Proposed Revision of:

Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

Draft Date 6/2020

TENTATIVE
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ASME Codes and Standards
be accessible for opening by the operator and must be connected in a way that the functional protection required by para. 6432.3 is provided.

6432.5 Motion Power Disconnecting Devices (Type I Cranes). Control shall include a separate disconnecting means for each crane motion.

6433 Auxiliary Disconnects (Types I, II, and III Cranes). The crane manufacturer shall provide disconnecting means in the form of fused safety switches or circuit breakers as required by NEC to protect and disconnect all auxiliary equipment supplied by the manufacturer or specified by the purchaser. Auxiliary equipment may include (a) lighting (b) signal systems (c) heating/ventilating/air conditioning (d) convenience outlet (e) special devices when applicable

Ground fault circuit interrupters, if required for convenience outlets, shall be a part of the user’s specifications.

6440 Limit Devices

(15) 6441 General (Types I, II, and III Cranes). A limit device is defined as a switch or sensing system to provide control functions on the crane. This paragraph includes requirements for control limit devices that activate when the normal operating envelope has been reached and safety critical limit devices that indicate malfunction, failure, or inadvertent operator action.

Additional limit device requirements not addressed in this section shall be incorporated in the specifications. AC cranes shall have phase reversal protection.

6441.1 Type I Crane Safety Critical Limit Devices. This paragraph includes additional requirements for the following safety critical limit devices: (a) final hoist overtravel (b) hoist overspeed (c) hoist overload (d) hoist unbalanced load (e) hoist drum rope mis-spooling

(1) Manual Reset. When a safety critical limit device is activated, a manual reset is required. This may be accomplished by means of a key switch on the crane or some other administrative control that will prevent the crane operator from resetting the affected function before a person knowledgeable in the crane control system shall determine and correct the cause of device activation.

(2) Safety Critical Limit Devices. Safety critical limit devices shall be in addition to and separate from the limiting means or control devices provided for operation unless independently monitored.

6442 High Limits

6442.1 Type I Cranes. All hoists, including hoists that do not handle critical loads, shall include two separate overhoist limit switch systems as required in paras. 6442.1(a) and (b).

(a) First High Limit. The first upper hoisting limit shall be a control circuit device such as a geared-type, weight-operated, or paddle-operated switch. Actuation of this switch shall result in the removal of power from the motor and setting the hoist brakes. The operator may lower or back out of this tripped switch without further assistance.

(b) Final Overtrolley Limit. The second upper hoisting limit shall be actuated by the lower block by means of a weight or paddle, and shall operate through a separate control circuit from the first high limit switch (or may interrupt the motor leads directly) to cause the removal of power to the hoist motor and set the hoist brakes. Actuation of this limit switch shall prevent further hoisting or lowering.

6442.2 Types II and III Cranes. One high limit switch shall be provided.

6443 Hoist Low Limits (Type I Cranes). Hoists that handle critical loads shall include two separate low limits, as required in paras. 6443.1 and 6443.2.

6443.1 First Low Limit (Type I Cranes). Each hoist that handles critical loads shall include an overtravel low limit switch. This switch may be of the control circuit type. Actuation of this switch shall stop the lowering motion and set the hoist brakes. The operation of this switch shall not prevent hoisting.

6443.2 Final Overtrolley Low Limit (Type I Cranes). Hoists that handle critical loads shall include, in addition to a first low limit as specified in para. 6443.1, a final lowering limit switch of the control circuit type that shall be mechanically and electrically independent of the first low limit. Operation of this limit switch shall de-energize a power device other than the device operated by the first low limit to interrupt all power to the hoist motor and the hoist brakes. Actuation of this limit switch shall prevent further lowering or hoisting. When this occurs, a person knowledgeable in the hoist control system shall determine and correct the cause of tripping of the final low limit switch. That person shall direct the raising out of the final low limit after establishing a back out mode that shall prevent further lowering. The first low limit shall be tested for proper operation before making any additional lifts.

6443.3 Low Limits (Hoists on Types II and III Cranes and Hoists That Do Not Handle Critical Loads on Type I Cranes). A low limit shall be furnished

(a) as recommended by ASME B30.2, para. 2-1.10.5(e), when specified in the crane specifications, or

(b) when required by ASME B30.2, para. 2-1.11.3(c)(1)
Revised from 1st consideration ballot to recirculation ballot:

<table>
<thead>
<tr>
<th>Pg.</th>
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</table>
| 9   | 1160    | AWS D1.1/D1.1M-2010, Structural Welding Code — Steel  
Publisher: American Welding Society (AWS), 8669 NW 36 Street, No. 130, Miami, FL 33166 (www.aws.org) | AWS D1.1/D1.1M 2010, Structural Welding Code — Steel  
Publisher: American Welding Society (AWS), 8669 NW 36 Street, No. 130, Miami, FL 33166 (www.aws.org) | AWS D1.1 reference added back in based on 1st consideration ballot comments. | N/A |
Publisher: American Welding Society 8669 NW 36 Street, No. 130, Miami, FL 33166 (www.aws.org) | N/A | AMD1 added to reference to clarify that the 2017 amendment to the 2005 revision must be used. Change based on 1st consideration ballot comments. |
### Record 16-1546

No Change from 1st Consideration Ballot:

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<tbody>
<tr>
<td>24</td>
<td>4160</td>
<td>Dimensions of welded beams, girders, and built-up members shall be within the tolerances specified by AWS D1.1.</td>
<td>Dimensions of welded beams, girders, and built-up members shall be within the tolerances specified by AWS D14.1.</td>
<td>See Section 5.23</td>
<td>See Section 7.2.5</td>
</tr>
<tr>
<td>28</td>
<td>4231</td>
<td>All welding materials shall be in compliance with the requirements of AWS D1.1 and the additional requirements specified herein.</td>
<td>All welding materials shall be in compliance with the requirements of AWS D14.1 and the additional requirements specified herein.</td>
<td>See Table 3.1, Section 3.3, and Section 5.3</td>
<td>See Table 1, Table 2, Table 10, and Section 8</td>
</tr>
<tr>
<td>29</td>
<td>4240</td>
<td>Studs welded to the structural components of the crane shall comply with the requirements for studs specified in AWS D1.1, and shall be compatible with the base material.</td>
<td>No Change</td>
<td>See Section 7</td>
<td>No Reference to stud welding requirements</td>
</tr>
<tr>
<td>29</td>
<td>4251</td>
<td>Welded connections shall comply with the requirements of AWS D1.1 except as specified herein.</td>
<td>Welded connections shall comply with the requirements of AWS D1.1 except as modified by AWS D14.1 and as specified herein.</td>
<td>Note: This proposed wording is similar to ASME B30.2 2-1.4.1 and is intended to cover things such as stud welding, postweld heat treatment, etc. that is not addressed/not addressed well in AWS D14.1.</td>
<td>See Section 2</td>
</tr>
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<td>29</td>
<td>4251.1</td>
<td>All welds for Types I and II cranes shall be performed in accordance with written procedures that establish limitations of variables consistent with AWS D1.1. These welds may be either prequalified or qualified in accordance with AWS D1.1.</td>
<td>All welds for Types I and II cranes shall be performed in accordance with written procedures that establish limitations of variables consistent with AWS D14.1. These welds may be either prequalified or qualified in accordance with AWS D14.1.</td>
<td>See Section 4 Part B</td>
<td>See Section 9 Part B</td>
</tr>
<tr>
<td>29</td>
<td>4251.2(b)</td>
<td>the base materials are in Material Group 1 of Table 3.1 of AWS D1.1, the weld is made by shielded metal arc welding, submerged arc welding, gas metal arc welding, or flux cored arc welding, and the filler metal is exempt per para. 4232(b)</td>
<td>the base materials are in Material Group 1 Class II of Table 3.1 of AWS D14.1, the weld is made by shielded metal arc welding, submerged arc welding, gas metal arc welding, or flux cored arc welding, and the filler metal is exempt per para. 4232(b)</td>
<td>See Table 3.1 Note: Table 3.1 in D1.1-2010 is Table 5.3 and 5.4 in D1.1-2020</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>4251.2(c)</td>
<td>the base materials are in Material Group 1 of Table 3.1 of AWS D1.1, the weld is made by shielded metal arc welding, submerged arc welding, gas metal arc welding, or flux cored arc welding, and the weld is postweld heat treated per para. 4251.5.</td>
<td>the base materials are in Material Group 1 Class II of Table 3.1 of AWS D14.1, the weld is made by shielded metal arc welding, submerged arc welding, gas metal arc welding, or flux cored arc welding, and the weld is postweld heat treated per para. 4251.5.</td>
<td>See Table 3.1 Note: Table 3.1 in D1.1-2010 is Table 5.3 and 5.4 in D1.1-2020</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>4251.4</td>
<td>Examination and acceptance criteria of welds and repairs shall be in accordance with AWS D1.1 unless otherwise stated below.</td>
<td>Examination and acceptance criteria of welds and repairs shall be in accordance with AWS D14.1 unless otherwise stated below.</td>
<td>See Section 4.9</td>
<td>See Section 10</td>
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<tr>
<td>29</td>
<td>4251.5-1</td>
<td><strong>Table 4251.5-1 Exemptions to Mandatory Postweld Heat Treatment</strong></td>
<td></td>
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<td></td>
<td></td>
<td><strong>Material Class</strong></td>
<td><strong>Effective Throat of Weld, in.</strong></td>
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<td></td>
<td></td>
<td>[Note (1)]</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>[Not Toughness Tested]</td>
<td>[Toughness Tested]</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>[Notes (2) and (3)]</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>I</td>
<td>1 1/2 or less</td>
<td>4 or less</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>II</td>
<td>1 1/2 or less</td>
<td>4 or less</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>IV</td>
<td>1 1/2 or less</td>
<td>4 or less</td>
<td></td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>(table)</td>
<td>Groups are per Table 3.1 of AWS D1.1. Carbon and low alloy steels not in this Table shall be exempt from postweld heat treatment for thicknesses of 1/2 in. or less, provided the carbon does not exceed 0.35%.</td>
<td>Groups Material Classes are per Table 3-1 of AWS D14.1. Carbon and low alloy steels not in this Table shall be exempt from postweld heat treatment for thicknesses of 1/2 in. or less, provided the carbon does not exceed 0.35%.</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>4251.5 (a)</td>
<td>Types I and II Cranes. Welded connections shall be postweld heat treated (stress relieved) in accordance with AWS D1.1 except where exempted by Table 4251.5-1.</td>
<td>No Change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>4251.5 (a)</td>
<td>However, exempted material may be postweld heat treated at the manufacturer’s option. Times and temperatures per AWS D1.1 shall be employed.</td>
<td>No Change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>4251.5 (a)</td>
<td></td>
<td></td>
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**Table 4251.5-1**

<table>
<thead>
<tr>
<th>Material Class</th>
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<th>Toughness Tested [Notes (2) and (3)]</th>
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</thead>
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<tr>
<td>I</td>
<td>1 1/2 or less</td>
<td>4 or less</td>
</tr>
<tr>
<td>II</td>
<td>1 1/2 or less</td>
<td>4 or less</td>
</tr>
<tr>
<td>IV</td>
<td>1 1/2 or less</td>
<td>4 or less</td>
</tr>
</tbody>
</table>

**Groups Material Classes**

See Table 3.1 Note: Table 3.1 in D1.1-2010 is Table 3.1 of AWS D1.1.

