)                           | <1                 | 1           | <1          |
|                                  |                     | <b>Contaminant Elemental [ppm]</b> |                    |             |             |
|                                  |                     | Boron (B)                          | 3                  | 10          | 7           |
|                                  | >250                | Sodium (Na)                        | 5                  | 8           | 8           |
|                                  | >100                | Silicon (Si)                       | 6                  | 5           | 6           |
|                                  |                     | Molybdenum (Mo)                    | <1                 | 1           | <1          |
|                                  |                     | Nickel (Ni)                        | 1                  | 3           | 4           |
|                                  |                     | Silver (Ag)                        | <1                 | <1          | <1          |
|                                  |                     | Vanadium (V)                       | 1                  | 3           | 4           |
|                                  |                     | <b>Additive Elements [ppm]</b>     |                    |             |             |
|                                  |                     | Calcium (Ca)                       | 3415               | 4944        | 5313        |



**Oil Rating:**  
The oil is fit 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:**  
No action required.

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

Dated: 07-Oct-2023

# BULK INDEPENDENCE [9374002]

## MAIN ENGINE DU-3708 [SYSTEM (AFTER PURIFIER)]

|                                  |  |                               |  |
|----------------------------------|--|-------------------------------|--|
| <b>Manufacturer</b> : SULZER     |  | <b>Model</b> : 6RT-flex50     |  |
| <b>Port Landed</b> : Netherlands |  | <b>Volume[ltr]</b> :          |  |
| <b>Fuel Grade / S%</b> :         |  | <b>Dispatched</b> : 02-Oct-23 |  |
| <b>Recommended</b> : NAVIGO 6 CO |  | <b>Received</b> : 05-Oct-23   |  |

| Sample Details    |  | 1 (Current) | 2           | 3           |
|-------------------|--|-------------|-------------|-------------|
| Rating            |  | Normal      | Critical    | Caution     |
| Sample No         |  | 23098208    | 23085385    | 23064028    |
| Bottle No         |  | 50333165    | 50252622    | 70004908    |
| Sampled Date      |  | 26-Sep-23   | 21-Aug-23   | 07-Jun-23   |
| Oil Grade In Use  |  | NAVIGO 6 CO | NAVIGO 6 CO | NAVIGO 6 CO |
| Unit Service Hrs  |  | 75148       | Not Stated  | 74181       |
| Oil Service Hrs   |  | Not Stated  | Not Stated  | Not Stated  |
| Daily Makeup[ltr] |  | Not Stated  | Not Stated  | Not Stated  |

| New Oil | Alert Value. | Analysis            |       |       |
|---------|--------------|---------------------|-------|-------|
| 100     | <85 or>150   | Appearance          | Clear | Dark  |
| 11.5    |              | KV@40°C[mm²/s]      | 109.6 | 121.7 |
| 6       |              | KV@100°C[mm²/s]     | 11.84 | 12.38 |
|         | >15          | BN[mgKOH/g]         | 8.6   | 12.2  |
|         | <180         | Flash Point[°C]     | >200  | >200  |
|         | >1           | Soot/Insoluble[%wt] | 0.10  | 0.20  |
|         | >0.3         | Water[%wt]          | 0.07  | 0.48  |
|         |              | PQ Index/2ml        | <10   | <10   |

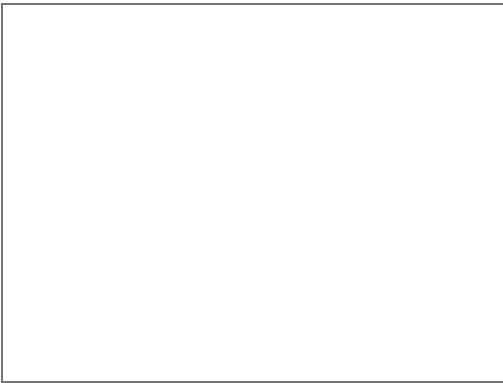
| Wear Elemental [ppm] |                |    |    |    |
|----------------------|----------------|----|----|----|
| >100                 | Aluminium (Al) | 1  | 3  | 2  |
| >50                  | Chromium (Cr)  | <1 | <1 | <1 |
| >100                 | Copper (Cu)    | 1  | 4  | 3  |
| >200                 | Iron (Fe)      | 4  | 13 | 15 |
| >100                 | Lead (Pb)      | <1 | <1 | 1  |
| >100                 | Tin (Sn)       | <1 | <1 | 1  |

| Contaminant Elemental [ppm] |                 |    |    |    |
|-----------------------------|-----------------|----|----|----|
|                             | Boron (B)       | 3  | 6  | 7  |
| >250                        | Sodium (Na)     | 4  | 8  | 5  |
| >100                        | Silicon (Si)    | 5  | 5  | 3  |
|                             | Molybdenum (Mo) | <1 | <1 | <1 |
|                             | Nickel (Ni)     | 1  | 3  | 3  |
|                             | Silver (Ag)     | <1 | <1 | <1 |
|                             | Vanadium (V)    | 1  | 3  | 3  |

| Additive Elements [ppm] |              |      |      |      |
|-------------------------|--------------|------|------|------|
|                         | Calcium (Ca) | 3392 | 4718 | 5211 |



