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# RULES FOR HULL MONITORING SYSTEMS

## Chapter 1      GENERAL

### 1.1      General

Hull monitoring systems (hereinafter referred to as “the systems”) stipulated in these Rules are to monitor the behavior of hull girders during navigation, loading and unloading, and to provide real-time information on stress levels due to longitudinal bending moments and acceleration levels due to ship motion. Furthermore, although such information is to be intended to aid the judgment of Shipmasters and crew members during navigational operations, it is not intended to be a substitute for the judgment and the responsibility of Shipmasters.

### 1.2      Application

These Rules apply to those hull monitoring systems of ships classified by the NIPPON KAIJI KYOKAI (hereinafter referred to as “the Society”) that have been registered before 1 July 2022 under [Chapter 3 of the Regulations for the Classification and Registry of Ships](#).

### 1.3      Equivalency

Hull monitoring systems which do not fully comply with the requirements of the Rules may be accepted provided that they are deemed by the Society to be equivalent to those specified in the Rules.

### 1.4      Systems with Novel Design Features

In the case of systems which are designed with novel design features, the Society may impose, to the extent that is practically applicable, all appropriate requirements of the Rules as well as any additional requirements other than those specified in the Rules.

### 1.5      Installations Characters

1    Character “HMS” is given in the Register for those systems which comply with the Rules.

2    Character “HMS•R” is given in the Register for those systems with continuous recording capabilities which comply with the Rules.

## Chapter 2 SURVEY

### 2.1 General

#### 2.1.1 Kinds of Surveys

The systems are to be subjected to the following surveys:

- (1) Surveys for registration of systems (hereinafter referred to as “Registration Surveys”)
- (2) Surveys for maintaining registration of systems (hereinafter referred to as “Registration Maintenance Surveys”), which are:
  - (a) Annual Surveys
  - (b) Occasional Surveys
  - (c) Unscheduled Surveys

#### 2.1.2 Time and Intervals of Surveys

- 1 Registration Surveys are to be carried out at the time of application for registration.
- 2 Registration Maintenance Surveys are to be carried out at the following intervals:
  - (1) Annual Surveys are to be carried out at those times stipulated in **1.1.3-1(1), Part B of the Rules for Survey and Construction of Steel Ships**
  - (2) Notwithstanding (1) above, Occasional Surveys are to be carried out independently of Annual Surveys in cases. To implement the survey, in lieu of the traditional ordinary surveys where a surveyor is in attendance, the Society may approve the survey methods which it considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys.
    - (a) Any main parts of systems have been damaged, repaired or renewed.
    - (b) Any systems are modified or altered.
    - (c) It is considered necessary by the Society.
  - (3) The classed ships may be subject to Unscheduled Surveys when the confirmation of the status of systems by survey is deemed necessary in cases where the Society considers the systems to be subject to **1.4-3** of the **Conditions of Service for Classification of Ships and Registration of Installations**.

#### 2.1.3 Surveys Carried Out in Advance

Annual Surveys may be carried out in advance of their due dates in accordance with the requirements given in **1.1.4, Part B of Rules for Survey and Construction of Steel Ships**.

#### 2.1.4 Preparations of Surveys

1 All such preparations considered necessary for surveys are to be made by and are the responsibility of survey applicants. Necessary arrangements are also to be made by survey applicants for persons having knowledge about the requirements of surveys to supervise survey preparation.

2 Surveyors may suspend surveys as follows:

- (1) In cases where necessary preparations have not been made.
- (2) In cases where an appropriate attendant is not present.
- (3) In cases where Surveyors consider that the safety for survey execution is not ensured.

#### 2.1.5 Disposition when Repairs are Considered Necessary as a Result of Surveys

In cases where repairs are deemed necessary as a result of surveys, surveyors notify survey applicants of their findings. Survey applicants, upon receiving such notification, are to obtain Surveyor verification after carrying out all necessary repairs.

#### 2.1.6 Laid-up Ships

1 Laid-up ships are not subject to Registration Maintenance Surveys. However, Occasional Surveys may be carried out at the request of owners.

2 When laid-up ships are about to be re-entering service, the following surveys and surveys for specific matters which have been postponed due to being laid-up, if any, are to be carried out.

- (1) If the due dates for Registration Maintenance Surveys have not transpired while the ship was laid-up, then an equivalent to the Annual Surveys specified in **2.3.1** is to be carried out.

- (2) If the due dates for Registration Maintenance Surveys have transpired while the ship was laid-up, then the Annual Surveys specified in 2.3.1 are to be carried out.

## 2.2 Registration Surveys

### 2.2.1 General

During Registration Surveys, performance, installation and initial set-up of systems are to be satisfied with the relevant requirements given in the Rules.

