

# MARINE ACCIDENT INVESTIGATION REPORT

October 3, 2017

Adopted by the Japan Transport Safety Board

|          |                    |
|----------|--------------------|
| Chairman | Kazuhiro Nakahashi |
| Member   | Yuji Sato          |
| Member   | Kenkichi Tamura    |
| Member   | Toshiyuki Ishikawa |
| Member   | Makiko Okamoto     |

|  |   |
|--|---|
| <b>Accident type</b>                             | Grounding   |
| <b>Date and time</b>                             | Around 06:00 on February 11, 2017 (local time, UTC+9 hours)   |
| <b>Location</b>                                  | On the southwest coast of the Suwanosejima Island, Toshima-mura, Kagoshima<br>Around 217° true bearing, 2.0 nautical miles (M) from the primary triangulation station of the Suwanosejima Island<br>(approximately 29°36.7'N, 129°41.4'E)   |
| <b>Summary of the Accident</b>                   | An oil tanker, SAGAN, with 18 crews, including the master, became unable to start and drifted due to failures in the main engine while heading northeast off the western coast of the Noma Peninsula, Satsuma-shi, Kagoshima. She grounded on the southwest coast of the Suwanosejima Island, Toshima-mura, Kagoshima.<br>SAGAN was completely destroyed with cracks, etc. on the bottom shell, but there were no casualties.   |
| <b>Process and Progress of the Investigation</b> | (1) Setup of the Investigation<br>The Japan Transport Safety Board appointed an investigator-in-charge and one other marine accident investigator on February 13, 2017 and another marine accident investigator on March 1st to investigate this accident.<br>(2) Collection of Evidence<br>February 13, 14, April 9, May 18, 31, December 1, 2017:<br>Interview<br>April 5-8, 2017: On-site investigation<br>September 6, 7, 2017: Interview and collection of questionnaire<br>The Japan Transport Safety Board entrusted a private analysis company with the analysis of the fuel oil used at the time of the accident.<br>(3) Comments from Parties Relevant to the Cause<br>Comments on the draft report were invited from parties relevant to the cause of accident.<br>(4) Comments from the Flag State<br>Comments on the draft report were invited from the Flag State of the SAGAN. |
| <b>Factual Information</b>                       |   |
| Vessel type and name,                            | Oil tanker SAGAN (Nationality: Republic of Panama), 5,404 tons  |

| <p>Gross tonnage<br/>IMO number<br/>Owner, etc.<br/>Vessel borrower<br/><br/>Management company<br/><br/>Certified agent*<sup>1</sup><br/>L×B×D, Hull material<br/>Engine, Output, Date of launch<br/>Navigation instrument, etc.<br/>Anchor, Chain cable length</p> | <p>9184043<br/>GLOBAL EMINENCE LIMITED<br/>GOOD CREATION LIMITED (hereinafter referred to as "Company A")<br/>MING JIN SHIPMANAGEMENT CONSULTANT LIMITED (hereinafter referred to as "Company B")<br/>Overseas Marine Certification Service Inc. (Republic of Panama)<br/>107.90 m x 19.20 m x 9.30 m, steel<br/>Diesel engine, 3,312 kW, January 1999<br/><br/>Voyage data recorder (VDR), 2 radars, VHF radiotelephone, GPS plotter, AIS, and echo sounder<br/>JIS stockless anchor, about 3,300 kg weight (one for each side), 9 shackles (one shackle is 27.5 m length)</p>  |                    |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
|--|--|--------------------|-------------------|--------------------|------|-----|------|------|-----|------|------|----|-----|-----------|----|-----|
| <p>Main Engine Information</p>   | <p>The main engine is a two-cycle crosshead low-speed diesel engine with 6 cylinders, and it was manufactured in the middle of December 1998. Its revolutions per minute (rpm) at the time of the continuous maximum power were 178.<br/>Revolutions and speed were as shown in Table 1.</p> <p style="text-align: center;">Table 1 Table of speed in the harbor</p> <table border="1" data-bbox="595 1064 1394 1330"> <thead> <tr> <th></th> <th>Main engine (rpm)</th> <th>Average speed (kn)</th> </tr> </thead> <tbody> <tr> <td>Full</td> <td>140</td> <td>12.0</td> </tr> <tr> <td>Half</td> <td>120</td> <td>10.0</td> </tr> <tr> <td>Slow</td> <td>75</td> <td>7.0</td> </tr> <tr> <td>Dead slow</td> <td>65</td> <td>5.0</td> </tr> </tbody> </table> |                    | Main engine (rpm) | Average speed (kn) | Full | 140 | 12.0 | Half | 120 | 10.0 | Slow | 75 | 7.0 | Dead slow | 65 | 5.0 |
|  | Main engine (rpm)  | Average speed (kn) |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
| Full   | 140  | 12.0               |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
| Half   | 120  | 10.0               |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
| Slow   | 75   | 7.0                |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
| Dead slow  | 65   | 5.0                |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
| <p>Crew Information</p>  | <p>Master (Nationality: Republic of the Union of Myanmar), male, 54 years old<br/>Certificate of Master (issued by the Republic of Panama)<br/>Date of issue: October 21, 2016 (valid until December 31, 2020)<br/>Chief Engineer (Nationality: Republic of the Union of Myanmar), male, 53 years old<br/>Certificate of Chief Engineer (issued by the Republic of Panama)<br/>Date of issue: February 11, 2016 (valid until December 31, 2020)</p>  |                    |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
| <p>Injuries to Persons</p>   | <p>None</p>  |                    |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |
| <p>Damage to Vessel (or Other Facilities)</p>  | <p>There were cracks and dents on the bottom shell, and the engine room was wet (completely destroyed).</p>  |                    |                   |                    |      |     |      |      |     |      |      |    |     |           |    |     |

