

## GUIDANCE NOTES ON

# FAILURE MODE AND EFFECTS ANALYSIS (FMEA) FOR CLASSIFICATION

MAY 2015

**CORRIGENDA/EDITORIALS – 1 July 2015**

**CORRIGENDA/EDITORIALS – 1 September 2017**

**CORRIGENDA/EDITORIALS – 1 March 2018**

Page No.	Paragraph	Comments
Section 7	System-Specific	FMEA Requirements
97	7/1.11	Under “Technical Notes”, revise last sentence of first paragraph to read “Validation Testing is to be conducted for each manufactured unit for all equipment/control systems...”.
108	7/1.13	Rule/Guide to read “Rules for Building and Classing Steel Vessels Part 5C, Chapter 8 “Vessels Intended to Carry Liquefied Gases in Bulk””.
108	7/1.13	Rule Reference to read: <b>“Part 5C Specific Vessel Types</b> <b>Chapter 8 Intended to Carry Liquefied Gases in Bulk</b> <b>Appendix 5 Reliquefaction System (ABS)</b> <b>Subsection 1 General</b> <b>Subsection 7 Instrumentation and Safety Systems</b> *** <b>Appendix 7 Dual Fuel Diesel and Single Gas Fuel Engines (ABS)</b> <b>Subsection 5 Gas Fuel Engines”.</b>
108	7/1.13	Rule Requirements to read: <b>“5C-8-A5/1.5 Plans and Data to be Submitted</b> <ul style="list-style-type: none"> <li>• Failure Modes and Effects Analysis (FMEA) to determine possible failures and their effects in the safe operation of the reliquefaction system [see 5C-8-A5/7.1ii)]</li> </ul> <b>5C-8-A5/7.1 General</b> <i>ii)</i> An analysis is to be carried out for the reliquefaction system identifying component criticality. *** <b>5C-8-A7/5.7 Protection against Explosion</b> In addition to the requirements in 4-2-1/7, a Failure Modes and Effects Analysis (FMEA) is to be carried out by the engine manufacturer in order to determine necessary additional means of safeguards to address the hazard associated with the use of gas as a fuel. The analysis is to identify all plausible scenarios of gas leakage and the resulting possible explosion. Then the analysis is to identify necessary means to control the identified explosion hazards.

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Section 7	System-Specific	FMEA Requirements
108	7/1.13 (continued)	<p>The FMEA is to be submitted to ABS for approval.</p> <p>Unless the FMEA proves otherwise, the monitoring and safety system functions for the dual fuel diesel engine are to be provided in accordance with 5C-8-A7/Table 1.</p> <p>The alarms required by 5C-8-A7/Table 1 are to be provided at the engine control station. In addition, a summary alarm is to be provided at the navigation bridge.</p> <p>***</p> <p><b>5C-8-A8/5 Plans and Data to be Submitted</b></p> <ul style="list-style-type: none"> <li>Failure Modes and Effects Analysis (FMEA) to determine possible failures and their effects in the safe operation of the dual fuel gas turbine”</li> </ul>
113	7/1.14	<p>Rule/Guide to read “Rules for Building and Classing Steel Vessels Part 5C, Chapter 13 “Vessels Using Gases or other Low-Flashpoint Fuels””.</p>
113	7/1.14	<p>Rule Reference to read:</p> <p>“<b>Part 5C</b> Specific Vessel Types  <b>Chapter 13</b> Vessels Using Gases or other Low-Flashpoint Fuels  <b>Section 6, Appendix 2</b> Reliquefaction Systems (ABS)  <b>Subsection 7</b> Instrumentation and Safety Systems                      ***  <b>Section 6, Appendix 3</b> Gas Combustion Units (ABS)  <b>Subsection 5</b> Gas Burner Unit and Burner Management System                      ***  <b>Section 9</b> Fuel Supply to Consumers  <b>Subsection 4</b> Regulations on Safety Functions of Gas Supply System  <b>Subsection 10</b> Vaporizers, Heaters and Pressure Vessels (ABS)                      ***  <b>Section 10</b> Power Generation Including Propulsion and other Gas Consumers  <b>Subsection 3</b> Regulations for Internal Combustion Engines of Piston Type                      ***  <b>Section 10, Appendix 1</b> Dual Fuel Gas Turbine Propulsion System (ABS)  <b>Subsection 3</b> Electrical, Automation, Instrumentation and Control Systems                      ***  <b>Section 14</b> Electrical Installations  <b>Subsection 3</b> Regulations - General                      ***  <b>Section 15</b> Control, Monitoring and Safety Systems  <b>Subsection 3</b> Regulations for Gas Engine Monitoring”.</p>
113	7/1.14	<p>Rule Requirements to read:</p> <p>“<b>5C-13-6A2/1.5 Plans and Data to be Submitted</b></p> <ul style="list-style-type: none"> <li>Failure Modes and Effects Analysis (FMEA) to determine possible failures and their effects in the safe operation of the reliquefaction system [see 5C-13-6A2/7.1ii]</li> </ul>

