

Rules for the Classification of Steel Ships

(Development Review : For external opinion inquiry)

Part 6 Electrical Equipment and Control Systems

2022. 9.



Machinery Rule Development Team

Effective Date : 1 July 2023

(The contract date for ship construction)

Present	Amendment	Remark
<p style="text-align: center;">CHAPTER 1 ELECTRICAL EQUIPMENT</p> <p style="text-align: center;">Section 1 General</p> <p>101. <same as the present Rules></p> <p>102. Drawings and data The drawings and data to be submitted for approval before the commencement of work are generally as follows:</p> <ol style="list-style-type: none"> 1. <same as the present Rules> 2. Drawings and data to be submitted by the manufacturers of electrical equipment Drawings and data are to be submitted and approved by manufacturers of electrical equipment in accordance with 103. 1. Table 6.1.1. <p>103. <same as the present Rules></p>	<p style="text-align: center;">CHAPTER 1 ELECTRICAL EQUIPMENT</p> <p style="text-align: center;">Section 1 General</p> <p>101. <same as the present Rules></p> <p>102. Drawings and data The drawings and data to be submitted for approval before the commencement of work are generally as follows:</p> <ol style="list-style-type: none"> 1. <same as the present Rules> 2. Drawings and data to be submitted by the manufacturers of electrical equipment Drawings and data are to be submitted and approved by manufacturers of electrical equipment in accordance with 103. 1. Table 6.1.1. <p style="text-align: center;"><u>Table 6.1.1 <see the next page></u></p> <p>103. <same as the present Rules></p>	<p>(Amended)</p> <ul style="list-style-type: none"> - In the Table 6.1.1, test and inspection, and type approval requirements for UPS has been added. - Electric couplings and frequency converters has been amended to cover for power supply. <p>(newly added)</p> <ul style="list-style-type: none"> - Test and inspection, and type approval requirements for electric power converters has been added.

〈Present〉

Table 6.1.1 Electrical equipment and cables subject to the approval and test (2019)

No.	Electrical equipment and cables	Drawing approval	Test and inspection	Type approval
1-5	〈same as the present Rules〉			
6	Electronic coupling and frequency <u>changer for electric propulsion unit</u>	X	X	X
7 - 20	〈same as the present Rules〉			
(Notes) (1) - (10) 〈same as the present Rules〉 (11) <u>Type approval apply for Uninterrupted power supplies for essential services 5kVA or more and emergency source of electrical power of 50kVA or more. Test and inspection apply for Uninterrupted power supplies of 50kVA or more (2019)</u> (12) - (15) 〈same as the present Rules〉 (16) 〈newly added〉				

〈Amendments〉

Table 6.1.1 Electrical equipment and cables subject to the approval and test (2019) (2023)

No.	Electrical equipment and cables	Drawing approval	Test and inspection	Type approval
1-5	〈same as the present Rules〉			
6	Electronic couplings and frequency <u>changer converters for electric propulsion unit</u>	X	X	X
7 - 20	〈same as the present Rules〉			
(Notes) (1) - (10) 〈same as the present Rules〉 (11) <u>Type approval apply for Uninterrupted power supplies for essential services 5kVA or more and emergency source of electrical power of 50kVA or more are to satisfy the requirements of the type approval test specification in accordance with Ch 3, Sec 39 of the 「Guidance for Approval of Manufacturing Process and Type Approval, etc.」. Test and inspection apply for Uninterrupted power supplies of 50kVA or more are to satisfy the requirements of the test and inspection in accordance with 1203. 6. (2019)</u> (12) - (15) 〈same as the present Rules〉 (16) <u>Converters for power supply of 50kVA or more and for motor drives or propulsion of 100kW or more are to satisfy the requirements of the type approval test specification in accordance with Ch 3, Sec 39 of the 「Guidance for Approval of Manufacturing Process and Type Approval, etc.」. For power and control modules certified type approval such as IGBT are installed in enclosures, test and inspection may be accepted.</u>				