\*<sup>1</sup> The term "certified agent" refers to an organization that is granted the authority to implement checks based on international conventions, such as the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL Convention), or the domestic regulations of the country of registry and to issue a certificate by the government of the said country of registry.

| <p>Weather and Sea Conditions</p>     | <p>Weather: Weather - Rainy, Wind - Northwest, Wind force - 7<br/>Sea conditions: Wave direction - Northwest, Wave height – About 4.5 m</p> <p>According to the logbook of the vessel, the observed values during the drift were as shown in Table 2.</p> <p>Table 2 Record of observation in the logbook (from the start of the drift to a day before the grounding)</p> <table border="1" data-bbox="523 450 1428 801"> <thead> <tr> <th>Date and time</th> <th>Wind direction</th> <th>Wind force</th> <th>Weather</th> <th>Atmospheric pressure<br/>hPa</th> <th>Temperature<br/>°C</th> <th>Wave Scale*2</th> <th>Swell Scale*3</th> </tr> </thead> <tbody> <tr> <td>Feb. 6th, 12:00</td> <td>N</td> <td>5</td> <td>Fog</td> <td>1,027</td> <td>9</td> <td>4</td> <td>2</td> </tr> <tr> <td>7th, 12:00</td> <td>NE</td> <td>4</td> <td>Slightly cloudy</td> <td>1,030</td> <td>17</td> <td>4</td> <td>2</td> </tr> <tr> <td>8th, 12:00</td> <td>N</td> <td>3</td> <td>Slightly cloudy</td> <td>1,026</td> <td>14</td> <td>3</td> <td>2</td> </tr> <tr> <td>9th, 12:00</td> <td>NW</td> <td>6</td> <td>Rain</td> <td>1,022</td> <td>11</td> <td>6</td> <td>5</td> </tr> <tr> <td>10th, 12:00</td> <td>N</td> <td>6</td> <td>Rain</td> <td>1,024</td> <td>9</td> <td>6</td> <td>5</td> </tr> <tr> <td>10th, 24:00</td> <td>NW</td> <td>6</td> <td>Slightly cloudy</td> <td>1,026</td> <td>9</td> <td>6</td> <td>5</td> </tr> </tbody> </table> | Date and time | Wind direction  | Wind force                  | Weather           | Atmospheric pressure<br>hPa | Temperature<br>°C | Wave Scale*2 | Swell Scale*3 | Feb. 6th, 12:00 | N | 5 | Fog | 1,027 | 9 | 4 | 2 | 7th, 12:00 | NE | 4 | Slightly cloudy | 1,030 | 17 | 4 | 2 | 8th, 12:00 | N | 3 | Slightly cloudy | 1,026 | 14 | 3 | 2 | 9th, 12:00 | NW | 6 | Rain | 1,022 | 11 | 6 | 5 | 10th, 12:00 | N | 6 | Rain | 1,024 | 9 | 6 | 5 | 10th, 24:00 | NW | 6 | Slightly cloudy | 1,026 | 9 | 6 | 5 |
|---------------------------------------|---|---------------|-----------------|-----------------------------|-------------------|-----------------------------|-------------------|--------------|---------------|-----------------|---|---|-----|-------|---|---|---|------------|----|---|-----------------|-------|----|---|---|------------|---|---|-----------------|-------|----|---|---|------------|----|---|------|-------|----|---|---|-------------|---|---|------|-------|---|---|---|-------------|----|---|-----------------|-------|---|---|---|
| Date and time                         | Wind direction  | Wind force    | Weather         | Atmospheric pressure<br>hPa | Temperature<br>°C | Wave Scale*2                | Swell Scale*3     |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |
| Feb. 6th, 12:00                       | N   | 5             | Fog             | 1,027                       | 9                 | 4                           | 2                 |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |
| 7th, 12:00                            | NE  | 4             | Slightly cloudy | 1,030                       | 17                | 4                           | 2                 |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |
| 8th, 12:00                            | N   | 3             | Slightly cloudy | 1,026                       | 14                | 3                           | 2                 |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |
| 9th, 12:00                            | NW  | 6             | Rain            | 1,022                       | 11                | 6                           | 5                 |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |
| 10th, 12:00                           | N   | 6             | Rain            | 1,024                       | 9                 | 6                           | 5                 |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |
| 10th, 24:00                           | NW  | 6             | Slightly cloudy | 1,026                       | 9                 | 6                           | 5                 |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |
| <p>Events Leading to the Accident</p> | <p>The vessel had the master, the chief engineer, and 16 other persons (the nationality of 15 crew members was the Republic of the Union of Myanmar and the nationality of one crew member was Taiwan) on board and departed from the Port of Kaohsiung in Taiwan toward the Port of Onsan in the Republic of Korea at around 10:00 (local time) on February 1, 2017 in the empty state for the purpose of loading marine diesel oil.</p> <p>While the vessel was heading north at the speed over the ground of about 2.4 kn, a scavenge air box fire*4 occurred at cylinder No. 5 of the main engine around 17:00 on the 2nd. Therefore, the vessel wandered with the main engine stopped, and after extinction of the fire, the chief engineer extracted the piston of cylinder No. 5 and checked it.</p> <p>The chief engineer recognized that out of the four piston rings, two suffered excessive abrasion and replaced them with spare piston rings supplied by Company A. After that, the chief engineer started the main engine and reassumed navigation around 18:20.</p> <p>As a scavenge air box fire occurred at cylinder No. 3 of the main engine around 08:30 on the 4th, the chief engineer stopped the main engine to have the vessel wander. After extinction of the fire, the chief engineer extracted the piston of cylinder No. 3 and checked it, and then, he recognized that two piston rings suffered excessive</p>        |               |                 |                             |                   |                             |                   |              |               |                 |   |   |     |       |   |   |   |            |    |   |                 |       |    |   |   |            |   |   |                 |       |    |   |   |            |    |   |      |       |    |   |   |             |   |   |      |       |   |   |   |             |    |   |                 |       |   |   |   |

