Guideline No.E-13 (201610)

E-13

MONITORING AND ALARM (DISPLAY) SYSTEM

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Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

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Main changes:

1. Guideline on Type Approval Test of Electrical and Electronic Products (GD01-2006) (2006)" is modified to "CCS GD 22-2015 <Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version)". "GD01-2006" appearing in this guideline is modified to <Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version) , which is enter into force from Jan.1 2016.

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MONITORING AND ALARM (DISPLAY) SYSTEM

1 Application

1.1 The Guideline applies to the approval and inspection of the monitoring and alarm (display) system installed on the marine ship and offshore installations (hereinafter referred to as the ship) specified in Part Seven of the *Rules for Classification of Sea-Going Steel Ships*.

1.2 According to the universality of the computer system definition in the regulations of CCS and recognized standards, the products involved in the above-mentioned devices can all be classified as the computer system (except for individual product) in spite of different complexity.

1.3 According to the requirement on the system classification specified in Article 1.4 of Annex of Chapter 2 in Part Seven of the *Rules for Classification of Sea-Going Steel Ships*, the equipment should be classified as the Category-II equipment, namely, such system failure will endanger eventually the personnel and ship safety as well as the environment.

2 Basis for approval and inspection

2.1 CCS *Rules for Classification of Sea-Going Steel Ships*

2.2 IEC60092-504: 2001 *Electrical Installations in Ships- Part 504: Special Features-Control and Instrumentation*

2.3 IMO A.1021 (26) *Code on Alerts and Indicators, 2009*

2.4 CCS GD22-2015: Guideline on Type Approval Test of Electrical and Electronic Products (Current edition)

3 Definitions

The terms and definitions specified in the above-mentioned basis apply to the Guideline. To facilitate the compilation and use, the Guideline directly cites or supplements the following definitions.

3.1 Rules for Classification of Sea-Going Steel Ships

It means the *CCS Rules for Classification of Sea-Going Steel Ships*

3.2 Alarm

Alarm means a visual and audible signal of a predetermined out-of-limits parameter for the monitored machinery or system.

3.3 Group alarm

Group alarm means a common alarm activated by any abnormal conditions of the monitored machinery or system.

3.4 Computer-based system

A system that consists of one or more interconnected programmable electronic equipment, peripherals and necessary software and is capable of completing specified functions automatically. The following programmable equipment can constitute a computer-based system: mainframe, minicomputer, microprocessor-based computer, and programmable logic controller.

3.5 Safety systems mean systems which will operate automatically for safeguarding the machinery or electrical equipment in question in the following three modes of operation in case of serious faults endangering the main propulsion machinery, boilers, electric generating plants and other essential machinery or electrical equipment:

Mode a: immediate shutdown, e.g. emergency stop of main engines, emergency cutoff of boiler fuel oil supply and emergency cutoff of electric power supply to consumers. And such machinery or equipment is not to be put into operation again if without the manual resetting;

Mode b: the operation of the machinery is temporarily adjusted to the prevailing conditions, e.g., by reducing the output or rate of turn of the machinery;

Mode c: the normal operating conditions are restored by starting of standby machinery.

3.6 Control system

The system used to adjust the operation of the equipment or system

3.7 Control station (room)

Control stations (rooms) means spaces fitted with monitoring means capable of controlling the machinery and electrical installations. They are mainly divided into four categories as follows in the *Rules for Classification of Sea-Going Steel Ships*:

3.7.1 Centralized control station (room) of the engine room: means a control station (room) in which all monitoring means for automated equipment in engine room are concentrated;

3.7.2 Bridge control station (abbreviated to BCS) means a control station monitoring the propelling plant and other equipment in bridge;

3.7.3 Local control station means a control station where machinery and electrical installations are locally controlled;

3.7.4 Other control stations mean control stations except the above-mentioned three ones.

3.8 Fail-safe

Fail-safe principle means that upon failure or malfunction of a component or system, the output automatically reverts to a predetermined design state of least critical consequence. The system should enter the preset safety status when it is initially started or restarted due to any failure. The fail-safe principle should take into consideration not only the safety of the system-related machinery but also the safety of the whole device, and even the safety of the ship and personnel.