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113	7/1.14	<p><b>5C-13-6A2/7.1 General</b>  <i>ii)</i> An analysis is to be carried out for the reliquefaction system identifying component criticality.</p> <p>***</p> <p><b>5C-13-6A3/1.3 Plans and Data to be Submitted</b></p> <ul style="list-style-type: none"> <li>• Failure Modes and Effects Analysis (FMEA) [see 5C-13-6A3/5i)]</li> </ul> <p><b>5C-13-6A3/5 Gas Burner Unit and Burner Management System</b>  <i>i)</i> The gas burner management control philosophy for all modes of operation is to be submitted. This should be accompanied by a safety analysis identifying the modes of failures and shutdown and startup sequences of the system.</p> <p>***</p> <p><b>5C-13-9/4.14 (ABS)</b>                      Where the auxiliary heat exchange circuits are likely to contain gas in abnormal conditions as a result of a component failure (refer to FMEA), they are to be arranged with gas detection in the header tank. Alarm is to be given when the presence of gas is detected. Vent pipes are to be independent and to be led to a non-hazardous area and are to be fitted with a flame screen or flame arrester.</p> <p><b>5C-13-9/10.4 (ABS)</b>                      Where the auxiliary heat exchange circuits are likely to contain gas in abnormal conditions as a result of a component failure (refer to FMEA), they are to be arranged with gas detection in the header tank. Alarm is to be given when the presence of gas is detected. Vent pipes are to be independent and to be led to a non-hazardous area and are to be fitted with a flame screen or flame arrester.</p> <p>***</p> <p><b>5C-13-10/3.1.4 Interpretation – Auxiliary System Venting (ABS)</b>                      Auxiliary system circuits, such as cooling water or dry/wet sump lubricating oil systems, that are likely to contain gas in normal conditions or abnormal conditions as a result of a component failure (refer to FMEA) are to be arranged in accordance with the following requirements:</p> <ul style="list-style-type: none"> <li><i>i)</i> Auxiliary system circuits are to be arranged to avoid cross connection between engine systems and to avoid the migration of gas to non-hazardous areas;</li> <li><i>ii)</i> Vent pipes are to be independent and to be led to a safe location external to the machinery space and to be fitted with a flame screen or flame arrester.</li> </ul> <p><b>5C-13-10/3.1.14 Protection Against Explosion (ABS)</b>                      A Failure Modes and Effects Analysis (FMEA) is to be carried out by the engine manufacturer in order to determine necessary additional safeguards to address the hazards associated with the use of gas as a fuel. This is in addition to the FMEA required by 4-2-1A1/Table 1.</p> <p>The analysis is to identify all plausible scenarios of gas leakage and the resulting possible explosion. Then the analysis is to identify necessary means to control the identified explosion hazards.</p> <p>The FMEA is to be submitted to ABS for review.</p> <p>***</p>

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Section 7	System-Specific FMEA Requirements	
113	7/1.14	<p><b>5C-13-14/3.4</b>  <i>Failure modes and effects of single failure for electrical generation and distribution systems in 5C-13-14/2 shall be analysed and documented to be at least equivalent to those acceptable to the Organization.<sup>(30)</sup></i></p> <p><i>(Note 30 Refer to IEC 60812)</i></p> <p>***</p> <p><b>5C-13-15/7.1 Engine Control and Monitoring Systems (ABS)</b></p> <p>ii) Unless the FMEA proves otherwise, the monitoring and safety system functions for the engines are to be provided in accordance with 5C-13-15/Table 8 (ABS), as applicable.”.</p>