\*2 The term "wave scale" refers to a scale for wind waves, and wind waves are classified into 10 scales. In Japan, the wave scale is set as a sea state by the Director-General of the Japan Meteorological Agency based on a public notice under the provisions of Article 1-3, paragraph (3) of the Regulation for Enforcement of the Meteorological Service Act (specifying the Japan Meteorological Agency's wind scale table, etc.).

\*3 The term "swell scale" refers to a scale for swells, and swells are classified into 10 scales. In Japan, the swell scale is set as a sea state by the Director-General of the Japan Meteorological Agency based on a public notice under the provisions of Article 1-3, paragraph (3) of the Regulation for Enforcement of the Meteorological Service Act (specifying the Japan Meteorological Agency's wind scale table, etc.).

\*4 The term "scavenge air box fire" refers to the occurrence of a fire in the scavenging chamber before air supply (scavenging air) enters inside the cylinder of an engine.

abrasion. Therefore, the chief engineer replaced them with spare piston rings supplied by Company A, and started the main engine around 12:00 to continue navigation.

All of a set of four spare piston rings were used, and there was no spare on the vessel.

The vessel wandered because a scavenge air box fire occurred again at cylinder No. 3 of the main engine around 07:07 on the 5th. After extinction of the fire, the chief engineer extracted the piston of cylinder No. 3 and checked it. Although the chief engineer recognized that the piston rings suffered excessive abrasion, there was no spare. Therefore, he decided to continue to use these piston rings, cleaned the piston crown and the piston ring grooves, and started the main engine around 10:15. The vessel started navigation with the main engine under low load conditions.

A scavenge air box fire occurred at cylinder No. 1 around 20:25 on the 5th, 10 hours after the start of navigation, at cylinder No. 3, which was different from the one at which a fire previously, around 23:05, and at cylinder No. 1 again around 03:00 on the 6th. At the time of each fire, the vessel wandered, and after extinction of the fire, the chief engineer extracted the relevant piston and recognized that the piston rings suffered excessive abrasion. However, as there was no spare piston ring, the chief engineer only cleaned the piston crown and the piston ring grooves and started the main engine, and the vessel navigated under the low load conditions.

Scavenge air box fires occurred at cylinder Nos. 1 and 3 around 08:50 on the 6th, and the chief engineer conducted the work of only cleaning the piston crown and the piston ring grooves. However, the main engine became impossible to start, and the vessel started drifting. In addition, the chief engineer reported to Company A that the main engine became impossible to start around 17:31.

Scavenge air box fires that occurred during the period from departure to the drift were as shown in Table 3.

Table 3 Process of occurrence of scavenge air box fires

| Date | Time  | Cylinder No. |   |          |   |          |   | Handling                            | Recovery   |
|------|-------|--------------|---|----------|---|----------|---|-------------------------------------|------------|
|      |       | 1            | 2 | 3        | 4 | 5        | 6 |                                     |            |
| 2    | 17:00 |              |   |          |   | Occurred |   | Replacing two rings                 | 18:20      |
| 4    | 08:30 |              |   | Occurred |   |          |   | Replacing two rings                 | 12:00      |
| 5    | 07:07 |              |   | Occurred |   |          |   | Cleaning the crown and ring grooves | 10:15      |
| 5    | 20:25 | Occurred     |   |          |   |          |   | Cleaning the crown and ring grooves |            |
| 5    | 23:05 |              |   | Occurred |   |          |   | Cleaning the crown and ring grooves |            |
| 6    | 03:00 | Occurred     |   |          |   |          |   | Cleaning the crown and ring grooves |            |
| 6    | 08:50 | Occurred     |   | Occurred |   |          |   | Cleaning the crown and ring grooves | Impossible |

The chief engineer and engine crews conducted replacement works several times by using used piston rings that suffered relatively less

abrasion during the drift, but were unable to start the main engine.

The master reported to Company A the conditions of the vessel's main engine, etc. during the drift.

The master talked about the conditions of the main engine with the chief engineer during the evening on the 9th, and determined that the vessel was unable to head for the Port of Onsan on her own and decided to call for a rescue to request the immediate arrangement of a tugboat.

Around 08:42 on the 10th, the master told Company A that the sea was rough with heavy swell and that the vessel was drifting toward an island of Japan, and requested the immediate arrangement of a tugboat.

Around 19:29, the master told the agent at the Port of Onsan that the vessel was unable to navigate due to the failure of the main engine and was drifting in the marine area about 60 M from an island of Japan, and requested rescue and the arrangement of another tugboat (one that is different from the one he requested Company A).