3.9 Redundancy design

Redundancy design means standby technical means to be used in case of system or equipment fault, by which a corresponding function can be taken over to continue an action or an original function is restored to continue the operation condition.

3.10 Independence

Control, safety and alarm systems are to be designed or rendered to function independently of each other so that a failure or malfunction in one or two of these systems will not prevent the other system(s) from operating.

System A independent of system B: A single failure of system B will not affect the normal operation of system A. However, a single failure of system A may affect the normal operation of system B.

Mutual independence of systems A and B: Any single failure of system A or B will not affect each other.

4 Plans and documents

4.1 The following plans and documents should be submitted to CCS for approval:

4.1.1 System instructions (technical conditions of product)

The system instructions (technical conditions of product) should specify the general requirements on product performance and design, including at least the applicable part of the following contents:

－Requirement on product environment condition: The adaptability requirement on the working conditions (including the electromagnetic compatibility) of the product specified in the Rules for Classification of Sea-Going Steel Ships. －Details on product functions: including detailed description on system configuration, product application, product control and monitoring function and the realization method, detailed safety status of the function realized, features of the system under various operation conditions (including emergency or failure), as well as operation Guidelines under normal and abnormal status.

－Details on transfer of control.

－Details on redundancy setting and conversion mechanism.

－Details on failure monitoring and recognition function (manually or automatically).

－Details on data security and user safety level (function access permission).

－List of control and inspection items: List of all system input/output signals (service description, instrument, system and signal type, range and limit setting range).

4.1.2 Hardware instructions

It should include at least the applicable part of the following contents:

－Details on main hardware configurations of the product.

－System block diagram: Describes the connection between main components of all systems (software/hardware unit and module) as well as the interface with other systems.

－Detailed data on input/output equipment.

－Detailed data on power supply unit.

4.1.3 Wiring diagram

It should include at least the applicable part of the following contents:

－Power supply arrangement: The power supply arrangement of the system as well as the connection between the system and the switch panel, battery, convertor or UPS.

－Circuit diagram of key hardware circuit involving emergency operation and interlock, details on input/output equipment, and power supply status of each circuit.

4.1.4 Software instructions

It should include at least the applicable part of the following contents:

－Descriptions on basic software installed on each hardware unit.

－Descriptions on communication software installed in the network node.

－Descriptions on application software: Information on guaranteeing mandatory function of the system module and dependency upon other systems, relationship between software modules for guaranteeing mandatory operation of each function, as well as the data flow and control flow between software modules.

－Software configuration, including priority scheme.

－Handoff mechanism between redundancy systems

4.1.5 UI instructions

It should include at least the applicable part of the following contents:

－Descriptions on function allocation of each workstation and operation station as well as the transfer of control between stations.

－Descriptions on the function specified for each input equipment

－Arrangement, size and necessary photo of the input/output equipment

－Descriptions on each user input interface and menu

4.1.6 Test procedures: It should describe the test configuration and analogy method. Each test should specify the initial status of the equipment/system, test method, test result analysis, acceptance criterion, normal mode and failure mode, as well as the power supply and communication failure mode.

4.2 The following plans and documents should be submitted to CCS for information:

4.2.1 Operation manual (including troubleshooting instructions);

It should include at least the system start-up, function recovery, maintenance and regular test, data security and backup, user permission, software re-installation and system recovery, failure positioning and troubleshooting, system updating, and other items to be noted by users.

4.2.2 Software quality control plan

It is compiled according to the software service cycle and should include the technical software requirement, data requirement, software function test (parameter test and effectiveness test), system development plan, software modification and version control.

Note: 1 The above-mentioned items provide the general requirements on contents to be covered in the documents submitted by the manufacturer, which vary with specific product features.

Note: 2 The contents involved in each item mentioned above does not mean it should be submitted separately.