Present	Amendment	Remark
<p style="text-align: center;">Section 2 System Design</p> <p>201. General</p> <p>1. – 7. <same as the present Rules></p> <p>8. Harmonic distortion (2020)</p> <p>(1) General</p> <p>(A) The total harmonic distortion (THD) of electrical distribution systems is not to exceed 8% and any single order harmonics not to exceed <u>3%</u>.</p> <p>(B) <same as the present Rules></p> <p>(2) <same as the present Rules></p> <p>202. – 205. <same as the present Rules></p> <p style="text-align: center;">Section 3 – 11 <same as the present Rules></p> <p style="text-align: center;">Section 12 Semi-Conductor Converters (2021)</p> <p>1201. General</p> <p>1. The requirements in this Section apply to semi-conductor converters <u>for motor drives</u>, uninterruptible power system(UPS) and semi-conductor rectifiers(hereinafter referred to as "rectifiers") not less than 5kW.</p> <p>2. <same as the present Rules></p> <p>1202. <u>Semi-conductor converters for motor drives</u></p> <p>1. Design requirements</p> <p>(1) – (2) <same as the present Rules></p> <p>(3) – (9) <newly added></p>	<p style="text-align: center;">Section 2 System Design</p> <p>201. General</p> <p>1. – 7. <same as the present Rules></p> <p>8. Harmonic distortion (2020)</p> <p>(1) General</p> <p>(A) The total harmonic distortion (THD) of electrical distribution systems is not to exceed 8% and any single order harmonics not to exceed <u>3% 5%</u>.</p> <p>(B) <same as the present Rules></p> <p>(2) <same as the present Rules></p> <p>202. – 205. <same as the present Rules></p> <p style="text-align: center;">Section 3 – 11 <same as the present Rules></p> <p style="text-align: center;">Section 12 Semi-Conductor Converters (2021)</p> <p>1201. General</p> <p>1. The requirements in this Section apply to semi-conductor converters(<u>hereinafter referred to as "converters"</u>) for motor drives, uninterruptible power system(UPS) and semi-conductor rectifiers(hereinafter referred to as "rectifiers") not less than 5 kW.</p> <p>2. <same as the present Rules></p> <p>1202. Semi-conductor c<u>Converters for motor drives</u></p> <p>1. Design requirements</p> <p>(1) – (2) <same as the present Rules></p> <p>(3) <u>Converters shall be equipped with separate control and monitoring systems.</u></p>	<p>(Amended)</p> <p>– Single order harmonics has been matched with International standard.</p> <p>(Amended)</p> <p>– Section 12. has been amended to cover converters for power supply.</p> <p>– ‘Semi-conductor converters’ is unified with the term ‘converters’.</p> <p>(newly added)</p> <p>– Requirements for power converters mentioned on Guidance for Battery Systems on Board of Ships is unified this section.</p>

Present	Amendment	Remark
<p>2. Creepage and clearance distances (1) <same as the present Rules></p> <p>Table 6.1.20 Clearance distance for low voltage <u>semi-conductor</u> converter</p> <p>Table 6.1.21 Clearance distance for high voltage <u>semi-conductor</u> converter</p> <p>Table 6.1.22 Creepage distances for <u>semi-conductor</u> converters</p>	<p>(4) Converters shall comply with the requirements of harmonics in Pt 6, Ch 1, 201. 8 of the Rules for the Classification of Steel Ships.</p> <p>(5) Charge/discharge shall be controlled in accordance with the instruction of the upstream controller responsible for the power control of the ship.</p> <p>(6) In case of failure of converters, the converters shall be immediately disconnected from the system so that the effect of the failure does not spread to the power system.</p> <p>(7) Emergency stop devices for emergency isolation shall be provided for converters for power supply.</p> <p>(8) Power semi-conductors devices or other heat sources in converters for power supply or motor drives shall be equipped with temperature monitors. When the heat sources does not affect converters in operation, they may be exempted.</p> <p>(9) The internal capacitor shall be discharged to less than 60V within 5 seconds of power removal. However, except when the residual charge amount is 50μC or less, if this is not possible, the warning shall be displayed in a position easily visible to the operator so that it can wait for a certain time before opening the enclosure.</p> <p>2. Creepage and clearance distances (1) <same as the present Rules></p> <p>Table 6.1.20 Clearance distance for low voltage semi-conductor converter</p> <p>Table 6.1.21 Clearance distance for high voltage semi-conductor converter</p> <p>Table 6.1.22 Creepage distances for semi-conductor converters</p>	<p>(Amended) - 'Semi-conductor converters' is unified with the term 'converter'.</p>