Both of the tugboats (of Japan) arranged by Company A and the agent at the Port of Onsan were unable to make their way for rescue due to heavy weather.

As the vessel approached the southwest coast (79-107 m deep; see Attached Figure 2 Anchored Point) of the Tairajima Island, Toshima-mura, Kagoshima around 01:30 on the 11th, the master felt the risk of grounding and let go the port anchor and veered the chain cable by seven shackles (about 193 m). However, the anchor and the chain cable were unable to hold the sea bed, and the vessel passed south of the Tairajima Island and continued drifting toward the Suwanosejima Island.

As the vessel continued drifting thereafter and grounded on the southwest coast of the Suwanosejima Island around 06:00. The Japan Coast Guard received a distress alert around 06:35. (see Figure 1, Figure 2, Attached Figure 1 Outline Map of Navigation Course, and Attached Table 1 GPS and AIS Records of the Vessel (Excerpt)).



Figure 1 Place of grounding on the southwest coast of the

Suwanosejima Island  
(Photo provided by the 10th Regional Coast Guard  
Headquarters)



Figure 2 Conditions of grounding on the southwest coast of the  
Suwanosejima Island  
(Photo provided by the 10th Regional Coast Guard  
Headquarters)

All the crew of the vessel were rescued by helicopters of the Japan Coast Guard which came to the rescue, and they embarked on a patrol boat and were then taken to the Port of Kagoshima.

The vessel was refloated at a later date by a salvage company contracted by Company A.

Other Matters

(1) Main Engine Operation Information

- ① Conditions of lubricating oil and fuel oil in the main engine at the time of departure from the Port of Kaohsiung
  - a. Alkalinity value\*5 40 was used for the cylinder oil injection of the main engine, and the quantity of filled oil per day of the cylinder oil was about 90 ℓ. Company A's approval was necessary in the case of adjusting the quantity of filled oil of the cylinder oil.
  - b. The chief engineer had never changed the quantity of filled oil of the cylinder oil since he went aboard the vessel in May 2016.
  - c. The vessel was subjected to the regular property analysis of

\*5 The term "alkalinity value" refers to the Base Number (BN) and indicates the mg number of potassium hydroxide equivalent to hydrochloric acid or perchloric acid required for neutralizing the basic components contained in a 1 g sample. The alkalinity value indicates the ability to neutralize sulfuric acid and other acids refined from the sulfur content in fuel and prevent wear damages to engine parts caused by acids.

the lubricating oil of the main engine through Company B, but the analysis result showed no abnormality. Therefore, the use of the lubricating oil was continued as it was.

d. No abnormality was recognized in the main engine when the vessel was subjected to a sea trial after docking on January 4, 2017.

② Used fuel oil information

The property analysis of used fuel oil was entrusted to a private analysis company. The analysis results were as shown in Table 4.

The used fuel oil was a product based on the ISO8217RME180, which is an international standard for marine fuel oil.

Table 4 Results of fuel oil property analysis

| Analysis item                                     | Unit             | Result             | ISO8217 RME180 |         |
|---|------------------|--------------------|----------------|---------|
| Density   | 15°C             | g/cm <sup>3</sup>  | 0.9785         | < 0.991 |
| Kinetic viscosity                                 | 50°C             | mm <sup>2</sup> /s | 157            | < 180.0 |
| Flash point (rapid equilibrium closed cup method) | JIS K2265-2 2007 | °C                 | >70            | 60 <    |
| Flow point  |                  | °C                 | ≤15            | < 30    |
| Moisture content                                  |                  | Weight %           | 0.13           | < 0.50  |
| Carbon residue content                            |                  | Weight %           | 9.23           | < 15.0  |
| Ash content                                       |                  | Weight %           | 0.025          | < 0.07  |
| Sulfur content                                    |                  | Weight %           | 2.34           | < 3.50  |
| Asphaltene  |                  | Weight %           | 3.81           | -       |
| CCAI* <sup>6</sup> (ignition performance index)   |                  | -                  | 850            | < 860   |

(2) Conditions of the Piston Rings of the Main Engine at the Time of the Accident

According to a report from the vessel, the conditions of the piston rings of the main engine at the time of the accident were as shown in Table 5.

Table 5 Conditions of the piston rings of the main engine

| Ring No. | Cylinder No. |          |        |        |        |      |
|----------|--------------|----------|--------|--------|--------|------|
|          | 1            | 2        | 3      | 4      | 5      | 6    |
| 1        | Good         | No move  | Broken | Broken | Broken | Good |
| 2        | Good         | No move  | Broken | Broken | Broken | Good |
| 3        | No move      | Broken   | Broken | Broken | Broken | Good |
| 4        | No move      | Sticking | Broken | Broken | Broken | Good |

(Ring No. indicates the order of mounting from the top while cylinder No. indicate

\*<sup>6</sup> The term "CCAI" refers to the Calculated Carbon Aromaticity Index, and if the CCAI value is high, engine combustion under low load conditions becomes unstable in some cases.