See Table 1
<table>
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<td>30</td>
<td>4251.5 (b)</td>
<td>Type III Cranes. The manufacturer shall determine the need for postweld heat treatment. When used, PWHT shall comply with AWS D1.1.</td>
<td>No Change</td>
<td>See Section 3.14, 5.8, C-3.14, C-5.8</td>
<td>See Section 8.5.1.2. Only mentions postweld heat treatment</td>
</tr>
<tr>
<td>30</td>
<td>4251.6</td>
<td>The welding of studs shall be in accordance with AWS D1.1.</td>
<td>No Change</td>
<td>See Section 7</td>
<td>No Reference to stud welding requirements</td>
</tr>
<tr>
<td>31</td>
<td>4314</td>
<td>Basic allowable stresses in welds shall be as specified in AWS D1.1. Allowable stresses for all types of welds may be increased for severe environmental load combinations by a factor of 1.33, and for extreme environmental load combinations by a factor of 1.50.</td>
<td>Basic allowable stresses in welds shall be as specified in AWS D14.1. Allowable stresses for all types of welds may be increased for severe environmental load combinations by a factor of 1.33, and for extreme environmental load combinations by a factor of 1.50.</td>
<td>See Section 2.6.4 (Table 2.3)</td>
<td>See Section 5 (Table 2)</td>
</tr>
<tr>
<td>31</td>
<td>Table 4311-1</td>
<td><strong>Table 4311-1 Maximum Allowable Stresses in Structural Steel Members</strong>&lt;br&gt;<strong>Stress Type (All Expressed in Terms of ( \sigma_t ))</strong>&lt;br&gt;<strong>Loading Condition</strong>&lt;br&gt;Operating&lt;br&gt;Construction&lt;br&gt;Severe environmental&lt;br&gt;Extreme environmental</td>
<td>N/A</td>
<td>N/A</td>
<td><strong>Note:</strong> This change aligns the base metal allowable stresses with the weld allowable stresses in AWS D14.1 (Table 2). This is also consistent with CMAA 70 (Section 3.2 and Table 3.4-1) for weld and base metal allowables.</td>
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<tr>
<td>81</td>
<td>5531</td>
<td>Type I Cranes. All welding design and procedures shall conform to the current issue of AWS D1.1.</td>
<td>Type I Cranes. All welding design and procedures shall conform to the current issue of AWS D14.1.</td>
<td>See Section 2</td>
<td>See Section 6</td>
</tr>
<tr>
<td>101</td>
<td>7100 (b)</td>
<td>100% radiographic test (RT) or ultrasonic test (UT) of butt welds in accordance with AWS D1.1 Acceptance criteria shall be in accordance with AWS D1.1</td>
<td>100% radiographic test (RT) or ultrasonic test (UT) of butt welds in accordance with AWS D14.1 Acceptance criteria shall be in accordance with AWS D14.1</td>
<td>See Sections 6.12 and 6.13</td>
<td>See Sections 10.9-10.12 and 10.13-10.15</td>
</tr>
<tr>
<td>101</td>
<td>7100 (c)</td>
<td>10% magnetic particle test (MT) or dye penetrant test (PT) of the linear feet of each weld that exceeds 10 in. in length unless stated otherwise in this Standard. Technique and acceptance criteria shall be in accordance with AWS D1.1</td>
<td>10% magnetic particle test (MT) or dye penetrant test (PT) of the linear feet of each weld that exceeds 10 in. in length unless stated otherwise in this Standard. Technique and acceptance criteria shall be in accordance with AWS D14.1</td>
<td>See Section 6.10</td>
<td>See Sections 10.16 and 10.17</td>
</tr>
<tr>
<td>102</td>
<td>7210 (c)</td>
<td>All structural welds shall be visually inspected over their entire lengths for any type crane. Acceptance criteria of welds and repair shall be in accordance with AWS D1.1</td>
<td>All structural welds shall be visually inspected over their entire lengths for any type crane. Acceptance criteria of welds and repair shall be in accordance with AWS D14.1</td>
<td>See Section 6.9 and Table 6.1</td>
<td>See Section 10.6</td>
</tr>
<tr>
<td>117</td>
<td>I-4251.2</td>
<td>Impact qualification of materials in Group I of Table 4.1.1 of AWS D1.1 shall be considered as procedure qualification for welding other steels in these classes or combination of them having a lower minimum yield strength.</td>
<td>Impact qualification of materials in Group I Class II of Table 4.1.1 of AWS D14.1 shall be considered as procedure qualification for welding other steels in these classes or combination of them having a lower minimum yield strength.</td>
<td>See Table 3.1</td>
<td>See Table 1. Similar but not equivalent to Table 3.1</td>
</tr>
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<tr>
<td>117</td>
<td>I-4251.2</td>
<td>Impact qualification of materials in Group II of Table 3.1 of AWS D1.1 shall be considered as a procedure qualification for welding of material of the specification and grade, class, or type in Group II to which the specimen is certified or combinations of this material with materials in Group I, or combinations of materials in Group I with a lower yield strength.</td>
<td>Impact qualification of materials in Group II Class III of Table 3.1 of AWS D14.1 shall be considered as a procedure qualification for welding of material of the specification and grade, class, or type in Group II Class III to which the specimen is certified or combinations of this material with materials in Group I Class II, or combinations of materials in Group I Class II with a lower yield strength.</td>
<td>See Table 3.1</td>
<td>See Table 1. Similar but not equivalent to Table 3.1</td>
</tr>
<tr>
<td>117</td>
<td>I-4251.2</td>
<td>Impact qualifications of materials in Group II, III, or of Table 3.1 of AWS D1.1, which are postweld heat treated per para. 4251.5 for production welding, shall be conducted on a specimen that has been postweld heat treated to the same procedure as production welding.</td>
<td>Impact qualifications of materials in Group II, Class III, IV, or V of Table 3.1 of AWS D14.1, which are postweld heat treated per para. 4251.5 for production welding, shall be conducted on a specimen that has been postweld heat treated to the same procedure as production welding.</td>
<td>See Table 3.1</td>
<td>See Table 1. Similar but not equivalent to Table 3.1</td>
</tr>
<tr>
<td>118</td>
<td>I-4251.4</td>
<td>Any area of the base metal that exhibits total loss of back reflection shall be marked. If the adjacent base metal meets the acceptance criteria of ASTM A578, Level I, the weld and the base metal below the weld, which is subject to shrinkage strains, shall be examined by angle beam ultrasonic scanning. The procedure and acceptance criteria shall be per AWS D1.1, Section 6, Parts A and C.</td>
<td>Any area of the base metal that exhibits total loss of back reflection shall be marked. If the adjacent base metal meets the acceptance criteria of ASTM A578, Level I, the weld and the base metal below the weld, which is subject to shrinkage strains, shall be examined by angle beam ultrasonic scanning. The procedure and acceptance criteria shall be per AWS D14.1, Section 10.15, Parts A and C.</td>
<td>See Section 6 parts A and C</td>
<td>See Sections 10.13-10.15</td>
</tr>
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<tr>
<td>121</td>
<td>Table II-1 B.(2)</td>
<td>The existing crane bridge welding standard shall be verified as having been either AWS D1.1 or AWS D14.1 from the original manufacturer’s drawings, calculations, documented design standards, etc. See item D.(2) if it cannot be confirmed that the crane was welded to either AWS D1.1 or AWS D14.1.</td>
<td>No Change</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>122</td>
<td>Table II-1 C.(a)(1)</td>
<td>Welds displaying deformation, cracks, or corrosion shall require the paint to be removed and shall then be given a visual inspection per AWS D1.1, with corrective actions take as needed.</td>
<td>Welds displaying deformation, cracks, or corrosion shall require the paint to be removed and shall then be given a visual inspection per AWS D14.1, with corrective actions take as needed.</td>
<td>See Section 6.9 and Table 6.1</td>
<td>See Section 10.6</td>
</tr>
<tr>
<td>122</td>
<td>Table II-1 D.(2)</td>
<td>If it cannot be confirmed that the crane was welded to either AWS D1.1 or AWS D14.1, then additional weld NDE shall be performed based upon the Supplemental Criteria D.(2) of this Mandatory Appendix.</td>
<td>No Change</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>124</td>
<td>Table II-2 D(2)-1</td>
<td>Additional NDE of welds, for welding not performed to either AWS D1.1 or AWS D14.1 shall be as follows, unless the maximum weld stress or, for members subjected to repeated loads, the weld stress range (maximum stress minus minimum stress) is 8,000 psi or less:</td>
<td>No Change</td>
<td>N/A</td>
<td>N/A</td>
</tr>
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<tr>
<td>124</td>
<td>Table II-2 D(2)-1 (a)(2)</td>
<td>All external accessible fillet welds within the critical load path shall be visually inspected for workmanship. Areas displaying poor workmanship shall have the paint removed and visually reinspected per the requirements of AWS D1.1, and corrective action shall be taken as needed.</td>
<td>All external accessible fillet welds within the critical load path shall be visually inspected for workmanship. Areas displaying poor workmanship shall have the paint removed and visually reinspected per the requirements of AWS D1.1, and corrective action shall be taken as needed.</td>
<td>See Section 6.9 and Table 6.1</td>
<td>See Section 10.6</td>
</tr>
<tr>
<td>124</td>
<td>Table II-2 D(2)-1 (a)(3)</td>
<td>A minimum of 10% of the total length of each accessible critical fillet weld in the critical load path greater than 10 in. shall be subjected to magnetic particle test (MT) or dye penetrant test (PT) per AWS D1.1 requirements.</td>
<td>A minimum of 10% of the total length of each accessible critical fillet weld in the critical load path greater than 10 in. shall be subjected to magnetic particle test (MT) or dye penetrant test (PT) per AWS D1.1 requirements.</td>
<td>See Section 6.10</td>
<td>See Sections 10.16 and 10.17</td>
</tr>
<tr>
<td>124</td>
<td>Table II-2 D(2)-1 (b)(1)</td>
<td>A minimum of 10% of the internal fillet welds within the critical load path shall be visually inspected for workmanship. Areas displaying poor workmanship shall have the paint removed and be visually reinspected per the requirements of AWS D1.1, and corrective actions shall be taken as needed.</td>
<td>A minimum of 10% of the internal fillet welds within the critical load path shall be visually inspected for workmanship. Areas displaying poor workmanship shall have the paint removed and be visually reinspected per the requirements of AWS D1.1, and corrective actions shall be taken as needed.</td>
<td>See Section 6.9 and Table 6.1</td>
<td>See Section 10.6</td>
</tr>
<tr>
<td>131</td>
<td>B-4251.4</td>
<td>The acceptance criteria are a combination of the requirements in ASTM A578 for the base material and AWS D1.1 for the weld metal.</td>
<td>No Change</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Pg.</td>
<td>Section</td>
<td>Current Wording</td>
<td>Suggested Wording</td>
<td>D1.1 - 2010 Reference</td>
<td>D14.1 – 2005-AMD1 Reference</td>
</tr>
<tr>
<td>-----</td>
<td>---------</td>
<td>----------------</td>
<td>-------------------</td>
<td>----------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>132</td>
<td>B-4251.5</td>
<td>The toughness requirements herein should eliminate failures of the first type, and the use of the fatigue design in CMAA 70 and AWS D1.1, Section 2, which is based on actual tests of nonstress-relieved components, should eliminate failures of the second type.</td>
<td>No Change</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>144</td>
<td>NUREG-0554/AS ME NOG-1 Conformance Matrix 2.8</td>
<td>NOG-1 addresses preheating by reference to AWS D1.1</td>
<td>NOG-1 addresses preheating by reference to AWS D14.1</td>
<td>See Table 3.2</td>
<td>See Table 10</td>
</tr>
<tr>
<td>144</td>
<td>NUREG-0554/AS ME NOG-1 Conformance Matrix 2.8</td>
<td>NOG-1 specifies postweld heat treatment for welds over 1.5 in. for steel not toughness tested and for toughness-tested welds over 4 in., except that for carbon and low alloy steels not included in Table 3.1 of AWS D1.1, the size threshold is over 0.5 in.</td>
<td>NOG-1 specifies postweld heat treatment for welds over 1.5 in. for steel not toughness tested and for toughness-tested welds over 4 in., except that for carbon and low alloy steels not included in Table 13.1 of AWS D14.1, the size threshold is over 0.5 in.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>145</td>
<td>NUREG-0554/AS ME NOG-1 Conformance Matrix 2.8</td>
<td>Weld joints susceptible to lamellar tearing should be postweld heat treated in accordance with Subarticle 3.9 of AWS D1.1 Structural Welding Code.</td>
<td>No Change</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
substrate: the uncoated base surface to which the coating is to be applied.