5 Design and technical requirements

5.1 Operating conditions

The equipment should work normally under the operating conditions specified in Section 1 of Chapter 2 in Part Seven of the *Rules for Classification of Sea-Going Steel Ships*. The operating conditions of the equipment are as follows, unless otherwise specified:

5.1.1 Environmental conditions

(1) Ambient air temperature: 0℃~55℃; For equipment that is required by the manufacturer to be installed in the location the ambient air temperature of which is to be controlled as per the requirement specified in 1.2.1.2 of Part Four in the *Rules for Classification of Sea-Going Steel Ships*, the max. ambient air temperature can be reduced from 55℃ to not less than 35℃, and relevant description should be added to corresponding certificate issued by CCS.

(2) Inclination and swinging: Heeling and rolling of 22.5 °and trimming and pitching of 22.5 °.

(3) Vibration and shock: The general vibration condition specified in CCS Guideline on Type Approval Test of Electrical and Electronic Products ..

(4) Damp air: Temperature of +55℃ and relative humidity of 95%.

5.1.2 Electrical operating conditions

(1) Voltage and frequency fluctuation

AC

Voltage: Steady state change of +6~-10%, transient state change of ±20%, and recover time of 1.5 s.

Frequency: Steady state change of ±5%, transient state change of ±10%, and recover time of 5 s.

DC:

Rectifier power supply: Steady-state voltage fluctuation of ±10 %, cyclical voltage fluctuation of 5%, and ripple voltage of 10%.

Battery power supply: Connect to the battery during charge Voltage: +30%~-25%

Battery power supply: Do not connect to the battery during charge Voltage: +20%~-25%

(2) Harmonic distortion

The AC electrical equipment should run normally when the voltage harmonic distortion of the power supply is not more than 5%.

5.2 General requirements

5.2.1 The requirements specified in Part Seven of the *Rules for Classification of Sea-Going Steel Ships* apply to the Guideline, with the following supplements.

5.2.2 Circuit design

(1) Each activity during the system development (from the initial design to realization, as well as the follow-up improvement during application) should be planned and managed systematically. Personnel to carry out such activity should be competent. Relevant activity, scope, personnel responsibility and competence requirement should be documented.

(2) The repairable and replaceable components should be accessible for replacement. All replaceable components should be arranged in such a way that they cannot be connected or used incorrectly. Otherwise, such components and relevant connectors should be marked clearly.

(3) The circuit design should facilitate the effective test, calibration, maintenance and repairing. It is more advisable that the circuit is designed in such a way that it can be repaired by replacing the unit or functional card. In some circumstances, simulation operation or test circuit should be provided, so as to check whether the equipment run normally.

(4) The circuit design should guarantee that there is no direct connection between the system/equipment and the main ship electric network, for example, to supply power via an isolated transformer. The equipment frame should not be part of the circuit, except for the functional grounding circuit.

(5) The signal should be strong enough so as to overcome any contactor corrosion and interference signals effect. The transmitter and amplifier should be arranged as close as possible. The shielding layer grounding and reference signal system should be paid special attention.

(6) To avoid any external interference to the control and instrument cable, the following methods should be adopted during cable selection and installation: adopting the shielded cable or paired cable and balanced input amplifier, and separating the signal cable with other cables during laying.

(7) The alarm circuit should be designed in the form of closing line generally (i.e. an alarm or failure signal should be given in case of disconnection), for example, to provide circuit monitoring means or adopt other circuit design method.

(8) In case of any alarm (or measuring) circuit grounding failure, alarm should be sent, unless the circuit is designed in a way that such failure will not affect the normal operation of the system or ship/personnel safety.

(9) The failure of one channel (or one module, which may involve multiple channels) will not affect other alarm channels (modules).

(10) The failure of the indicating lamp circuit (including short circuit) should not affect the audio alarm circuit.

(11) The accuracy of signal processing of the monitoring and alarm system should meet the requirement of the recognized standard, which should be specified by the manufacturer.

5.2.3 Equipment enclosure and enclosure protection level

(1) The equipment enclosure should be made of durable, flame-retarding and humidity-resistance materials, in which the metal part should be made of materials with sound corrosion resistance and provided with reliable protective layer.