Present	Amendment	Remark
<p>3. Cooling</p> <p>(1) <u>Semiconductor</u> converter assemblies are to be installed away from sources of radiant energy in locations where the circulation of air is not restricted to and from the assembly and where the temperature of the inlet air to air-cooled converters will not exceed that for which the converter has been designed.</p> <p>(2) – (5) <same as the present Rules></p> <p>4. Emergency stop</p> <p>When required, <u>semiconductor</u> converter assemblies shall be provided with an emergency stop function. The emergency stop circuit is to be hard-wired and independent of any control system signal.</p> <p>5. – 7. <newly added></p>	<p>3. Cooling</p> <p>(1) Semiconductor Converter assemblies are to be installed away from sources of radiant energy in locations where the circulation of air is not restricted to and from the assembly and where the temperature of the inlet air to air-cooled converters will not exceed that for which the converter has been designed.</p> <p>(2) – (5) <same as the present Rules></p> <p>4. Emergency stop</p> <p>When required, semiconductor converter assemblies shall be provided with an emergency stop function. The emergency stop circuit is to be hard-wired and independent of any control system signal.</p> <p>5. Installation</p> <p>(1) <u>Converters shall be installed in a dry place as far as possible from steam pipes, water pipes, oil pipes, etc.</u></p> <p>(2) <u>Converters shall be installed in a space where the proper temperature can be maintained in consideration of the characteristics.</u></p> <p>(3) <u>It shall be installed in a place where workers can access easily.</u></p> <p>(4) <u>It shall be installed away from heat sources such as engine exhaust manifolds.</u></p> <p>(5) <u>It shall have space for operation and maintenance.</u></p> <p>(6) <u>It shall be installed in a place where it can be firmly fixed to withstand vibration and so on.</u></p> <p>(7) <u>In the case of air-cooled type, it shall be installed in a place where the inlet air temperature does not exceed the limit of the manufacturing specification.</u></p> <p>6. Protection system</p> <p>(1) <u>Converters shall be protected from damage caused by transient overvoltage such as surge voltage due to circuit opening or closing and voltage rise due to regenerative braking.</u></p>	<p>(Amended)</p> <p>– ‘Semi-conductor converters’ is unified with the term ‘converter’.</p> <p>(newly added)</p> <p>– Requirements for power converters mentioned on Guidance for Battery Systems on Board of Ships is unified this section.</p>

Present	Amendment	Remark
	<p>(2) Under normal operating conditions, semiconductor devices shall be controlled so as not to exceed the allowable current.</p> <p>7. Testing and inspection</p> <p>(1) Converters are to be surveyed by the Society during manufacturing and testing. This is expected to include as a minimum in the Table 6.1.23.</p> <p>(2) Converters for motor drives are to satisfy the applicable requirements of the testing and inspection in accordance with 707.</p> <p>Table 6.1.23. <see the next page></p>	<p>(newly added)</p> <ul style="list-style-type: none"> - Requirements for power converters mentioned on Guidance for Battery Systems on Board of Ships is unified this section. - Converters for motor drives are to be tested the same as previous.