supplier: any individual or organization who furnishes items or services in accordance with a procurement document; an all-inclusive term used in place of any of the following: vendor, seller, contractor, subcontractor, fabricator, consultant, and their sub-tier levels.

surveillance: the act of monitoring or observing to verify whether an item or activity conforms to specified requirements.

switch: a device for making, breaking, or changing connections in an electric circuit.

switch, emergency stop: a manually operated switch to cut off electric power independently of the regular operating controls.

switch, limit: a switch that is operated by some part or motion of a power-driven machine or equipment to alter or disconnect the electric circuit associated with the machine or equipment.

switch, main: a switch on the crane controlling the main power supply to the crane.

switch, master: a switch that dominates the operation of contactors, relays, or other remotely operated devices.

temperature, minimum operating: the minimum ambient temperature at which the crane is operated, either during the construction phase or plant in-service phase of use of the crane.

test, break strength: a physical test to destruction performed on a sample of an item to verify the rated strength of that item.

test, dynamic load: a test wherein designated loads are hoisted, lowered, rotated, or transported through motions and accelerations required to simulate handling of the intended item.

test, proof load: a physical load test, with magnitude to be as specified but always in excess of the design load.

testing: an element of verification for the determination of the capability of an item to meet specified requirements by subjecting the item to a set of physical, chemical, environmental, or operational conditions.

traceability: the ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

transit carriers, closed: trucks, trailers, railroad cars, barges, aircraft, or ships that do provide protection of items from the environment.

transit carriers, open: trucks, trailers, railroad cars, barges, aircraft, or ships that do not provide protection of items from the environment.

transportation mode: a method identified by the conveyance used for transportation of items. It includes any motor vehicle, ship, railroad car, or aircraft; each cargo-carrying body (trailer, van, boxcar, etc.) is a separate vehicle.

trolley: the unit that travels on the bridge rails and supports the load block.

trolley, man: a trolley having an operator’s cab attached to it.

trolley frame: an assembly consisting of two side frames or trucks that are connected together by one or more load girts to form a one-piece unit capable of transmitting the load to the crane bridge without undue deflection. The hoist machinery and supports for the sheaves or equalizer are assembled into and supported by the trolley frame.

truck: the unit, consisting of a crane, wheels, bearings, and axles, that supports the bridge girders, the end ties of an overhead crane, or the sill of a gantry crane.

two-blocking: the act of hoisting (beyond the intended upper limit) in which the load block comes into physical contact with the head block (upper block) or its supporting structure, preventing further upward movement of the load block and creating an overload of the rope reeving system and hoisting machinery.

upper block: a fixed block located on a trolley, that, through a system of sheaves, bearings, pins, and frames, supports the load block and its load.

use-as-is: a disposition permitted for a nonconforming item when it can be established that the item is satisfactory for its intended use.

verification: the act of reviewing, inspecting, testing, checking, auditing, or otherwise determining and documenting whether items, processes, services, or documents conform to specified requirements.

visual inspection: a macroscopic examination to determine conformance to quality requirements.

void: an area of missing coating through which the substrate or base coat is visible.

waiver: documented authorization to depart from specified requirements.

web plate: the vertical plate connection and upper and lower flanges or cover plates of a girder.

wrap: a flexible material formed around the item or package, to exclude dirt and to facilitate handling, marking, or labeling.

1160 References

See Insert 1

The following is a list of codes and standards referenced in NOG-1. These codes and standards apply to the extent invoked at the point of reference.

AGMA 9005-E02, Industrial Gear Lubrication
ANSI/AGMA 2001-C95, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
The following three documents are contained in the AISC Manual of Steel Construction (ASD), Ninth Edition:

- Code of Standard Practice for Steel Buildings and Bridges, March 7, 2000
- Specification for Structural Joints Using ASTM A325 or A490 Bolts, June 23, 2000

Publisher: American Institute of Steel Construction (AISC), 1 East Wacker Drive, Suite 700, Chicago, IL 60601 (www.aisc.org)

AISC TR No. 1, 1991, DC Mill Motors
AIST/AISC TR No. 6, 2005, Specification for EOT Cranes for Steel Mill Service

Publisher: Association for Iron & Steel Technology (AIST), 186 Thorn Hill Road, Warrendale, PA 15086 (www.aist.org)

ASME B30.2-2011, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.10-2009, Hooks
ASME NQA-1-2012, Quality Assurance Requirements for Nuclear Facility Applications

Publisher: The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990; Order Department: 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900 (www.asme.org)

ASTM A275/A275M-98, Magnetic Particle Examination of Steel Forgings
ASTM A370-02, Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A388/A388M-01, Standard Practice for Ultrasonic Examination of Heavy Steel Forgings
ASTM A435/A435M-90, Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates
ASTM D7-456, Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D772-47, Standard Test Method for Evaluating Degree of Blistering (Scaling) of Exterior Paints
ASTM D5144-00, Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants
ASTM D5146-96, Standard Guide for Specifying Inspection Requirements for Coating and Lining Work (Metal Substrates)
ASTM E165-02, Standard Test Method for Liquid Penetrate Examination
ASTM F380-93, Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

ASTM E709-01, Standard Guide for Magnetic Particle Examination

Manual of Coating Work

Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

AWS D1.1/D1.1M-2010, Structural Welding Code — Steel
Publisher: American Welding Society (AWS), 8669 NW 36 Street, No. 130, Miami, FL 33166 (www.aws.org)

CMAA 70-2010, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
Publisher: Crane Manufacturers Association of America, Inc. (CMAA), 8720 Red Oak Boulevard, Charlotte, NC 28217 (www.mhia.org/industrygroups/cmaa)

NEMA ICS 2-2002 (R2005), Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts (R2005)
NEMA ICS 3-1993, Industrial Control and Systems: Factory Build Assemblies
NEMA ICS 6-1993 (R2001, R2006), Industrial Control and Systems Enclosures

Publisher: National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Rosslyn, VA 22209 (www.nema.org)

NFPA 70-2014, National Electrical Code (NEC)
Publisher: National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169 (www.nfpa.org)

OSHA Safety and Health Standards, Title 29, Code of Federal Regulations Part 1910 (29 CFR 1910), Occupational Safety and Health Standards
Publisher: U.S. Department of Labor — Occupational Safety & Health Administration (OSHA), U.S. Department of Labor, 200 Constitution Avenue, Washington, DC 20210 (www.osha.gov)

Publisher: American Society for Nondestructive Testing (ASNT), 1711 Arlingate Lane, P.O. Box 28518, Columbus, OH 43228 (www.asnt.org)

Publisher: SSPC: The Society for Protective Coatings, 40 24th Street, Pittsburgh, PA 15222 (www.sspc.org)
The following is a list of codes and standards referenced in NOG-1. These codes and standards apply to the extent invoked at the point of reference. Unless a specific revision is referenced, the latest revisions of the codes and standards should be used.