|   |  |
|---|--|
|   | <p>the order of arrangement from the bow side.)</p> <p>(3) Conditions of the Cylinder Liner of the Main Engine at the Time of the Accident</p> <p>No information was obtained about the cylinder liner of the main engine at the time of the accident.</p> <p>(4) Main Engine Manufacturer Information</p> <p>According to the statement of a representative of the main engine manufacturer, the information is as follows.</p> <p>① Even a new piston ring suffers abrasion immediately if the cylinder liner is not a true circle.</p> <p>② The filled oil quantity per day of the cylinder oil injection of the vessel decided by Company A is about 90 ℓ, and it is within the allowable range of the main engine manufacturer.</p> <p>③ Where a blow-by*7 occurs in a situation where a piston ring or cylinder liner suffers abrasion, an oil film inside the cylinder liner is destroyed, or cylinder oil inside the cylinder liner vaporizes, and the piston ring or the cylinder liner will suffer greater abrasion.</p> |
| <p><b>Analysis</b></p> <p>Involvement of crew members</p> <p>Involvement of vessel, engine, etc.</p> <p>Involvement of weather and sea conditions</p> <p>Analysis of the findings</p> | <p>Involved</p> <p>Involved</p> <p>Involved</p> <p>(1) Conditions of the Vessel</p> <p>It is somewhat likely that the master continued to wait for the start of the main engine and many days were required before calling for a rescue because the vessel had a record of having stopped due to occurrence of a scavenge air box fire at the main engine but started after only cleaning even without spare piston ring.</p> <p>(2) Impossibility of Starting the Main Engine</p> <p>The causes of impossibility of starting the main engine were as follows.</p> <p>① Defects in the piston rings</p> <p>It is probable that the piston rings were unable to keep an airtight connection with the cylinder liner because they suffered excessive abrasion and were broken.</p> <p>② Defects in the cylinder liner</p> <p>It is somewhat likely that the inside diameter of the cylinder</p>  |

\*7 The term "blow-by" refers to the outflow of exhaust gas that becomes at high pressure in the combustion stroke through blow-by from a space between the piston and the cylinder liner to a scavenging chamber in a two-stroke engine and a crankcase in a four-stroke engine.



liner is not of a true circle and that the ability to retain oil on the surface by expansion had been reduced, based on the facts that the piston rings with which the sliding part has contact suffered excessive abrasion and that new piston rings also suffered abrasion at an early date even after repair. However, it could not be determined whether the cylinder liner had defects because it was impossible to obtain any information about the cylinder liner, including the measured value of the inside diameter.

③ Lack of replacement parts for piston rings

As a result of being unable to stop excessive abrasion and breakage of the piston rings due to the impossibility of understanding the causes thereof, used parts were mounted. Therefore, lack of replacement parts is obvious.

On the basis of the above, it is probable that the vessel became unable to start because air supply leaked to a scavenging chamber in the compression process and did not reach sufficiently high temperature and injected fuel oil was not ignited because it became impossible to keep the piston and the cylinder liner airtight due to excessive abrasion and breakage of the piston rings and the impossibility of replacing them with spare products. In addition, it is probable that scavenge air box fires were ignited by blow-by that was caused by lubricating oil, etc. deposited at the bottom of the scavenging chamber going through the space between the piston and the cylinder liner that were not kept sufficiently airtight.

(3) Weather and Sea Conditions

① It is probable that, from the 6th: the date on which the vessel started drifting, to the 8th, it was foggy or slightly cloudy, that the north to northeast winds with force 3-5 (wind speed: about 3.4-10.8 m/s) blew, and that there were waves with sea state 3-4 (wave height: about 0.5 to 2.5 m) from the northwest.

② It is probable that, from the 9th to the 11th: the date on which the accident occurred, it was slightly cloudy or rainy, that the north to northwest wind with force 6 (wind speed: about 10.8-13.9 m/s) blew, and that there were waves with sea state 6 (wave height: about 4-5 m) from northwest (flowing to the southeast).

From the above, it is probable that rescue by a tugboat, etc. was difficult on the 9th and thereafter.