(2) The enclosure protection level should meet relevant requirement specified in Table 1.3.2.2 of Section 3 in Chapter 1 of Part Four of the *Rules for Classification of Sea-Going Steel Ships*.

5.2.4 Internal and external wring and connection

(1) If any plug/socket connection is adopted, the contact point should not bear any other mechanical load even when components are pulled out and replaced except for maintaining necessary contact force. Wiring slot used for the needle joint, circuit board slot or other multi-point connector should be provided with fixing devices to avoid any looseness due to vibration/impact.

(2) The internal cable and insulated conductor should be of flame-retarding type. Any mechanical damage to the cable due to vibration should be avoided.

(3) The control equipment (including the convertor) should be provided with sufficient space for wiring, so as to guarantee satisfactory cable connection, and it is suggested to connect one connection terminal with one conductor. All connection terminals should be marked clearly. The cable shielding layer should be provided with proper connection terminal.

5.2.5 Power supply

The alarm system should be supplied with power at least from the main power supply. In case of the above-mentioned power supply loss, the alarm system should be switched over automatically to the independent backup power supply used by the automation system and give alarm. Such backup power supply can be a battery set with capacity of supplying power for at least 30 min. If the above-mentioned system is affected adversely due to power interruption, the backup power supply should be applied without any delay.

5.2.6 Fail-safe, system independence and redundancy setting

(1) The monitoring and alarm system should be designed according to the fail-safe principle.

(2) The control system, safety system and alarm system should be designed independent or with independent functions, and that one or more systems failure should not affect the normal

operation of other systems. In any circumstance, category-A safety system should be independent of the control system and alarm system, so as to avoid any effect from other system failure, but category-B/C safety system is not required to be completely independent of other control system and alarm system.

(3) The design of the monitoring and alarm system should guarantee that any system failure (such as the sensor or external equipment failure) will not cause any failure of the monitored equipment, the computer system, the monitoring and alarm system itself.

(4) The host computer, network controller and display unit based on the monitoring and alarm system of the computer should adopt the redundancy setting. The system should be provided with reliable redundancy conversion mechanism.

5.3 Functional requirement

5.3.1 General requirement

(1) The design and manufacturing of the monitoring and alarm (display) system should fit specific applications of the ship. The quantity and function of the alarm control stations (or extended display stations) as well as the quantity and specific contents of the monitoring items should meet relevant requirements specified in Chapters 3 and 4, Part Seven of the *Rules for Classification of Sea-Going Steel Ships*.

(2) The monitoring and alarm (display) system should be designed in such a way that initialization setting can be carried out on the ship according to the plan approved by CCS and user's requirement (such as the monitoring alarm items and text description, time delay process of the alarm signal, and alarm limit), provided with relevant protective facilities to guarantee that the computer can be used only for monitoring and alarm and avoid unauthorized modification after the initialization setting is completed and approved by CCS.

(3) If the system is provided with multiple workstations, the operating status of the station should be displayed, and the conversion between stations should adopt the method of request-response.

(4) The alarm function should take precedence over other operations of the monitoring and alarm system, including the failure searching program.

(5) The monitoring and alarm system should process the monitoring signal properly to eliminate transient signal (such as the pressure surge, sensor output value variation, and electromagnetic interference), and set time delay for the liquid level signal. In case of any deviation from the alarm setting during normal equipment shutdown and startup, it should lock the alarm channel automatically. If the alarm channel is locked manually, it should be displayed clearly via visual signal.

(6) The alarm signals should be displayed as per the occurrence sequence and searched according to the occurrence time.

(7) Alarm data update time: The update times of the site data involved in the alarm items with priorities of levels 1 & 2 should not exceed 2 s and 30 s respectively, and those with other priorities should not exceed 300 s.

(8) Upon alarm triggering, the alarm channels of alarm items with priorities of levels 1 and 2 should be displayed in 2 s, and others in 30 s.

(9) The centralized control station (room) of the engine room should be provided with automatic record equipment for recording key parameters and failures.