IEEE/ASTM SI 10 American National Standard for Metric Practice

ASTM MNL8 - Manual on Maintenance Coatings for Nuclear Power Plants

ANSI/ASNT CP-189, ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel
### Table I-1180-1 SI Conversion Factors

<table>
<thead>
<tr>
<th>Quantity</th>
<th>English to SI Units</th>
<th>SI to English Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 in.</td>
<td>2.54 cm</td>
<td>1 cm</td>
</tr>
<tr>
<td>1 ft</td>
<td>0.3048 m</td>
<td>1 m</td>
</tr>
<tr>
<td>1 mil</td>
<td>25.4 μm</td>
<td>1 μm</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 in.²</td>
<td>6.4516 cm²</td>
<td>1 cm²</td>
</tr>
<tr>
<td>1 ft²</td>
<td>0.09290304 m²</td>
<td>1 m²</td>
</tr>
<tr>
<td>Volume</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 in.³</td>
<td>16.379564 cm³</td>
<td>1 cm³</td>
</tr>
<tr>
<td>1 ft³</td>
<td>0.028316847 m³</td>
<td>1 m³</td>
</tr>
<tr>
<td>1 gal</td>
<td>3.785412 l</td>
<td>1 l</td>
</tr>
<tr>
<td>Velocity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ft/sec</td>
<td>0.3048 m/s</td>
<td>1 m/s</td>
</tr>
<tr>
<td>1 ft/min</td>
<td>0.0060504 m/s</td>
<td>1 m/min</td>
</tr>
<tr>
<td>1 rpm</td>
<td>0.1047197 m/s</td>
<td>1 rad/s</td>
</tr>
<tr>
<td>Mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 lb</td>
<td>0.45359237 kg</td>
<td>1 kg</td>
</tr>
<tr>
<td>1 ton</td>
<td>1016.0469088 kg</td>
<td>1 ton</td>
</tr>
<tr>
<td>Force</td>
<td>1 lbf</td>
<td>4.44822 N</td>
</tr>
<tr>
<td>Bending, torque</td>
<td>1 ft-lbf</td>
<td>1.35582 N·m</td>
</tr>
<tr>
<td>Pressure, stress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 lbf/in.²</td>
<td>6894.76 Pa</td>
<td>1 Pa</td>
</tr>
<tr>
<td>1 kip/in.²</td>
<td>6.89476 kPa</td>
<td>1 kPa</td>
</tr>
<tr>
<td>1 kgf/cm²</td>
<td>0.070307 kgf</td>
<td>1 kgf/cm²</td>
</tr>
<tr>
<td>Energy, work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Btu (N·m)</td>
<td>1055.056 J</td>
<td>1 J</td>
</tr>
<tr>
<td>1 ft-lbf</td>
<td>1.35582 J</td>
<td>1 J</td>
</tr>
<tr>
<td>Power</td>
<td>1 hp</td>
<td>745 W</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t°C (t - 32)/1.8</td>
<td></td>
<td>t°F (t x 1.8) + 32</td>
</tr>
</tbody>
</table>

GENERAL NOTE: For others, see ASTM E380.

Testing shall be conducted after welding and any required stress relief.

When accessible, a straight beam ultrasonic scan shall be conducted over the entire area of the plate to be examined from the side opposite the weld. The procedure should be per ASTM A578, except that the scanned area shall be as defined above. When the principal direction of load transfer is parallel to the axis of the weld, the acceptance shall be per ASTM A578, Level I.

### Table I-1180-2 Conversion Factors for Weight in Tons

<table>
<thead>
<tr>
<th>English to SI Units</th>
<th>SI to English Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ton (long)</td>
<td>1016.0469 kg</td>
</tr>
<tr>
<td>1 metric ton</td>
<td>907.1847 kg</td>
</tr>
</tbody>
</table>

U.S. Customary to SI Units

<table>
<thead>
<tr>
<th>SI to U.S. Customary Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 metric ton (short)</td>
</tr>
</tbody>
</table>

U.S. Customary to English Units

<table>
<thead>
<tr>
<th>English Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ton (long)</td>
</tr>
<tr>
<td>1 short ton</td>
</tr>
</tbody>
</table>

GENERAL NOTE: For others, see ASTM E380.

Other directions of load transfer, the acceptance shall be per ASTM A578, Level II, except that the size of the circle shall be reduced to 2 in. diameter.

When the side opposite the weld is not accessible, the base metal adjacent to the weld on all members shall be examined from the accessible sides by a straight beam ultrasonic scan. Any area of the base metal that exhibits total loss of back reflection shall be marked. If the adjacent base metal meets the acceptance criteria of ASTM A578, Level I, the weld and the base metal below the weld, which is subject to shrinkage strains, shall be examined by angle beam ultrasonic scanning. The procedure and acceptance criteria shall be per AWS D1.1, Section 6, Parts A and C. If the base metal adjacent to the weld exhibits a loss of back reflection in a position that would interfere with the normal weld scanning procedures, the alternate scanning procedures in the referenced sections may be employed. When examining the base metal below the weld, the criteria for the angle of the transducer should be similar to that for evaluating the fusion zone; i.e., the sound path should be as nearly perpendicular to any suspected laminar reflector as possible.

#### I-5100 GENERAL

I-5110 Load Spectrum Crane Classification

I-5111 Crane Service Data Report Form. See Fig. I-5111 for an example Crane Service Data Report Form.
(b) Discontinuities detected in other than inorganic zinc coatings may be corrected by light sanding, removal of all dust and chalk, and solvent wiping. Where not detrimental to the coating being used, additional coating material may then be applied by brush and worked to fill discontinuities.

(c) Gouges or scratches (including areas damaged due to the use of certain destructive inspection instruments) may be repaired by using a compatible filler or patching compound and sanded smooth when necessary. Before application of the filler, all loose coating shall be removed and the area feathered a minimum of 2 in. onto the film coating.

(d) Runs and sags not repaired while coating is wet may be removed by sanding or grinding. If occurring in the prime coat and upon removal the necessary minimum film thickness is maintained, recoating of additional primer is not required. Where additional coating is required, full-bodied or thinned coats may be applied in accordance with the requirements of the coating manufacturer. The application of a thinned coat may be used to improve the appearance of repaired areas.

(e) Localized blistering may be corrected by power sanding or grinding to firm coating or substrate. After grinding, a needle gun should be used to roughen the surface. Edges shall be feathered a minimum of 2 in. onto the firm coat. All dust and chalk shall be removed, and, where not detrimental to the coating, the area shall be solvent wiped. The area may then be recoated by an appropriate method.

(f) Film thickness below the specified minimum may be corrected as indicated in para. A-3243.3 or by removal of all material back to bare substrate and repreparation and application in accordance with the original requirements.

(g) Localized areas with film thickness above the specified maximum may be reduced by sanding or grinding. For inorganic zinc systems, wire screening down to the required thickness may be done if the coating is acceptable, except for the excess thickness. An example of this would be the case of an inorganic zinc coating that exhibits no mud cracking but exceeds the required film thickness. If the excess film thickness is considered by the coating manufacturer and the purchaser to not be detrimental to the integrity of the system, the system may be accepted with the excess film thickness at the discretion of the purchaser. If the excess film thickness is considered by the coating manufacturer and the purchaser to be detrimental to the integrity of the system, the system shall be removed to a previously acceptable film or to base metal as recommended by the coating manufacturer.

A-7600 DOCUMENTATION

This subsection defines recommendations for the collection, storage, and maintenance of Quality Assurance Records applicable to the procurement, design, manufacture, shipment, receipt, storage, installation, and start-up of Types I and II cranes.

Type III cranes should require a records collection, storage, and maintenance system consistent with their procurement documents.

A-7610 Manufacturer

The crane manufacturer should establish a system for the administration of the collection and temporary storage of records received and generated during the design, manufacture, and shipment of the crane.

A-7611 Records Received. The crane manufacturer will typically receive the following types of records:

(a) material test reports
(b) nondestructive examination (NDE) reports
(c) NDE inspector and examiner qualifications in accordance with SNT-TC-1A
(d) performance test reports
(e) other test reports as generated by subsuppliers

A-7612 Records Generated. The crane manufacturer will typically generate the following types of records:

(a) material test reports
(b) NDE reports
(c) NDE inspector and examiner qualifications in accordance with SNT-TC-1A
(d) performance test reports
(e) nonconformance reports
(f) supplier deviation requests
(g) load summary report

A-7613 Records Submitted to Owner. The following Quality Assurance Records should be submitted to the owner’s designated representative for Types I and II cranes. Additional requirements for records may be included in the crane procurement documents.

A-7613.1 Records Submitted During Design and Manufacture

(a) assembly and outline drawings
(b) electrical schematics and wiring diagrams
(c) seismic calculations
(d) supplier deviation requests
(e) load summary report (see para. 4140)
(f) inspection and test plan

A-7613.2 Records Submitted Upon Completion of the Crane

(a) material test reports as required by Table 7210-1 or Table 7210-2
(b) NDE reports as required by Table 7210-1 or Table 7210-2
(c) radiographic film as required by Table 7210-1 or Table 7210-2
Proposed Addition re Shear Bars

Basic reasons for change:
1. Presentation by Eureka! Engineering that showed load drop due to drum gear disengagement, leading to:
2. A Committee request to review the current NOG-1 requirements and make recommendations.

Additional issues:
3. We find some missing words related to bridge drives, for Types I and II cranes.
4. The meaning of 5456.3.a.5 is not clear

Clean Version of Proposal
(Modifications made for recirculation highlighted in the table on page 2)