(4) Analysis on the Occurrence of Accident

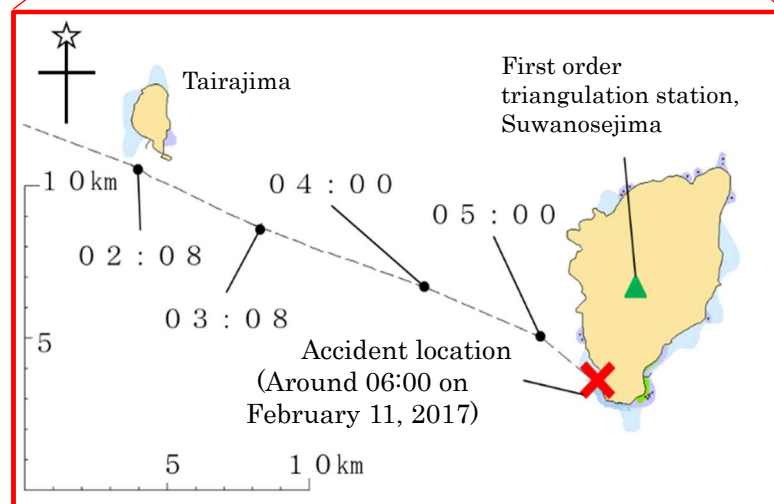
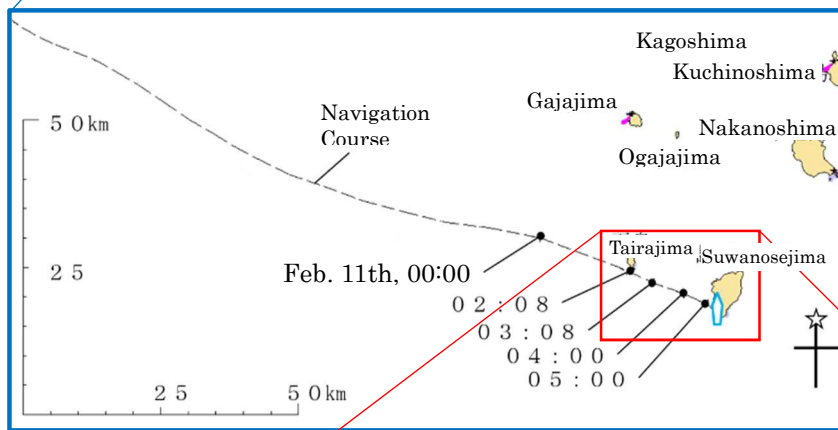
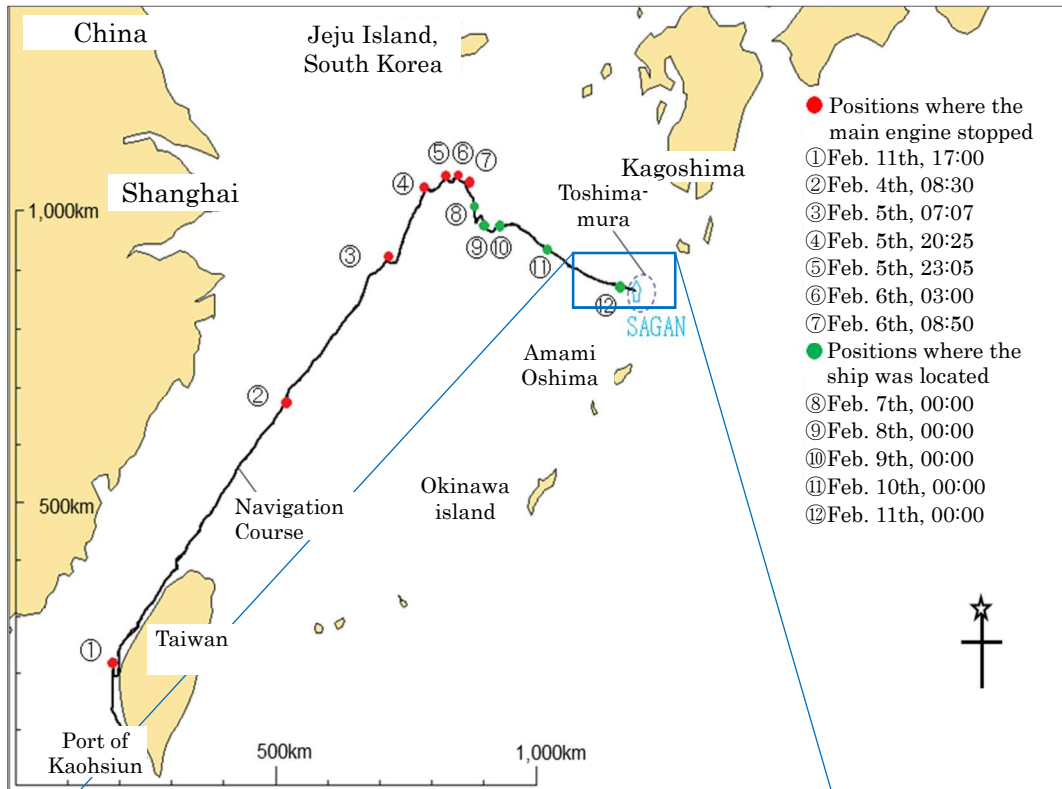
As described in Events Leading to the Accident and (1) to (3) above, it is probable that the accident occurred as follows.

① The vessel departed from the Port of Kaohsiung in Taiwan toward the Port of Onsan around 10:00 (Taiwan time) on February 1.

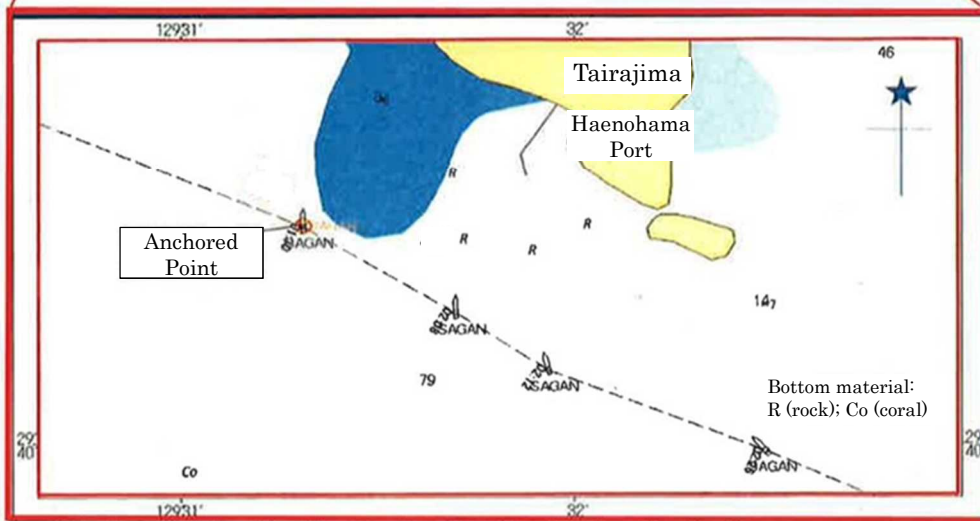
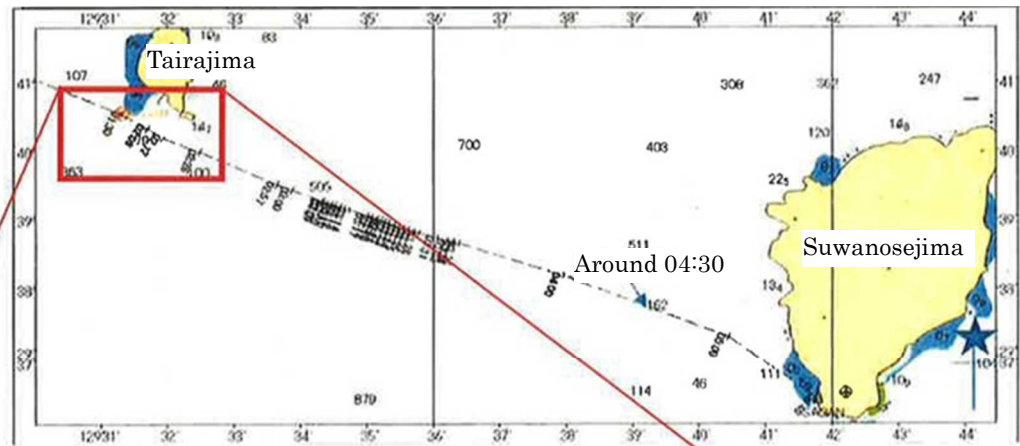
② While heading northeast in the East China Sea, the vessel