5.3.2 Alarm and confirmation

(1) All failures of the monitored electromechanical equipment and the monitoring system itself should be displayed in relevant control station (room), with an alarm signal given as well, so as to let the duty engineer know the failure. Regardless of the display type, the alarm signal should be clear and unambiguous, which can facilitate the recognition of the details and position of failures at the machinery location.

(2) All the alarms should be given with both the visual and audio alarm signals. In general, the colors for major failures and common ones are red and yellow respectively. The audio signal should be loud enough with obvious difference with the fire alarm, telephone and other audio signals (for example, releasing CO_2).

(3) The alarm system should give an alarm signal for all failures occurred at the same time. The alarm and /or alarm response of certain failure should not hamper those of other failures occurred at the same time. The partial elimination of audio alarm signal at the navigation bridge and living place should not prevent generation of the audio alarm signal at the machinery location.

(4) If the alarm is responded, and there is another failure occurred before the first failure is eliminated, the visual and audio alarm signals should be given again at this time. The alarm sent out for transit failure should be held before being responded.

(5) The alarm equipment can be provided with device to eliminate audio alarm signal (silencing). When the silencing button is pressed down after the alarm signal is responded, the visual alarm signal can be changed (for example, from flashing to front light) rather than being eliminated, which should remain clean and distinguishable. The silencing button for the audio alarm signal at the machinery location can only be set at the machinery location or in the centralized control room, and the audio signal should be held till the failure is eliminated. After failure elimination, such alarm channel should be restored to normal operation status automatically.

(6) If an alarm is displayed at the centralized control station (room) of the engine room, it should also be displayed at other relevant control station (group alarm can be adopted). Four types of group alarms can be adopted in the navigation bridge control station, namely, the group alarm for safety system operation, individual alarm, group alarm for major failure, and group alarm for common failure.

(7) If the navigation bridge control station is available, and the local control station detects failure from the machinery, the alarm system should let the duty officer be aware of the following:

① A failure has occurred;

② The failure occurred has been noticed (such as being responded or silencing made);

③ The failure has been eliminated.

(8) The group alarm can be adopted to display the failure in the navigation bridge. However, the alarm on the deceleration failure of the propelling plant or that of the automatic shutdown should be distinguished.

(9) Change-over switch should be set for monitoring and alarm system at the regularly-unattended machinery location, so that all failure alarms can be extended to the marine engineer's public space and each marine engineer's living space in the form of group alarm, guaranteeing such alarm signal can be extended to one compartment of the marine engineers.

(10) If the monitoring and alarm system is to be used on ships with unmanned engine room, it should be designed such that an alarm, if not being responded at the machinery location (including the centralized control station (room)) within certain time, should trigger automatically the marine engineer's alarm device specified in 2.8.4 of Chapter 2 in Part Four of the *Rules for Classification of Sea-Going Steel Ships*, which should be heard clearly in the marine engineer's compartment and relevant public spaces.

5.3.3 Supplementary requirement on alarm and parameter display

(1) Instrument and display can be used for parameter display. The parameter can be displayed separately, selectively, with text or graph, but clearly. If signs are adopted to display the alarm and information, an explanatory list of such signs should be provided, which should be used uniformly in the whole computer system. The indicating lamp signal should be in green and white generally.

(2) The alarm display arrangement should facilitate the recognition of the details and position of failures at the machinery location.

(3) If a display is used to replace the common indicating lamp alarm display, the following requirements should be met:

① The contents displayed on the display should be clean in bright environment, and the data and information displayed on the display should be read easily by operators at normal operation positions; the display brightness should be adjusted in the navigation bridge under night light conditions. If color display is adopted, various alarms can still be distinguished in case of single color failure; the letter, digital and graph displayed under all illumination conditions should be clear and distinguishable at a place 1.5 m away.

② The display should display clearly all the alarms;

③ The display should display the difference of failure alarms before/after being responded properly (the method using different colors for distinguishing is not sufficient);

④ Printer should be provided to record the failure contents and failure occurrence time;

⑤ At least 1 backup display or lamp panel should be provided;

⑥ In case of the main power supply loss, the display can still work normally;

⑦ If a display is used for both parameter display and alarm, the parameter display should not hamper the alarm signal.