5456.3 Mounting of Machinery
(a) Types I and II Cranes
(1) Mounting surfaces for machinery (except for bridge cross-shafting) shall be machined for direct mounting, or with allowances for shimming as dictated by the design.
(2) Single machinery elements such as motors and gear reducers shall not be mounted on multiple support structures that can deflect with respect to each other unless the design specifically allows for this deformation.
(3) Machinery or machine parts whose alignment is important to its operation shall not depend on friction but shall use positive means such as dowel pins, shear bars, or fitted bolts to maintain alignment.
(4) Gear engagements shall be protected such that equipment deformation could not cause disengagement and drop the load.
(5) Dowel pins, shear bars, jacking screws, fitted bolts or similar restraints that are stressed by the lifted load shall be designed so that combined stresses from the rated load (not including pretensioning loads for bolts) do not exceed 20% of the minimum ultimate strength of the restraint materials, not including the effects of friction. For extreme environmental and abnormal event conditions such as seismic, load hang-up and two-blocking, combined stresses (but not including pretensioning loads for bolts) shall not exceed 90% of the minimum yield stress of the materials, not including the effects of friction.
(6) Machinery weights shall be adjusted by appropriate dynamic factors when considering seismic loads, and analyzed by the static method, to determine fastener mounting loads. Allowable stresses shall be in accordance with para. 5456.2
<table>
<thead>
<tr>
<th>CURRENT PARAGRAPHS</th>
<th>PROPOSED REVISIONS</th>
</tr>
</thead>
</table>
| **5456.3 Mounting of Machinery**  
(a) Types I and II Cranes  
(1) Mounting surfaces for machinery (except for bridge) shall be machined for direct mounting or with allowances for shimming as dictated by the design.  
(2) Single machinery elements such as motors and gear reducers shall not be mounted on multiple support structures that can deflect with respect to each other unless the design specifically allows for this deformation.  
(3) Machinery or machine parts whose alignment is important to its operation shall not depend on friction but shall use positive means such as dowel pins, shear bars, or fitted bolts to maintain alignment.  
(4) Gear engagements shall be protected such that equipment deformation could not cause disengagement and drop the load.  
(5) Machinery weights shall be increased by appropriate dynamic factors and analyzed by the static method to determine fastener mounting loads. Allowable stresses shall be in accordance with para. 5456.2 | **5456.3 Mounting of Machinery**  
(a) Types I and II Cranes  
(1) Mounting surfaces for machinery (except for bridge cross-shafting) shall be machined for direct mounting, or with allowances for shimming as dictated by the design.  
(2) Single machinery elements such as motors and gear reducers shall not be mounted on multiple support structures that can deflect with respect to each other unless the design specifically allows for this deformation.  
(3) Machinery or machine parts whose alignment is important to its operation shall not depend on friction but shall use positive means such as dowel pins, shear bars, or fitted bolts to maintain alignment.  
(4) Gear engagements shall be protected such that equipment deformation could not cause disengagement and drop the load.  
---  
(b) Type III Cranes  
(1) Mounting surfaces for machinery (except for bridge cross-shafting) shall be machined for direct mounting or with allowances for shimming as dictated by the design.  
(2) Single machinery elements such as motors and gear reducers shall not be mounted on multiple support structures that can deflect with respect to each other unless the design specifically allows for this deformation.  
(3) Machinery or machine parts whose alignment is important to its operation shall not depend on friction but shall use positive means such as dowel pins, shear bars, or fitted bolts to maintain alignment.  
(4) Gear engagements shall be protected such that equipment deformation could not cause disengagement and drop the load.  
---  
(b) Type III Cranes  
(5) Dowel pins, shear bars, jacking screws, fitted bolts or similar restraints that are stressed by the lifted load shall be designed so that combined stresses from the rated load (not including pretensioning loads for bolts) do not exceed 20% of the minimum ultimate strength of the restraint materials, not including the effects of friction. For extreme environmental and abnormal event conditions such as seismic, load hang-up and two-blocking, combined stresses (but not including pretensioning loads for bolts) shall not exceed 90% of the minimum yield stress of the materials, not including the effects of friction.  
(b) Type III Cranes  
(6) Machinery weights shall be adjusted by appropriate dynamic factors when considering seismic loads, and analyzed by the static method, to determine fastener mounting loads. Allowable stresses shall be in accordance with para. 5456.2 |
Evaluation of Yield Terms and Definitions

1150 Definitions

**yield point**: First stress in a material at which an increase in strain occurs without an increase in stress.

**yield strength**: Stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain.

**yield stress**: Generic term to denote either *yield point* (for steels that have a yield point) or *yield strength* (for steels that do not have a yield point), as appropriate for the material.
For the aforementioned definitions to make sense, the following occurrences of yield strength and yield point need to be changed to yield stress.

<table>
<thead>
<tr>
<th>NOG-1 2015 Section</th>
<th>Yield Strength</th>
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Each hoist shall be verified to stop and hold 100% load while lowering at maximum speed upon loss of power. Opening the mainline magnetic contactor by means of the E-Stop may be used to simulate a loss of power condition.
Original Text Currently in NOG 6441.1:
(2) Safety Critical Limit Devices. Safety critical limit devices shall be in addition to and separate from the limiting means or control devices provided for operation unless independently monitored.

New Text to ballot:

(2) Safety Critical Limit Devices. Safety critical limit devices shall be separate from the controller provided for normal operation and shall be added separate from control limit devices that provide normal operational limits. Safety critical limit devices may separately monitor a control device that is included in the normal operating control system.
RECORD 19-1263; RECIRCULATION BALLOT 19-2718RC103

This record is being revised to address comments on Ballot 19-2718RC102 to clarify that Section 4160 also applies to runway rails. Change for this ballot is highlighted yellow.

**INSERT 1 at the end of paragraph 1110:** The items qualified by the NOG-1 standard are the bridge wheels up through the crane bridge and trolley. The runway bridge runway rails and rail clips are qualified with the runway and building structure and shall also meet the requirements of Section 4160, Tolerances, and Section 4460, Rails. See Figure 11150-1.

![Diagram of Crane Boundary](image)

**FIGURE 1110-1** Crane Boundary

The previously proposed **INSERT 2 (RC101)** is not to be included:

The bridge rails are not qualified to the NOG-1 standard as indicated in para. 11150.
RULES FOR CONSTRUCTION OF OVERHEAD AND
GANTRY CRANES
(TOP RUNNING BRIDGE, MULTIPLE GIRDER)

Section 1000
Introduction

1100 GENERAL
Cranes covered under this Standard shall be designed in accordance with the Standard's requirements, but not necessarily with its recommendations. The word shall is used to denote a requirement, the word should is used to denote a recommendation, and the word may is used to denote permission, which is neither a requirement nor a recommendation.

1110 Scope
This Standard covers electric overhead and gantry multiple girder cranes with top running bridge and trolley used at nuclear facilities and components of cranes at nuclear facilities.

1120 Applications
This Standard applies to the design, manufacture, testing, inspection, shipment, storage, and erection of the cranes covered by this Standard.

1130 Responsibility
The cranes covered by this Standard are classified into three types (see para. 1150, Definitions, crane, Type), depending upon crane location and usage of the crane at a nuclear facility.

The owner shall be responsible for determining and specifying the crane type. The owner shall also be responsible for determining and specifying the environmental conditions of service, performance requirements, type and service level of coatings and finishes, and degree of quality assurance.

Determining the extent to which this Standard can be used, either in part or in its entirety, at other than nuclear facilities, shall be the responsibility of those referencing the use of this Standard.

1140 Environmental Conditions (Types I, II, and III Cranes)

1141 Radiation
(a) The purchase specification shall specify the accumulated radiation dosage expected to be seen by the crane in the life of the nuclear facility.
(b) Components whose normal life could be reduced by the effects of the specified radiation shall be tabulated and submitted to the crane purchaser.
(c) Components whose failure, due to radiation, could result in loss of one of the single-failure proof features that hold the load either shall be designed to withstand the specified radiation or shall have a specific replacement period. Where state-of-the-art is such that sufficient data are not available, periodic inspections shall be made by the purchaser to determine when replacement should be made.

1142 Temperature
(a) The purchase specification shall specify the following temperature requirements in the area where the crane operates:

(1) maximum operating temperature
(2) minimum operating temperature
(3) ambient temperature for motors
(4) maximum construction temperature
(5) minimum construction temperature

(b) The crane shall be designed to withstand the effects of the specified temperatures, or the limitations of the crane's design concerning these temperature conditions shall be specified by the crane designer.

1143 Pressure
(a) The purchase specification shall specify the following pressure requirements in the area where the crane operates:

(1) normal operating pressure
(2) any test or abnormal event of these pressures including the rate of change
Section 6000
Electrical Components

6100 GENERAL

(a) The specification for each crane shall state which crane classification applies (para. 1130). Types are summarized from para. 1150 as follows:
   (1) Type I Cranes: single-failure-proof features and seismic considerations
   (2) Type II Cranes: seismic considerations only
   (3) Type III Cranes: neither single-failure-proof features nor seismic considerations

(b) The specifications for each crane shall include any special requirements for components in accordance with the following:
   (1) limiting the use of aluminum, zinc, mercury, and other specified materials (para. 6130)
   (2) painting (para. 6140)
   (3) life at specified values of radiation exposure (para. 6150)
   (4) environmental conditions (para. 6160)
   (5) quality assurance (para. 6170)

(c) Generally available equipment that conforms to industry standards, such as those of NEMA, shall be used unless special designs are necessary.

(d) The electrical equipment is not required to qualify as IEEE 323 Class 1E.

(e) The specification for each Type III crane shall state whether Section 6000 or CMAA 70 is to be invoked for electrical components.

6110 Single-Failure-Proof Features (Type I Cranes)

(a) The electrical system shall be designed so that it is possible for the operator to stop and hold a critical load regardless of the failure of any single component used in normal operation.

(b) In addition to the emergency stop(s) required by para. 6310(c), a minimum of one hard-wired emergency stop shall be provided at ground level (or an appropriate location, e.g., the operating level of the load) that will remove supply power from the crane. The hard-wired emergency stop shall be located in an area that is accessible to crane operation support personnel other than the crane operator.

(c) Any inadvertent short circuit or ground shall be considered a single component failure.

(d) The avoidance of two-blocking shall be accomplished by the use of single-failure-proof features and shall not rely on any action by the operator. The normal hoist limit switch shall be supplemented by an independent final hoist limit switch operated by the load block to remove power from the hoist motor and brakes.

6120 Seismic Considerations (Types I, II, and III Cranes)

(a) Type I Cranes. The user shall provide the equipment that shall de-energize the crane power supply in the event of either a safe shutdown earthquake (SSE) or an operational basis earthquake (OBE). The hoist brakes shall be capable of holding the credible load during an SSE or OBE event, as determined in accordance with para. 6422.1(b). All electrical equipment shall remain on the crane during these seismic events.

(b) Type II Cranes. Requirements are the same as for Type I cranes, except that the brakes need not be capable of holding the load during a seismic event.

(c) Type III Cranes. Seismic considerations are not required for Type III cranes.

6130 Limiting the Use of Specified Materials (Types I, II, and III Cranes)

(a) If the crane specifications require that the content of certain specified materials for use on a crane be kept at a minimum [para. 1145(a)], but it is not practical to eliminate these specified materials completely, the electrical supplier shall tabulate their weight or surface area or the content of an alloy under the following categories:

   (1) exposed, as in the head of a master switch
   (2) bare, within a ventilated enclosure, as in the shaft fan and rotor bars of a ventilated squirrel cage motor
   (3) bare, within a nonventilated enclosure, as in a totally enclosed nonventilated squirrel cage motor
   (4) coated, as in insulated windings within a nonventilated motor, lighting transformer, reactor, etc.

(b) Galvanized conduit may be used except when specifically prohibited by the crane specifications.