### 2.2.2 Submission of Plans and Documents

1 In the case of hull monitoring systems to be registered, the plans and documents specified in (1) to (8) below are to be submitted to the Society for approval.

- (1) Documentation explaining system functions.
- (2) General arrangements and Midship section drawings of ships showing cable arrangements and positions of any strain gauges, accelerometers and main units of systems.
- (3) Block diagrams illustrating system operation.
- (4) Documentation regarding output display methods.
- (5) Documentation regarding the manufacture names, types, accuracy measurements, range and frequency response characteristics of sensors.
- (6) Documentation regarding data content, recording methods and data storage device capabilities.
- (7) Operation manual for the system.
- (8) Any other documents deemed necessary by the Society.

2 The plans and documents specified in (1) to (3) below other than those listed in -1 above are to be submitted.

- (1) Procedures for installing, adjusting and calibrating sensors.
- (2) Procedures for system simulation tests.
- (3) Any other documents deemed necessary by the Society.

3 The plans and documents specified in -1 and -2 above are to be submitted the Society in accordance with (1) to (3) below.

- (1) Where the submission of plans and documents by paper, 2 sets for the Society and necessary sets for returning to the applicant are to be submitted.
- (2) Where the submission of plans and documents electrically, the plans and documents are to be submitted using the systems prepared by the Society.
- (3) Where the submission of plans and documents by means other than (1) and (2) above, the plans and documents are to be submitted by the means deemed appropriate by the Society.

### 2.2.3 Simulation Tests

After installation, processing functions of systems are to be tested in the presence of Surveyors in order to confirm they are satisfactory. Simulation tests are to be conducted using simulated input signals in accordance with those simulation test procedures submitted prior to such tests. Values produced by systems are to be compared with those values calculated using simulated input signals.

### 2.2.4 Surveys for Installation and Initial Set-up

1 After installation, it is to be ascertained, in the presence of a Surveyor, that the sensors and other devices of systems are installed and set up according to plan.

2 Initial set-up and its verification are to be carried out as follows:

- (1) Strain gauges are to be initially set in ballast conditions or light ship conditions in accordance with the requirements given in 3.3.1-1.
- (2) Verification of the initial set-up mentioned (1) above is to be carried out in full draught conditions within a period of three months in the presence of a Surveyor. During such verification, stress levels obtained from strain gauges are to be compared with outputs of any loading instruments or calculations using loading manuals. In cases where the difference is greater than  $50\mu$  strain, those procedures stipulated in (1) and the above mentioned procedures are to be repeated.

## **2.3 Registration Maintenance Surveys**

### **2.3.1 Annual Surveys**

**1** During Annual Surveys, the following examinations and confirmations of systems are to be carried out:

- (1) It is to be ascertained that systems are in good order in accordance with those procedures submitted prior to the survey.
- (2) It is to be ascertained that current calibration certificates for sensors, including strain gauges, accelerometers and so on are kept on board. In cases where deemed necessary by Surveyors, such sensors are to be re-calibrated.
- (3) The following examinations are to be carried out:
  - (a) It is to be examined to see whether the mean values of those longitudinal hull girder bending moments stipulated in **3.2.4-1(2)** coincide with those values given by loading computers or loading manuals.
  - (b) Any data recorded in accordance with the requirements given in **3.2.5** is to be examined.
- (4) Operation manuals are to be verified as being on board.

### **2.3.2 Occasional Surveys**

During Occasional Surveys, inspections, tests or investigations are to be carried out on necessary items according to those cases stipulated in **2.1.2-2(2)** in order to ascertain that systems comply with the Rules. To implement the survey, in lieu of the traditional ordinary surveys where a surveyor is in attendance, the Society may approve the survey methods which it considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys.

### **2.3.3 Unscheduled Surveys**

At Unscheduled Surveys, investigations, examinations or tests are to be made to the satisfaction of the Surveyor with respect to the matters concerned.

## Chapter 3 HULL MONITORING SYSTEMS

### 3.1 General

#### 3.1.1 General

In order to allow systems to be efficiently used, operation manuals written in English and in a language understandable by the crew are to be kept on board.

### 3.2 System Requirements

#### 3.2.1 General

1 Systems are to consist at least of the following (1) to (5):

- (1) Sensors for measuring stress and acceleration of ships.
- (2) Microprocessors that can interpret sensor signals into information on stress and acceleration, and compare these with those warning indices stipulated in 3.3.2.
- (3) Displays that can show information about stress and acceleration.
- (4) Audible and visible alarms that can provide warning when levels of stress and acceleration obtained from sensors exceed those warning indices stipulated in 3.3.2.
- (5) Data storage devices that can record information on stress and acceleration.