|                               |  |
|-------------------------------|--|
|                               | <p>repeatedly stopped navigation due to the occurrence of scavenge air box fires at multiple cylinders of the main engine and reassumed navigation after repair and cleaning.</p> <p>③ The vessel started drifting because the main engine was stopped due to a scavenge air box fire that occurred around 08:50 on February 6 and became impossible to start.</p> <p>④ Many days were required to decide to call for a rescue on evening of 9th because the master continued to wait for the start of the main engine because the main engine of the vessel had a record of having been started even after occurrence of a scavenge air box fire.</p> <p>⑤ The vessel was subjected to a pressured flow by the strong northwest wind and waves and continued drifting toward east-southeast.</p> <p>⑥ No tugboat was able to head to rescue the vessel due to heavy weather.</p> <p>⑦ As the vessel approached the Tairajima Island, the master felt the risk of grounding and let go the port anchor. However, the anchor and the chain cable were unable to hold the sea bed. The vessel passed south of the Tairajima Island and continued drifting toward the Suwanosejima Island.</p> <p>⑧ The vessel was subjected to a pressured flow toward east-southeast and grounded at the site of occurrence of the accident around 06:00 on the 11th.</p> |
| <p><b>Probable Causes</b></p> | <p>It is probable that in the accident, while heading northeast in the East China Sea, the vessel became unable to operate because the main engine could not be started due to the impossibility of repairing failures and that the vessel continued drifting and was pushed to flow toward east-southeast by strong wind and waves and grounded.</p> <p>It is probable that the main engine could not be started to start because it became impossible to keep the piston and the cylinder liner airtight due to excessive abrasion and breakage of the piston rings that were in use.</p> <p>It is probable that the vessel continued drifting because she was not rescued due to heavy weather though the master called Company A and the agency for a rescue when the vessel approached the site of occurrence of the accident.</p>  |
| <p><b>Safety Actions</b></p>  | <p>Matters that are probably useful for the prevention of the occurrence of a similar accident, etc. in the future are as follows.</p> <ul style="list-style-type: none"> <li>▪ The chief engineer regularly inspects the cylinder liner and the piston (including the piston rings) and checks whether they are within the tolerance.</li> <li>▪ When receiving a report that the main engine is unable to be repaired, the master promptly calls for a rescue.</li> </ul>  |

Attached Figure 1 Outline Map of Navigation Course



Attached Figure 2 Anchored Point



Attached Table 1 GPS and AIS Records of the Vessel (Excerpt)