**Oil Rating:**  
The oil is fit 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:**  
No action required.

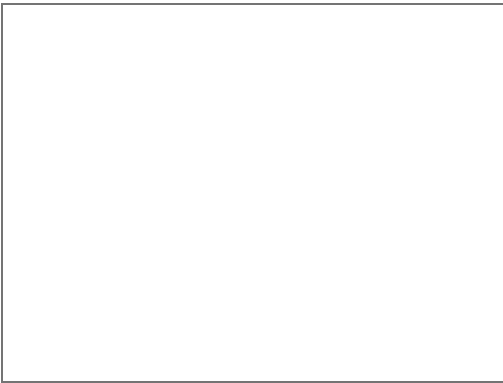
Alert Value : \* Indicate Oil supplier/operator critical limits.  
Support : technical @lukoil.com

Dated: 07-Oct-2023

BULK INDEPENDENCE [9374002]

M/E L.O. SETTLING TANK [-]

|                                      |                     |                                    |                    |          |          |
|--------------------------------------|---------------------|------------------------------------|--------------------|----------|----------|
| <b>Manufacturer</b> : NOT APPLICABLE |                     | <b>Model</b> : N.A.                |                    |          |          |
| <b>Port Landed</b> : Netherlands     |                     | <b>Volume[ltr]</b> :               |                    |          |          |
| <b>Fuel Grade / S%</b> :             |                     | <b>Dispatched</b> : 02-Oct-23      |                    |          |          |
| <b>Recommended</b> : NAVIGO 6 CO     |                     | <b>Received</b> : 05-Oct-23        |                    |          |          |
|                                      |                     | <b>Sample Details</b>              | <b>1 (Current)</b> | <b>2</b> | <b>3</b> |
|                                      |                     | Rating                             | Normal             |          |          |
|                                      |                     | Sample No                          | 23098209           |          |          |
|                                      |                     | Bottle No                          | 50333166           |          |          |
|                                      |                     | Sampled Date                       | 26-Sep-23          |          |          |
|                                      |                     | Oil Grade In Use                   | NAVIGO 6 CO        |          |          |
|                                      |                     | Unit Service Hrs                   | 75148              |          |          |
|                                      |                     | Oil Service Hrs                    | Not Stated         |          |          |
|                                      |                     | Daily Makeup[ltr]                  | Not Stated         |          |          |
| <b>New Oil</b>                       | <b>Alert Value.</b> | <b>Analysis</b>                    |                    |          |          |
| 100                                  |                     | Appearance                         | Dark               |          |          |
| 11.5                                 | <9.3 or>15.5*       | KV@40°C[mm²/s]                     | 118.9              |          |          |
| 6                                    | <2 or>30*           | KV@100°C[mm²/s]                    | 12.61              |          |          |
|                                      | <170*               | BN[mgKOH/g]                        | 8.9                |          |          |
|                                      | >1.2*               | Flash Point[°C]                    | >200               |          |          |
|                                      | >0.5*               | Soot/Insoluble[%wt]                | 0.20               |          |          |
|                                      |                     | Water[%wt]                         | 0.07               |          |          |
|                                      |                     | PQ Index/2ml                       | <10                |          |          |
|                                      |                     | <b>Wear Elemental [ppm]</b>        |                    |          |          |
|                                      | >100*               | Aluminium (Al)                     | 2                  |          |          |
|                                      | >50*                | Chromium (Cr)                      | <1                 |          |          |
|                                      | >100*               | Copper (Cu)                        | 4                  |          |          |
|                                      | >200*               | Iron (Fe)                          | 14                 |          |          |
|                                      | >100*               | Lead (Pb)                          | <1                 |          |          |
|                                      | >100*               | Tin (Sn)                           | <1                 |          |          |
|                                      |                     | <b>Contaminant Elemental [ppm]</b> |                    |          |          |
|                                      |                     | Boron (B)                          | 6                  |          |          |
|                                      | >250*               | Sodium (Na)                        | 22                 |          |          |
|                                      | >100*               | Silicon (Si)                       | 7                  |          |          |
|                                      |                     | Molybdenum (Mo)                    | <1                 |          |          |
|                                      |                     | Nickel (Ni)                        | 3                  |          |          |
|                                      |                     | Silver (Ag)                        | <1                 |          |          |
|                                      |                     | Vanadium (V)                       | 3                  |          |          |
|                                      |                     | <b>Additive Elements [ppm]</b>     |                    |          |          |
|                                      |                     | Calcium (Ca)                       | 3524               |          |          |



**Oil Rating:**

The oil is fit 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:**

No action required.