2 All sensors and devices associated with systems located in hazardous areas are to be intrinsically safe types.

3 Systems are to be connected to main power supplies, and to be arranged to operate automatically from alternative power supplies in the event of any main power supply failures.

4 Audible and visible alarms are to be given on bridges in the event of any power supply failures.

5 Systems are to be linked to loading computers and are to be able to show the output values of systems with the approved values of allowable longitudinal hull girder bending moments at the intermediate and final stages of any loading and unloading operations on the same display in order to be able to compare such values.

#### 3.2.2 Strain Gauges

1 Strain gauges are to be suitable for measuring structural responses of hull structures. In cases where measuring hull girder stresses, the effects of other local stresses and stress concentrations are to be excluded.

2 Strain gauges are to be located as close as practicable to those positions where hull girder stress can be expected to be at a maximum based on design loading conditions. In general, strain gauges are to be fitted at both sides around amidships as well as one side around  $L/4$  afore from aft end and  $L/4$  abaft fore end of ships corresponding to their size.

3 In the case of container carriers, in addition to -2 above, strain gauges are to be fitted at both sides under neutral axis in the same section to those strain gauges fitted around amidships.

4 Strain gauges are to be sufficiently durable according to their surrounding environment.

5 Strain gauges are to be able to compensate any temperature effects on hull structures due to sunshine.

6 Strain gauges are to be able to measure strain with an accuracy to at least  $10\mu$  strain. Measuring ranges are to cover full ranges of any expected still water stress and variable stress due to wave loads.

7 Strain gauges are to have frequency responses capable of measuring any strain in the range 0 to 5Hz.

#### 3.2.3 Accelerometers

1 Vertical acceleration is to be measured on centerlines, within  $0.01L$  abaft of fore ends.

2 In the case of container carriers, transverse acceleration at main deck levels around amidships is to be measured in addition -1 above.

3 Acceleration is to be measured to an accuracy of at least  $0.01G$ , and to be measured over the range  $-2G$  to  $+2G$ .

4 Accelerometers are to have frequency responses capable of measuring acceleration in the range of 0 to 5Hz. Those accelerometers measuring vertical acceleration of the fore parts of ships are to have frequency responses capable in the range of 0 to

100 Hz.

#### 3.2.4 Displays

1 Systems are to be able to display the following four sets of data in navigation bridges in an understandable manner, taking due consideration of the importance of human interface.

- (1) Real-time values of stress and acceleration.
- (2) Mean values of stress and acceleration.
- (3) Standard deviations of stress and acceleration.
- (4) Peak values of stress and acceleration.

2 Systems are to be able to display the number of times acceleration occurred due to slamming within a period of one hour period as well as to display any vertical acceleration of fore parts.

3 Any data stipulated in -1(1) to (4) above is to always be displayed as default settings of systems.

4 Data related to longitudinal hull girder bending stresses stipulated in -1(1) to (4) above is to be displayed for positions that coincide with one of the readout points of loading computers.

5 Those values stipulated in -1(2) to (4) above are to be displayed in a manner that any trends in such data over at least the last 4 hours are indicated. Displays are to be updated at least every 10 to 30 minutes.

6 Systems are to have functions to visually compare any values obtained from sensors with those warning indices stipulated in 3.3.2.

#### 3.2.5 Data Storage Devices

1 Data storage devices are to be provided for the purpose of verifying that all sensors are working during navigation. Such devices are to record the following information at least once per month during voyages, for over a period of 30 minutes.

- (1) Mean values of stress and acceleration.
- (2) Standard deviations of stress and acceleration.
- (3) Peak values of stress and acceleration.
- (4) Mean periods of stress and acceleration.
- (5) The number of occurrences of slamming.
- (6) Dates and times.

2 In cases where systems are intended to be registered as “HMS•R”, data storage devices are to be able to continuously record information for a period of at least one month.

3 Any data recorded by data storage devices is to be protected from any corruption caused by power loss.

4 In cases where voyage data recorder systems (VDR) are installed onboard, such VDR systems are to record real-time information of stress and acceleration at the all times.

### 3.3 Set-up of Systems

#### 3.3.1 Initial Set-up of Strain Gauges and Accelerometers

1 Strain gauges are initially to be set to stresses calculated in approved loading conditions which are compatible with outputs of loading computers or loading manual calculations. Initial set-up is not to be carried out in cases where variable stress due to wave loads and temperature effects due to sunshine are present.

2 Accelerometers are to be initially set in accordance with the specification of manufactures approved by the Society.

#### 3.3.2 Warning Indices

Index values for setting up alarms in order to judge danger to ships from stress and acceleration are to be decided by shipowners in consultation with the Society.