<newly added>

Table 6.1.23 Power conversion system

No.	Test	Test Standard
1	<u>Visual inspection⁽¹⁾</u>	=
2	<u>Functional test</u>	a) <u>The functions of the power conversion system described in maker's specification shall be basically checked.</u> b) <u>Emergency stop and restart function of power conversion system shall be checked.</u> c) <u>Other functions required by the Society shall be checked.</u>
3	<u>High voltage test</u>	IEC 60146-1-1, 7.2
4	<u>Insulation resistance test</u>	IEC 60146-1-1, 7.2.3.1
5	<u>Cooling failure test⁽²⁾</u>	IEC 61800-5-1, 5.2.4.5
6	<u>Cooling pipe/hose water pressure test⁽³⁾</u>	a) <u>The hydraulic test shall be carried out for a minimum of 1 hour at a pressure of at least 1.5 times the rated pressure of the pipe/hose.</u> b) <u>Acceptance criterion: No leakage or damage to joints shall occur.</u>
<p>(Notes)</p> <p>(1) <u>Checking for degree of protection, clearance and creepage distance, and items(name plate, etc.) shown on specifications</u></p> <p>(2) <u>Applicable only for forced cooling type</u></p> <p>(3) <u>Applicable only for water-cooling type</u></p>		

Present	Amendment	Remark
<p>1203. <same as the present Rules></p> <p>1204. Rectifiers</p> <p>1. – 6. <same as the present Rules></p> <p>7. Testing and inspection</p> <p>(1) – (3) <same as the present Rules></p> <p>(4) High voltage test</p> <p>Rectifiers are to withstand the high voltage by applying the test voltage of Table 6.1.23 for 1 minute between rectifier cells or live parts of components charged with main circuit potential and earth. (2018)</p> <p>Table 6.1.23 Test voltages for equipment connected to main circuits (2018)</p> <p>(5) <same as the present Rules></p> <p>Section 13 – 14 <same as the present Rules></p> <p>Section 15 High Voltage Electrical Installations</p> <p>1501. – 1506. <same as the present Rules></p> <p>1507. Installation</p> <p>1. <same as the present Rules></p> <p>2. Cables</p> <p>(1) – (2) <same as the present Rules></p> <p>(3) Installation arrangements</p> <p>High voltage cables, in general, are to be <u>installed on cable trays when they are provided with a continuous metallic sheath or armour which is effectively bonded to earth;</u> otherwise they are to be installed for their entire length in metallic castings effectively bonded to earth.</p> <p>(4) – (6) <same as the present Rules></p>	<p>1203. <same as the present Rules></p> <p>1204. Rectifiers</p> <p>1. – 6. <same as the present Rules></p> <p>7. Testing and inspection</p> <p>(1) – (3) <same as the present Rules></p> <p>(4) High voltage test</p> <p>Rectifiers are to withstand the high voltage by applying the test voltage of Table 6.1.23 Table 6.1.24 for 1 minute between rectifier cells or live parts of components charged with main circuit potential and earth. (2018)</p> <p>Table 6.1.23 Table 6.1.24 Test voltages for equipment connected to main circuits (2018)</p> <p>(5) <same as the present Rules></p> <p>Section 13 – 15 <same as the present Rules></p> <p>Section 15 High Voltage Electrical Installations</p> <p>1501. – 1506. <same as the present Rules></p> <p>1507. Installation</p> <p>1. <same as the present Rules></p> <p>2. Cables</p> <p>(1) – (2) <same as the present Rules></p> <p>(3) High voltage cables, in general, are to be installed on cable trays when they are provided with a continuous metallic sheath or armour which is effectively bonded to earth and be <u>installed on cable trays;</u> otherwise high voltage cables are to be installed for their entire length in metallic castings effectively bonded to earth.</p> <p>(4) – (6) <same as the present Rules></p>	<p>(Amended)</p> <p>– Number changed. 6.1.23 -> 6.1.24</p> <p>(Amended)</p> <p>– It has been amended to avoid misunderstanding that cable trays for high voltage cables are to be provided with a continuous metallic sheath or armour.</p>