6140 Painting (Types I, II, and III Cranes)

When the crane specifications include special painting requirements, the electrical items are exempt from the special painting requirements and shall be furnished with a standard industrial finish [see para. 3230(d)].
Section 6000
Electrical Components

6100 GENERAL
(a) The specification for each crane shall state which crane classification applies (para. 1130). Types are summarized from para. 1150 as follows:

(1) Type I Cranes: single-failure-proof features and seismic considerations
(2) Type II Cranes: seismic considerations only
(3) Type III Cranes: neither single-failure-proof features nor seismic considerations
(b) The specifications for each crane shall include any special requirements for components in accordance with the following:

(1) Limiting the use of aluminum, zinc, mercury, and other specified materials (para. 6130)
(2) Painting (para. 6140)
(3) Life at specified values of radiation exposure (para. 6150)
(4) Environmental conditions (para. 6160)
(5) Quality assurance (para. 6170)
(c) Generally available equipment that conforms to industry standards, such as those of NEMA, shall be used unless special designs are necessary.
(d) The electrical equipment is not required to qualify as IEEE 323 Class 1E.
(e) The specification for each Type III crane shall state whether Section 6000 or CMAA 70 is to be invoked for electrical components.

6110 Single-Failure-Proof Features (Type I Cranes)
(a) The electrical system shall be designed so that it is possible for the operator to stop and hold a critical load regardless of the failure of any component used in normal operation.
(b) In addition to the emergency stop(s) required by para. 6310(c), a minimum of one hard-wired emergency stop shall be provided at ground level (or an appropriate location, e.g., the operating level of the load) that will remove supply power from the crane. The hard-wired emergency stop shall be located in an area that is accessible to crane operation support personnel other than the crane operator.
(c) Any inadvertent short circuit or ground shall be considered a single component failure.
(d) The avoidance of two-blocking shall be accomplished by the use of single-failure-proof features and shall not rely on any action by the operator. The normal hoist limit switch shall be supplemented by an independent limit hoist limit switch operated by the load block to remove power from the hoist motor and brakes.

6120 Seismic Considerations (Types I, II, and III Cranes)
(a) Type I Cranes. The user shall provide the equipment that shall de-energize the crane power supply in the event of either a safe shutdown earthquake (SSE) or an operational basis earthquake (OBE). The hoist brakes shall be capable of holding the credible load during an SSE or OBE event, as determined in accordance with para. 6422.1(b). All electrical equipment shall remain on the crane during these seismic events.
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(a) If the crane specifications require that the content of certain specified materials for use on a crane be kept at a minimum [para. 1145(a)], but it is not practical to eliminate these specified materials completely, the electrical supplier shall tabulate their weight or surface area or the content of an alloy under the following categories:

1. Exposed, as in the head of a master switch
2. Bare, within a ventilated enclosure, as in the shaft fan and rotor bars of a ventilated squirrel cage motor
3. Bare, within a non-ventilated enclosure, as in a totally enclosed non-ventilated squirrel cage motor
4. Covered, as in insulated windings within a non-ventilated motor, lighting transformer, reactor, etc.
(b) Galvanized conduit may be used except when specifically prohibited by the crane specifications.

6140 Painting (Types I, II, and III Cranes)
When the crane specifications include special painting requirements, the electrical items are exempt from the special painting requirements and shall be furnished with a standard industrial finish [see para. 5230(b)].

Specification for Structural Joints Using ASTM A325 or A490 Bolts, June 23, 2000


ASME NQA-1-2012, Quality Assurance Requirements for Nuclear Facility Applications

ASTM A388-A388M-01, Standard Practice for Ultrasonic Examination of Heavy Steel Forgings

ASTM E709-01, Standard Guide for Magnetic Particle Examination

Manual of Coating Work

Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

AWS D1.1/D1.1M-2010, Structural Welding Code — Steel

Publisher: American Welding Society (AWS), 8669 NW 36 Street, No. 130, Miami, FL 33166 (www.aws.org)

CMAA 70-2010, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

Publisher: Crane Manufacturers Association of America, Inc. (CMAA), 8720 Red Oak Boulevard, Charlotte, NC 28217 (www.mhia.org/industrygroups/cmaa)


NEMA ICS 2-2002 (R2005), Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts (R2005)

NEMA ICS 3-1993, Industrial Control and Systems: Factory Build Assemblies


Publisher: National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Rosslyn, VA 22209 (www.nema.org)

NFPA 70-2014, National Electrical Code (NEC)

Publisher: National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169 (www.nfpa.org)

OSHA Safety and Health Standards, Title 29, Code of Federal Regulations Part 1910 (29 CFR 1910), Occupational Safety and Health Standards

Publisher: U.S. Department of Labor — Occupational Safety & Health Administration (OSHA), U.S. Department of Labor, 200 Constitution Avenue, Washington, DC 20210 (www.osha.gov)


Publisher: American Society for Nondestructive Testing (ASNT), 1711 Arlington Lane, P.O. Box 28518, Columbus, OH 43228 (www.asnt.org)


Publisher: SSPC. The Society for Protective Coatings, 40 24th Street, Pittsburgh, PA 15222 (www.sspc.org)
Reference documents listed in NOG-1-2015 were evaluated for update in the next edition of NOG-1. The current and proposed language is summarized in the table below, along with commentary providing rationale for the updates. If “No change” is noted, the reference is either acceptable as stated or was not evaluated as part of this record. In addition to the list of references in Section 1160, there are proposed updates to other sections of NOG-1 where the references are used.