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

Dated: 07-Oct-2023

**Standard Test Methods Employed:**

**Analysis Test Method**

|   |  |
|---|--|
| Viscosity (KV@40°C and 100°C)                               | (ASTM D445-21)   |
| Flash Point (@200°C)  | (ASTM D3828-16a Method A)                                  |
| Flash Point (°C)  | (ASTM D3828-16a Method B;ASTM D92-18)                      |
| Soot/Insoluble  | (ASTM D7899-19; ASTM D893-14 (2018); ASTM E2412-10 (2018)) |
| Base Number   | (ASTM D2896-15 Procedure B)                                |
| Acid Number   | (ASTM D664-18e2 Method A)                                  |
| Water   | (ASTM E2412-10 (2018); ASTM D6304-20; ASTM D95-13 (2018))  |
| Oxidation   | ASTM D7414/E2412 (FTIR @5.85µm)                            |
| PQ Index  | (Manufacturer Method)                                      |
| ISO Cleanliness Code  | (ISO 11500:2008 & ISO 4401:2021)                           |
| Elemental Analysis(Wear,Contaminants and Additive Elements) | (ASTM D5185-18)  |



## **Lubricant Analysis Glossary**

The service utilizes the latest analytical techniques and computer programming to offer an advanced lubricant analysis package that provides a valuable lubricant monitoring tool for the ship operator.

### **Lubricant properties reported on lubricant analysis reports**

(tests conducted depend on machinery type and oil grade)

#### **Acid Number**

Tests the acidity of the oil. Certain oils have an inherent acidity level related to their additive chemistry. Increasing acidity may be indicative of the presence of organic acids derived from oil oxidation.

#### **Asphaltenes**

Give an indication of heavy fuel derived components from raw fuel ingress and/or products of combustion from blowby.

#### **Base Number**

Previously known as Total Base Number (TBN) is a measure of the reserve alkalinity of an engine oil and its ability to neutralise harmful acids.

#### **Fe**

Iron - (Fe) Indicate level of iron (ferro-magnetic and non-magnetic) in the oil sample, up to a particle size of 7 microns. Typical sources of iron are cylinder liners, crankshafts, piston rings, gears. Can indicate the level of corrosive wear in cylinder scrapedown samples.

#### **Feed Rate [g/kW/h]**

Feed rate setting, which is e.g. the "Basic Feed Rate" for MAN engines, the "Base Feed Rate" for Wartsila engines and the "MCR Feed Rate" for MHI engines at the time of sampling reported on submission form by crew.

#### **Flash Point**

Primarily a test for fuel dilution in engine oils. A decrease in flash point is generally an indication of fuel ingress which has contaminated the lubricant.

#### **Insolubles**

A test for the total solids contamination in a lubricant such as combustion soot, dirt, oxidation products and metal wear debris.

#### **ISO 4406 Cleanliness Code**

The code for expressing the particulate contamination level per milliliter of fluid sample with 4, 6 and 14 micron size. Dirt ingress, filter failure and generated wear etc. results higher particulate contamination in the fluid which can cause damage to the sensitive control valves of high pressure hydraulic systems by plugging small orifices.

#### **Oxidation**

A chemical process in which a carbon atom gains bonds to oxygen in organic components like petroleum fluids. Oil oxidation leads into the degradation of the oil properties. Oxidation test result has been expressed in this report as Abs/0.1mm, it can be converted to Abs/cm by multiplying with 100.

#### **PQ ( Particle Quantification) Index**

Not an oil property but an index that provides a quantitative assessment for trending purposes. It detects the amount of ferro-magnetic wear debris in the oil sample. Can indicate the level of abrasive / adhesive wear in cylinder scrapedown samples

#### **Viscosity**

A measure of the resistance of a liquid to flow. Commonly referred to as the 'thickness of an oil'.

#### **Water**

The percentage (by volume) of the total amount of water contamination.

### **Elemental analysis with some typical sources**

#### **(Elements reported depend on machinery type and oil grade and are reported in PPM, Parts Per Million)**

Aluminium – Pistons, specific piston rings, bearing, housing, fuel derivative

Antimony - Bearings

Calcium - Lubricant derivative

Chromium - Piston rings

Copper - Bearings, gears, oil coolers, pipework, pistonrod glands

Iron - Cylinder liners, crankshafts, piston rings, gears

Lead - Bearings

Magnesium - Casings, housings, lubricant derivative

Manganese - Cylinder liners

Molybdenum - Piston rings

Nickel - Bearings, valves, gears, fuel derivative

Potassium - Salt Water

Phosphorus - Lubricant derivative

Silicon - Dust, dirt, fuel derivative, lubricant derivative

Silver - Bearings

Sodium - Salt water, coolant derivative, fuel derivative

Tin - Bearings

Vanadium - Fuel derivative

Zinc - Lubricant derivative

#### **Alert Value**

Where OEM values are known, those are the Alert Values indicated on reports, otherwise Alert Values considered suitable by Lukoil are indicated by an asterisk '\*'

**The information above is considered to be accurate as of the dates specified. We have reviewed this information; however, no warranty or representation, express or implied, is made as to the accuracy or completeness of the data and the information contained in this note.**