5.3.4 Alarm system inspection and self-inspection

(1) The alarm system should be provided with self-inspection function, i.e. it can inspect the failure of itself and give an alarm (or indication), so as to avoid any failure not alarm or false alarm. The self-inspection range and degree can vary with the maintenance and replacement measures. In case of any failure occurred in the system (such as power supply failure or sensor failure), it should give and display an alarm, which should have obvious difference with those of the external failures. If only the manual self-inspection operation facility is provided, it should be approved by CCS to ensure that it meets the above-mentioned function requirement. In addition, it should monitor the program execution and information transmission automatically and periodically, and give alarm in case of any data transmission intervention;

(2) The monitoring and alarm setting (sensitivity and limit value) should be inspected and recognized easily, as well as modified conditionally, i.e. only designated personnel can conduct the modification with the tools such as the key, special code or other methods. If multiple terminals (workstations) are in operation, measures should be taken to prevent parameters from being set at different workstation at the same time.

5.3.5 Network

The intranet of the monitoring and alarm system should meet the requirement specified in Section 7 of Chapter 2 in Part Seven of the *Rules for Classification of Sea-Going Steel Ships*. The capacity of data communication should meet the alarm data updating requirement specified in 5.3.1 of the Guideline.

5.3.6 Interface with other systems

Specific requirement should be available for the interface of the monitoring and alarm system with other systems (such as the VDR system, control system, and safety system). For specific interface requirements, see the ship plans approved by CCS.

5.4 Electromagnetic compatibility

The facility should meet the test requirement specified in CCS Guideline on Type Approval Test of Electrical and Electronic Products .

6 Materials and components

The materials and components of the product should be controlled as per relevant requirement of current regulations of CCS.

7 Type approval and unit/batch inspection

7.1 The monitoring and alarm system should be approved by CCS. The issuing, maintaining, modification, replacement, and cancellation of the type approval certificate should be conducted according to Chapter 3 in Part One of the *Rules for Classification of Sea-Going Steel Ships*.

7.1.1 Selection of Typical Sample

(1) The model and specification of the test sample should be typical in technology, and cover the scope of products applied for type approval.

(2) For products with same structure and electrical design, models with all software and hardware functions of the products to be subject to type approval can be selected for type approval test. One set of such product can be selected as the test sample. The test sample should be selected by the CCS Surveyor at the factory.

(3) If the main components of the facility are produced by different manufacturers, CCS can select samples separately for approval test according to the above-mentioned principle.

7.1.2 Test agency

Test agencies accepted by CCS or the authoritative and impartial ones have the priority for type approval test. For some functional test items, the test can be conducted at the factory provided that the factory meets the test requirement and the test is approved and supervised by the CCS Surveyor.

7.1.3 Type approval test item and requirement

(1) Environmental condition test

It should be conducted according to the requirement in the *Guideline on Type Approval Test of Electrical and Electronic Products*

(2) Electromagnetic compatibility test

It should be conducted according to Article 5.4 of the Guideline.

(3) Functional test

① Test arrangement

For initial approval, the samples selected should be formed into an integrated system for test. Simulation test method should be provided for each type of alarm channel, which should simulate the actual conditions as far as possible.

② Test item, method and result

It should be conducted based on the test procedure approved by CCS. The test procedure should specify the test method and test result criterion for each function to be verified according to the requirement of 5.2 and 5.3 of the Guideline as well as the features of specific products, and include such contents as the system self-inspection, system failure simulation test, and redundant equipment conversion (if any).

7.2 Unit/batch inspection

7.2.1 General requirement

After passing the type approval, the factory should conduct the following factory tests on each product, and issue factory test report. The CCS Surveyor will inspect the product one by one.

7.2.2 Factory test items

(1) Main components (parts) data verification

(2) Appearance and interior wiring inspection

(3) Insulation resistance measurement

(4) High voltage test

(5) Functional test

It should be carried out according to the approved factory test program. For specific items, see 7.1.3 (3) of the Guideline. The function test can be carried out via simulation test.

CCS will issue the certificate of marine product after the product passes the factory tests specified above.