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<td>2</td>
<td>1150</td>
<td><em>blisters:</em> bubble-like protrusions formed in a cured, or nearly cured, coating film; see ASTM D714-56 for photographic examples.</td>
<td><em>blisters:</em> bubble-like protrusions formed in a cured, or nearly cured, coating film; see ASTM D714 for photographic examples.</td>
<td>Remove revision number. Latest revision shows updated photographic examples.</td>
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<td>5</td>
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<td><em>flaking:</em> a defect in the coating film manifested by actual detachment of pieces of the film either from its substrate or from coating previously applied per ASTM D772-47 including photographic standards. Flaking is generally preceded by cracking, checking, or blistering and is the result of loss of adhesion.</td>
<td><em>flaking:</em> a defect in the coating film manifested by actual detachment of pieces of the film either from its substrate or from coating previously applied per ASTM D772 including photographic standards. Flaking is generally preceded by cracking, checking, or blistering and is the result of loss of adhesion.</td>
<td>Remove revision number. Latest revision shows updated photographic examples.</td>
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<td><em>scaling:</em> detachment of coating film from substrate.</td>
<td><em>scaling:</em> see <em>flaking.</em></td>
<td>Per ASTM D772, the terms flaking and scaling are considered synonymous.</td>
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<td>1160</td>
<td>The following is a list of codes and standards referenced in NOG-1. These codes and standards apply to the extent invoked at the point of reference.</td>
<td>The following is a list of codes and standards referenced in NOG-1. These codes and standards apply to the extent invoked at the point of reference. If a revision number is not specified, refer to the latest revision of the code or standard.</td>
<td>Add statement to use the latest revision for standards where the revision number was removed.</td>
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| 8-9  | 1160    | AGMA 9005-E02, Industrial Gear Lubrication  
ANSI/AGMA 2001-C95, Fundamental Rating 
Factors and Calculation Methods for Involute 
Spur and Helical Gear Teeth  
Publisher: American Gear Manufacturers 
Association (AGMA), 1001 North Fairfax Street, 
Suite 500, Alexandria, VA 22314 (wwwAGMA.org) | “No change” | AGMA 9005 was not evaluated as part of this record.  
ANSI/AGMA 2001-C95 is acceptable as stated. The most recent revision ANSI/AGMA 2001-D04 is not supported by industry. |
| 9    | 1160    | The following three documents are contained in the AISC Manual of Steel Construction (ASD), Ninth Edition:  
Code of Standard Practice for Steel Buildings and Bridges, March 7, 2000  
Specification for Structural Joints Using ASTM A325 or A490 Bolts, June 23, 2000  
Publisher: American Institute of Steel Construction (AISC), 1 East Wacker Drive, Suite 700, Chicago, IL 60601 (wwwAISC.org) | The following two documents are contained in the AISC Manual of Steel Construction (ASD), 15th Edition, 2017:  
Section 16-1, Specification for Structural Steel Buildings, July 7, 2016  
Section 16-2, Specification for Structural Joints Using High Strength Bolts, August 1, 2014  
Publisher: American Institute of Steel Construction (AISC), 130 East Randolph, Suite 2000, Chicago, IL 60601 (wwwAISC.org) | Update to latest edition and sections. The previous referenced edition (Ninth) was published in 1989 so could not have referenced documents from 2000.  
Delete code (Steel Buildings and Bridges) that is not referenced in NOG-1.  
Update publisher address. |
| 9    | 1160    | AISE TR No. 1, 1991, DC Mill Motors  
AIST/AISE TR No. 6, 2005, Specification for EOT Cranes for Steel Mill Service  
Publisher: Association for Iron & Steel Technology (AIST), 186 Thorn Hill Road, Warrendale, PA 15086 (wwwAIST.org) | AIST TR-01, 1991, DC Mill Motors  
AIST TR-06, 2005, Specification for EOT Cranes for Steel Mill Service  
Publisher: Association for Iron & Steel Technology (AIST), 186 Thorn Hill Road, Warrendale, PA 15086 (wwwAIST.org) | Update names only (these are still the latest revisions). On 1/1/04, the Association of Iron and Steel Engineers (AISE) was consolidated into the Association for Iron & Steel Technology (AIST). |
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<td>9</td>
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<td>ASME B30.2-2011, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist) ASME B30.10-2009, Hooks ASME NQA-1–2012, Quality Assurance Requirements for Nuclear Facility Applications</td>
<td>“No change”</td>
<td>These ASME Standards were not evaluated as part of this record.</td>
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<td>ASTM D772-47, Standard Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints</td>
<td>ASTM D714, Standard Test Method for Evaluating Degree of Blistering of Paints</td>
<td>“No change”</td>
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<td>Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (<a href="http://www.astm.org">www.astm.org</a>)</td>
<td>Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (<a href="http://www.astm.org">www.astm.org</a>)</td>
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| 9    | 1160    | CMAA 70-2010, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes  
Publisher: Crane Manufacturers Association of America, Inc. (CMAA), 8720 Red Oak Boulevard, Charlotte, NC 28217 (www.mhia.org/industrygroups/cmaa) | “No change” | CMAA 70 was not evaluated as part of this record. |
NEMA ICS 2-2002 (R2005), Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts (R2005)  
NEMA ICS 3-1993, Industrial Control and Systems: Factory Build Assemblies  
NEMA ICS 6-1993 (R2001, R2006), Industrial Control and Systems Enclosures  
Publisher: National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Rosslyn, VA 22209 (www.nema.org) | NEMA ICS 1-2000 (R2015), Industrial Control and Systems: General Requirements  
NEMA ICS 2-2002 (R2005), Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts (R2005)  
NEMA ICS 3-1993, Industrial Control and Systems: Factory Build Assemblies  
NEMA ICS 6-1993 (R2016), Industrial Control and Systems: Enclosures  
Publisher: National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Suite 900, Arlington, VA 22209 (www.nema.org) | Update name only (revalidation) for ICS 1.  
No change for ICS 2. This is still the latest revision.  
ICS 3 was not evaluated as part of this record.  
Update name only (revalidation) for ICS 6.  
Update publisher address. | |
| 9    | 1160    | NFPA 70-2014, National Electrical Code (NEC)  
Publisher: National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169 (www.nfpa.org) | “No change” | NFPA 70 was not evaluated as part of this record. |
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<td>9</td>
<td>1160</td>
<td>OSHA Safety and Health Standards, Title 29, Code of Federal Regulations Part 1910 (29 CFR 1910), Occupational Safety and Health Standards</td>
<td>“No change”</td>
<td>OSHA reference is acceptable as stated.</td>
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<td>Publisher: U.S. Department of Labor — Occupational Safety &amp; Health Administration (OSHA), U.S. Department of Labor, 200 Constitution Avenue, Washington, DC 20210 (<a href="http://www.osha.gov">www.osha.gov</a>)</td>
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<td>Publisher: American Society for Nondestructive Testing (ASNT), 1711 Arlingate Lane, P.O. Box 28518, Columbus, OH 43228 (<a href="http://www.asnt.org">www.asnt.org</a>)</td>
<td>Publisher: American Society for Nondestructive Testing (ASNT), 1711 Arlingate Lane, Columbus, OH 43228 (<a href="http://www.asnt.org">www.asnt.org</a>)</td>
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<td>9</td>
<td>1160</td>
<td>Systems and Specifications, Steel Structures Painting Manual, Volume 2, 8th Edition, 2000</td>
<td>“No change”</td>
<td>This manual was not evaluated as part of this record.</td>
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<td>Publisher: SSPC: The Society for Protective Coatings, 40 24th Street, Pittsburgh, PA 15222 (<a href="http://www.sspc.org">www.sspc.org</a>)</td>
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<td>12</td>
<td>3210</td>
<td><em>(c)</em> Inspection and testing of coatings for coating service level I shall be in accordance with ASTM D5144. Specific coating inspections shall be specified by the owner, dependent upon the coating system being used. See ASTM D5161 for selecting and specifying the appropriate inspection requirements.</td>
<td><em>(c)</em> Inspection and testing of coatings for coating service level I shall be in accordance with ASTM D5144. Specific coating inspections shall be specified by the owner, dependent upon the coating system being used.</td>
<td>Remove reference to withdrawn standard ASTM D5161.</td>
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<td>30</td>
<td>4252.1</td>
<td><strong>Structural Joints Using ASTM A325 or ASTM A490 Bolts.</strong> Structural joints for structural components identified under para. 4400 using ASTM A325 or ASTM A490 bolts shall be designed and installed in accordance with the AISC “Specification for Structural Joints Using ASTM A325 or A490 Bolts.”</td>
<td><strong>Structural Joints Using ASTM A325 or ASTM A490 Bolts.</strong> Structural joints for structural components identified under para. 4400 using ASTM A325 or ASTM A490 bolts shall be designed and installed in accordance with the AISC Manual of Steel Construction, 15th Edition, Section 16-2.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
</tr>
<tr>
<td>30</td>
<td>4252.2</td>
<td><strong>Structural Joints Using Bolts Other Than ASTM A325 or ASTM A490.</strong> Structural joints using bolts other than ASTM A325 or ASTM A490 shall be bearing type and shall comply with the requirements for non-high-strength bolts specified in the AISC “Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design.”</td>
<td><strong>Structural Joints Using Bolts Other Than ASTM A325 or ASTM A490.</strong> Structural joints using bolts other than ASTM A325 or ASTM A490 shall be bearing type and shall comply with the requirements for non-high-strength bolts specified in the AISC Manual of Steel Construction, 15th Edition, Section 16-1.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
</tr>
<tr>
<td>30</td>
<td>4252.3</td>
<td><strong>Pitch and Edge Distances.</strong> The minimum pitch between centers of bolt holes and minimum edge distances from the center of a bolt hole to any edge shall be as stipulated in the AISC “Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design.”</td>
<td><strong>Pitch and Edge Distances.</strong> The minimum pitch between centers of bolt holes and minimum edge distances from the center of a bolt hole to any edge shall be as stipulated in the AISC Manual of Steel Construction, 15th Edition, Section 16-1, Chapter J.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
</tr>
<tr>
<td>31</td>
<td>4312</td>
<td>In lieu of calculating the allowable stress by formula, the allowable stress listed in AISC divided by $N$ may be used.</td>
<td>In lieu of calculating the allowable stress by formula, the allowable stress listed in the AISC Manual of Steel Construction, 15th Edition, Section 16-1, Chapter E, divided by $N$ may be used.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
</tr>
<tr>
<td>31</td>
<td>4313</td>
<td><strong>Bending Stress.</strong> The allowable bending stress for members other than those girders conforming to the dimensional criteria outlined in para. 4333 shall conform to AISC “Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design” Chapter F divided by $1.12N$ for the different loading conditions.</td>
<td><strong>Bending Stress.</strong> The allowable bending stress for members other than those girders conforming to the dimensional criteria outlined in para. 4333 shall conform to the AISC Manual of Steel Construction, 15th Edition, Section 16-1, Chapter F, divided by $1.12N$ for the different loading conditions.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
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<tr>
<td>31</td>
<td>4315</td>
<td><strong>Bolts</strong>&lt;br&gt;(a) ASTM A325 or ASTM A490 Bolts. Allowable working stresses for operational or construction loads shall be in accordance with AISC “Specification for Structural Joints Using ASTM A325 or A490 Bolts.” Allowable working stresses for other loadings shall be as follows.</td>
<td><strong>Bolts</strong>&lt;br&gt;(a) ASTM A325 or ASTM A490 Bolts. Allowable working stresses for operational or construction loads shall be in accordance with the AISC Manual of Steel Construction, 15th Edition, Section 16-2. Allowable working stresses for other loadings shall be as follows.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
</tr>
<tr>
<td>36</td>
<td>4424</td>
<td><strong>Single Web Girders.</strong> Single web girders may be standard rolled beams or plate girders, reinforced with angles, channels, or plates. Where necessary, auxiliary girders shall be used to support overhanging loads to minimize torsional moments and lateral deflections on the single web girder. The analysis required for single web girders shall be the same as required for the plate box girder in para. 4423. The design shall be in accordance with the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, but with the allowable stresses set forth in para. 4310.</td>
<td><strong>Single Web Girders.</strong> Single web girders may be standard rolled beams or plate girders, reinforced with angles, channels, or plates. Where necessary, auxiliary girders shall be used to support overhanging loads to minimize torsional moments and lateral deflections on the single web girder. The analysis required for single web girders shall be the same as required for the plate box girder in para. 4423. The design shall be in accordance with the AISC Manual of Steel Construction, 15th Edition, Section 16-1, Chapter F, but with the allowable stresses set forth in para. 4310.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
</tr>
<tr>
<td>70</td>
<td>5456.1(a)</td>
<td>(2) Cranes that travel over the reactor pool or fuel pool shall use fasteners that do not depend upon lock washers unless they are so located as to be caught upon removal by drip pans or crane structure. For these cranes, when other than high-strength bolts are used, preferred locking methods are thread-upsetting fasteners, plastic insert fasteners, tack welding, cementing, or lock wire. High-strength bolts are considered restrained when torqued in accordance with the AISC method.</td>
<td>(2) Cranes that travel over the reactor pool or fuel pool shall use fasteners that do not depend upon lock washers unless they are so located as to be caught upon removal by drip pans or crane structure. For these cranes, when other than high-strength bolts are used, preferred locking methods are thread-upsetting fasteners, plastic insert fasteners, tack welding, cementing, or lock wire. High-strength bolts are considered restrained when torqued in accordance with the AISC Manual of Steel Construction, 15th Edition, Section 16-2.</td>
<td>Update AISC Manual of Steel Construction reference.</td>
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<tr>
<td>93</td>
<td>6471</td>
<td><em>(a) Direct Current Motors. DC motors shall be in accordance with either NEMA MG-1 or AISE TR No. 1.</em></td>
<td><em>(a) Direct Current Motors. DC motors shall be in accordance with either NEMA MG-1 or AIST TR-01.</em></td>
<td>Update AIST reference.</td>
</tr>
<tr>
<td>94</td>
<td>6472.2(c)</td>
<td>Where $K_a$ = a factor that includes……factors for constant potential DC series motor drives are to be in accordance with AISE TR No. 6, noting that….</td>
<td>Where $K_a$ = a factor that includes……factors for constant potential DC series motor drives are to be in accordance with AIST TR-06, noting that….</td>
<td>Update AIST reference.</td>
</tr>
<tr>
<td>96</td>
<td>6472.4</td>
<td><em>(a) When definite operating requirements have been specified, the time, motor torque, and average motor speed can be calculated for each step of acceleration, running, and deceleration. The procedure for checking the thermal adequacy of the motor will vary, depending on the type of motor and motor enclosure. For totally enclosed series wound AISE TR No. 1 DC mill motors used for constant-potential DC control at 230 V, published curves may permit determining whether or not the allowable percent time-on exceeds the actual percent time-on.</em></td>
<td><em>(a) When definite operating requirements have been specified, the time, motor torque, and average motor speed can be calculated for each step of acceleration, running, and deceleration. The procedure for checking the thermal adequacy of the motor will vary, depending on the type of motor and motor enclosure. For totally enclosed series wound AIST TR-01 DC mill motors used for constant-potential DC control at 230 V, published curves may permit determining whether or not the allowable percent time-on exceeds the actual percent time-on.</em></td>
<td>Update AIST reference.</td>
</tr>
</tbody>
</table>
6300 PERFORMANCE SPECIFICATIONS (TYPES I, II, AND III CRANES)

6310 General

(a) The rated load speeds recommended in paras. 5331, 5332, and 5333 are normal speeds based on the rated capacity of the crane. The characteristics of drive systems can vary widely with respect to speeds at other than rated load and with respect to lowering speeds at any load. Drive systems shall be chosen to conform to any speed–load constraints stated in the specifications.