| Date        | Time<br>(HH:MM:SS)          | Vessel's position*      |                          | Course<br>Over the<br>Ground*<br>(°) | Heading*<br>(°) | Speed<br>Over the<br>Ground<br>(kn) |
|-------------|-----------------------------|-------------------------|--------------------------|--------------------------------------|-----------------|-------------------------------------|
|             |                             | Latitude (N)<br>(°-′-″) | Longitude (E)<br>(°-′-″) |                                      |                 |                                     |
| February 1  | 10:24:00                    | 20-34-49.8              | 120-12-53.4              | 323.0                                | -               | 8.9                                 |
|             | 12:00:00                    | 22-48-48.0              | 120-04-23.4              | 332.0                                | -               | 9.3                                 |
| February 2  | 12:00:00                    | 23-33-43.8              | 120-00-42.0              | 225.0                                | -               | 5.1                                 |
|             | 17:00:00                    | 23-45-49.8              | 119-58-32.4              | 030.0                                | -               | 0.0                                 |
|             | 18:20:00                    | 23-40-19.8              | 119-58-07.2              | 330.0                                | -               | 0.0                                 |
|             | 19:00:00                    | 23-42-30.0              | 119-56-57.6              | 336.0                                | -               | 3.1                                 |
| February 3  | 00:00:00                    | 24-02-43.8              | 120-05-18.6              | 026.0                                | -               | 6.5                                 |
|             | 12:00:00                    | 25-12-00.0              | 120-59-59.4              | 032.0                                | -               | 7.1                                 |
| February 4  | 00:00:00                    | 26-47-30.0              | 122-13-46.8              | 031.0                                | -               | 10.3                                |
|             | 08:30:00                    | 27-59-12.0              | 123-12-58.8              | 039.0                                | -               | 5.3                                 |
|             | 12:00:00                    | 28-03-41.4              | 123-13-02.4              | 000.0                                | -               | 0.0                                 |
|             | 15:00:00                    | 28-07-41.4              | 123-13-50.4              | 060.0                                | -               | 4.4                                 |
| February 5  | 00:00:00                    | 29-08-34.8              | 124-14-39.0              | 038.0                                | -               | 10.2                                |
|             | 07:07:00                    | 30-05-06.6              | 125-02-58.2              | 000.0                                | -               | 0.0                                 |
|             | 10:15:00                    | 30-02-48.6              | 125-04-10.2              | 000.0                                | -               | 0.0                                 |
|             | 11:00:00                    | 30-04-43.8              | 125-11-20.4              | 032.0                                | -               | 6.9                                 |
|             | 12:00:00                    | 30-10-58.8              | 125-15-49.2              | 032.0                                | -               | 8.2                                 |
|             | 20:25:00                    | 31-10-18.6              | 125-49-15.0              | 000.0                                | -               | 0.0                                 |
|             | 21:40:00                    | 31-08-34.2              | 125-52-30.6              | 044.0                                | -               | 0.0                                 |
|             | 22:00:00                    | 31-09-42.0              | 125-54-08.4              | 042.0                                | -               | 8.4                                 |
|             | 23:05:00                    | 31-15-13.2              | 126-06-01.8              | 000.0                                | -               | 0.0                                 |
|             | 23:25:00                    | 31-14-43.2              | 126-02-03.6              | 037.0                                | -               | 8.4                                 |
| February 6  | 00:00:00                    | 31-15-35.4              | 125-03-48.6              | 064.0                                | -               | 4.2                                 |
|             | 03:00:00                    | 31-20-31.8              | 126-10-16.2              | 143.0                                | -               | 0.0                                 |
|             | 06:35:00                    | 31-16-57.0              | 126-14-32.4              | 030.0                                | -               | 3.4                                 |
|             | 07:00:00                    | 31-17-46.2              | 126-15-28.2              | 028.0                                | -               | 3.1                                 |
|             | 08:00:00                    | 31-19-51.6              | 126-17-30.6              | 049.0                                | -               | 3.4                                 |
|             | 08:50:00                    | 31-21-42.6              | 126-19-36.0              | -                                    | -               | -                                   |
|             | 12:00:00                    | 31-17-32.4              | 126-25-08.4              | -                                    | -               | -                                   |
| February 7  | 12:00:00                    | 30-45-04.8              | 126-47-01.2              | -                                    | -               | -                                   |
| February 8  | 12:00:00                    | 30-37-11.4              | 127-06-37.8              | -                                    | -               | -                                   |
| February 9  | 12:00:00                    | 30-28-30.0              | 127-05-44.4              | -                                    | -               | -                                   |
| February 10 | 12:00:00                    | 29-57-23.4              | 128-36-34.8              | -                                    | -               | -                                   |
| February 11 | 00:14:54: AIS was received. |                         |                          |                                      |                 |                                     |
|             | 00:14:54                    | 29-42-59.6              | 129-22-58.9              | 113.7                                | 047.0           | 4.4                                 |
|             | 01:00:00                    | 29-42-30.0              | 129-27-19.0              | 000.0                                | 358.0           | -                                   |
|             | 01:30:00                    | 29-40-31.8              | 129-31-18.6              | 000.0                                | 358.0           | -                                   |
|             | 02:08:11                    | 29-40-19.2              | 129-31-41.9              | 126.7                                | 358.0           | 3.4                                 |

|  |   |            |             |       |       |     |
|--|---|------------|-------------|-------|-------|-----|
|  | 03:08:05  | 29-39-15.7 | 129-34-20.4 | 111.4 | 311.0 | 3.3 |
|  | 03:18:54  | 29-39-02.2 | 129-35-05.2 | 110.7 | 292.0 | 4.5 |
|  | 03:28:05  | 29-38-48.9 | 129-35-47.2 | 104.8 | 288.0 | 4.3 |
|  | 03:31:35  | 29-38-44.3 | 129-36-03.2 | 110.2 | 296.0 | 4.2 |
|  | 03:35:05  | 29-38-40.7 | 129-36-18.8 | 105.2 | 285.0 | 4.1 |
|  | 03:36:05  | 29-38-39.6 | 129-36-23.3 | 107.1 | 284.0 | 4.0 |
|  | 03:36:35  | 29-38-39.0 | 129-36-25.5 | 108.5 | 285.0 | 4.0 |
|  | 04:00:00 and thereafter: No record of receiving AIS; the following records are the GPS records of the vessel. |            |             |       |       |     |
|  | 04:00:00  | 29-38-11.4 | 129-37-57.6 | -     | -     | -   |
|  | 05:00:00  | 29-37-18.6 | 129-40-26.4 | -     | -     | -   |
|  | 06:00:00  | 29-36-23.7 | 129-41-47.5 | -     | -     | -   |
|  | 06:40:00  | 29-36-23.7 | 129-41-47.5 | -     | -     | -   |

\* The vessel's position indicates the position of the GPS antenna installed above the bridge, and the courses over the ground and headings indicate in true bearings (hereinafter the same).