Present	Amendment	Remark
<p style="text-align: center;">Section 16 Electric Propulsion Unit</p> <p>1601. General (2017)</p> <p>1. Application</p> <p>The following electric propulsion unit is to meet the requirements in this Section in addition to (KS C)IEC 60092-501 and those in this Chapter.</p> <ul style="list-style-type: none"> - <u>generators and their prime movers,</u> - <u>switchboards,</u> - <u>transformers,</u> - <u>convertors,</u> - <u>propulsion motors,</u> - <u>excitation systems,</u> - <u>control, monitoring and safety systems,</u> - <u>wires, cables and busbars,</u> - <u>harmonic filters.</u> <p>(1) - (2) <newly added></p> <p>2. - 4. <same as the present Rules></p> <p>5. <newly added></p>	<p style="text-align: center;">Section 16 Electric Propulsion Unit</p> <p>1601. General (2017)</p> <p>1. Application</p> <p>The following electric propulsion unit is to meet the requirements in this Section in addition to (KS C)IEC 60092-501 and those in this Chapter.</p> <ul style="list-style-type: none"> - <u>generators and their prime movers;</u> - <u>switchboards;</u> - <u>transformers;</u> - <u>convertors;</u> - <u>propulsion motors;</u> - <u>excitation systems;</u> - <u>control, monitoring and safety systems;</u> - <u>wires, cables and busbars;</u> - <u>harmonic filters.</u> <p>(1) <u>The requirements in this section are in addition to those in Sec.2 to Sec.15 and apply to propulsion systems, where the main propulsion is performed by electric motors.</u></p> <p>(2) <u>Bow and stern thrusters intended as auxiliary steering devices, shaft generators operated in a power take in(PTI) or power take home(PTH) modes are excluded.</u></p> <p>2. - 4. <same as the present Rules></p> <p>5. Redundancy</p> <p>(1) <u>All operating modes shall be so designed that a single failure in the electrical system or the control system not disables the propulsion permanently.</u></p> <p>(2) <u>Vessels having two or more electric propulsion motors and converters, or two electric motors on one propeller shaft shall be arranged so that any unit may be taken out of service and electrically disconnected without affecting the operation of the others. It is accepted that the propulsion power is reduced after a disconnection, However, power sufficient to ensure the speed in 3 (2) shall be maintained.</u></p>	<p>(Amended)</p> <p>- It has been amended to clarify the application to electric propulsion units.</p> <p>(newly added)</p> <p>- It has been added to clarify requirements to electric propulsion units.</p>

Present	Amendment	Remark
<p>1602. – 1604. <same as the present Rules></p> <p>1605. Propulsion transformers</p> <p>1. General</p> <p>(1) At least two independent propulsion transformers are to be installed.</p> <p>(2) – (5) <same as the present Rules></p> <p>2. – 4. <same as the present Rules></p> <p>1606. Electric power convertors</p> <p>1. General</p> <p>(1) Two entirely separate electric power convertors are to be installed.</p> <p>(2) Common control of the electric power convertors is not permitted. This means, for example, that two single tachometer generators or one doubled tachometer generator are to be installed if a tachometer generator is needed for ship's operation.</p> <p>(3) Two galvanically isolated actual speed sensors are to be provided for each control system. Common housing of both sensors is permitted.</p> <p>(4) <same as the present Rules></p> <p>2. – 4. <same as the present Rules></p> <p>1607. – 1608. <same as the present Rules></p>	<p>1602. – 1604. <same as the present Rules></p> <p>1605. Propulsion transformers</p> <p>1. General</p> <p>(1) At least two independent propulsion transformers are to be installed.</p> <p>(2) – (5) (1) – (4) <same as the present Rules></p> <p>2. – 4. <same as the present Rules></p> <p>1606. Electric power convertors</p> <p>1. General</p> <p>(1) Two entirely separate electric power convertors are to be installed.</p> <p>(2) Common control of the electric power convertors is not permitted. This means, for example, that two single tachometer generators or one doubled tachometer generator are to be installed if a tachometer generator is needed for ship's operation.</p> <p>(3) Two galvanically isolated actual speed sensors are to be provided for each control system. Common housing of both sensors is permitted.</p> <p>(4) <same as the present Rules></p> <p>2. – 4. <same as the present Rules></p> <p>1607. – 1608. <same as the present Rules></p>	<p>(Deleted)</p> <p>– According to newly added requirements 'Redundancy', the requirement has been deleted.</p> <p>(Deleted)</p> <p>– (1) According to newly added requirements 'Redundancy', the requirement has been deleted.</p> <p>– (2), (3) Considering Sensor-less systems not using speed sensors, the requirements have been deleted.</p>