(b) If more than one control station is required (e.g., cab control and radio remote control), performance criteria for each of the stations shall be specified.

(c) An emergency stop shall be provided on each operator control device (cab control, pendant station, radio control, etc.) and shall be within reach of the operator in any operating position. The emergency stop shall open or de-energize a power device that is not required to open and close during normal run–stop operations. A fail-safe circuit shall be used to implement this provision. No method may be used to maintain power to any function of the crane once the emergency stop has been actuated. No method shall be used to maintain power to any motion of the crane while the emergency stop is actuated.

6417 AC Variable Frequency

6417.1 Hoist

(f) Type I cranes shall have controls with the following capabilities:

(1) A warning device shall be provided to warn the operator of a pending motor overheat condition.

(2) A warning device shall be provided to warn the operator that the dynamic braking resistors have over heated.

(3) A warning device shall be provided to warn the operator of a hoist holding brake failure. The detection of a brake failure shall limit hoist speed in the up direction.

(g) Type II and III cranes equipped with a brake failure detection circuit shall be provided with a warning device to warn the operator of a hoist holding brake failure. The detection of a brake failure shall limit hoist speed in the up direction.

Justification: Since ASME B30.2 has approved the use of E-Stop bypasses for crane hoists with VFD controls, ASME NOG-1 must clarify its stance on this change.
Record No. 20-600

ASME NOG-1 BALLOT on
A2 Bridge Drives, 5440(a)(2) & A2 Trolley Drives, 5430(a)(4)
Requiring Gears on Axles to be Pressed and Keyed

<table>
<thead>
<tr>
<th>5430</th>
<th>Trolley Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Type I Cranes. Trolley drives shall consist of one of the following arrangements, which are shown in Fig. 5430-1. Each four-wheel trolley shall use a drive arrangement that provides drive to at least 50% of the wheels. Trolleys having more than four wheels shall have at least 25% of the wheels driven. In trolley travel drives, single-failure-proof features are generally not required. However, in those cases where a failure of a component could result in a facility unacceptable excursion, the design shall incorporate single-failure-proof features to ensure that the trolley can be brought to a safe stop.</td>
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</tr>
<tr>
<td>(1) A-1 Drive. The motor is located near the center of the trolley and is connected by means of a flexible coupling to a self-contained gear reduction unit also located at the center of the trolley, which shall be connected to the line shaft by solid or half-flexible couplings. The line shaft is in turn connected to the trolley wheel axles by means of floating shafts with half-flexible couplings.</td>
<td></td>
</tr>
<tr>
<td>(2) A-1A Drive. Same as A-1 drive, except the self-contained gear reduction unit is located closer to one of the trolley wheel axles.</td>
<td></td>
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<tr>
<td>(3) A-1B Drive. Same as A-1 drive, except the self-contained gear reduction unit is located outside the trolley frame close to one of the trolley wheel axles.</td>
<td></td>
</tr>
<tr>
<td>(4) A-2 Drive. The motor is connected by means of a flexible coupling to a self-contained gear reduction unit located at the center of the trolley. The trolley wheels shall be driven through gears that are either pressed or keyed to their axles, or which are attached directly to the wheel. Floating shaft couplings shall be half-flexible type at wheel and reducer connections. If splicing of floating shafts is required, couplings shall be of the solid type.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>5440</th>
<th>Bridge Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Type I Cranes. Bridge drives shall consist of one of the following arrangements, which are shown in Fig. 5440-1. Each four-wheel bridge shall use a drive arrangement that has at least 50% of the wheels driven. Bridges having more than four wheels, such as eight-wheel, twelve-wheel, or sixteen-wheel, shall have at least 25% of the wheels driven. Bridge drives shall be located directly opposite each other on rectilinear traveling overhead and gantry cranes [see Fig. 5440-1], and diagonally opposite on polar cranes [see Fig. 5440-2].</td>
<td></td>
</tr>
<tr>
<td>In bridge travel drives, single-failure-proof features are generally not required. However, in those cases where a failure of a component could result in a facility unacceptable excursion, the design shall incorporate single-failure-proof features to ensure that the bridge can be brought to a safe stop.</td>
<td></td>
</tr>
<tr>
<td>(1) A-1 Drive. The motor is located near the center of the bridge and is connected by means of a flexible coupling to a self-contained gear reduction unit also located at the center of the bridge, which shall be connected to the line shaft by solid or half-flexible couplings. The line shaft is in turn connected to the bridge wheel axles by means of floating shafts with half-flexible couplings [see (a)(7) below, Note].</td>
<td></td>
</tr>
<tr>
<td>(2) A-2 Drive. The motor is connected by means of a flexible coupling to a self-contained gear reduction unit located at the center of the bridge. The bridge wheels shall be driven through gears that are either pressed or attached directly to the wheel. Line shaft couplings at the center reducer shall be either solid or half-flexible. Line shaft couplings at the truck reduction pinion shall be of the half-flexible type. All other couplings shall be of the solid type [see (a)(7) below, Note].</td>
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</tbody>
</table>

pressed and keyed to their axles,
present and keyed to their axles, or which are
ASME NOG-1 BALLOT on
ROTATING AXLE FIT FOR BRIDGE & TROLLEY WHEELS, 5452.5
REQUIRING DRIVE WHEELS TO NOT RELY ON FRICITION

ASME NOG-1-2015

the applicable conditions, such as minimum wheel slippage or motor output torque.

5452 Wheels — Bridge and Trolley

5452.1 General. Unless other means of restricting lateral movement are provided, wheels shall be double flanged with treads accurately machined. Wheels may have either straight treads or tapered treads assembled with the large diameter toward the center of the span. Drive wheels shall be matched pairs within 0.001 in./in. of diameter, or a total of 0.010 in. on the diameter, whichever is smaller. When flangeless wheel and side roller assemblies are provided, they shall be of a type and design recommended by the crane manufacturer.

5452.2 Material. Wheels shall be rolled or forged from steel for Type I cranes. Types II and III cranes may have wheels cast of carbon or alloy steel. Wheel treads shall have a minimum surface hardness of 300 BHN.

5452.3 Loading. Wheels shall be designed to carry the maximum wheel load under normal conditions. The allowable maximum wheel load is determined by dividing the allowable wheel load in Table 5452.3-1 by the appropriate speed factor of Table 5452.3-2. The allowable load shown in Table 5452.3-1 is that load produced with trolley handling the rated load in the position to produce the maximum load and shall be used for determining wheel sizes. Impact loading due to handling rated load is not included in the allowable wheel loads.

5452.4 Clearances
(a) Bridge Clearances. Wheel treads shall be a minimum of \( \frac{3}{8} \) in. wider than the rail head for nontapered wheels.
(b) Trolley Clearances. Wheel treads shall be a minimum of \( \frac{3}{8} \) in. wider than the rail head for nontapered wheels.
(c) Tapered Wheel Clearances. Tapered tread wheels may have a clearance over the rail head of 150% of the clearance provided for straight tread wheels, or as recommended by the crane manufacturer.
(d) Special Conditions for Wheel Clearances. Wheel tread clearances may be greater than those specified in 5452.4 unless it is necessary to meet runway conditions, or excessive tempering of 1000. For guidance on wheel width and height, refer to Table 5452.4-1.

5452.5 Wheels with Rotating Axles

- 5452.5.1 Axle Fit. When rotating axles are used, wheels shall be mounted on the axle with a press fit or press fit and keys. All wheels shall have sufficient hub thickness to permit the use of keys.
- 5452.6 Overhung Wheels. Overhung wheels shall not be used.

5453 Axles — Bridge and Trolley

5453.1 General — Type I Cranes. Axles may be either of the fixed or rotating type.
(a) Load Combinations, Allowable Stresses, and Service Factors. The bridge and trolley axles shall be designed to resist the load combinations of Table 5453.1-1 with corresponding values of allowable stresses and service factors.
(b) Computation — Analysis. Analytical stress computations shall be performed according to procedures in para. 5470.

5453.2 General — Type II Cranes. Axles shall be designed according to CMAA 70.

5453.3 General — Type III Cranes. Axles shall be designed according to CMAA 70.

5454 Drive Shafts — Bridge and Trolley

5454.1 General — Type I Cranes. Drive shafting shall be designed for the rated load maximum wheel load in combination with the required torque. The magnitude of the torque shall be based on the drive output speed, skid torque, or braking torque, whichever is limiting.
(a) Computation — Analysis. Analytical stress computations shall be performed according to procedures in para. 5470.
(b) Service Factors. Service factors shall be applied according to para. 5520.
(c) Torsional Deflection. The torsional deflection of the cross-shafts and floating shafts shall not exceed the values shown in Table 5454.1-1. The types of drivers referred to in this table are defined in para. 5440. The percent motor torque is the portion of the full-load torque of the drive motor(s) at its normal time rating for the service involved, increased by any gear reductions between the motor and the shaft. If 60-min series wound motors are used, short time rating for the drives should be considered. The allowable angular deflection is expressed in degrees per foot (deg/ft).

5454.2 General — Types II and III Cranes. Drive shafting shall be designed according to CMAA 70.

5455 Bearings

5455.1 Antifriction Bearings (Type I Cranes)
(a) The type, size, and mounting of bearings shall be determined by criteria outlined in this Section. Computations confirming the adequacy of the bearing to meet the criteria shall be included as part of the crane analysis.
(b) Bearings with a calculable predicted life expectancy of a minimum of 5,000 hr shall be selected.
(1) Bearing life expectancy shall be determined from the bearing manufacturer’s published data or certified extension of published data.
(2) Bearing life expectancy shall be expressed as the number of hours of operation in which 90% of the bearings are expected to operate without failure.
RECORD 20-670: Add definition of lower block.

JUSTIFICATION: The terms lower block and load block are used interchangeably within NOG-1; however, lower block is not defined. A definition is being added to clarify they are one-and-the-same component.

lower block: see load block
RECORD 20-1025: NOG-1 Runway and Bridge Rails Clarification

RECIRCULATION BALLOT UPDATE: An instance of ‘trolley rail’ on page 21 was missed in the initial ballot. It has been included here (highlighted yellow). No other changes were made

BACKGROUND:

It was noted during review of ballots on Record 19-1263 that NOG-1 uses the term bridge rails to mean both the runway rails as well as the rails upon which the trolley rides, and NOG-1 also uses the term trolley rail to mean the rail upon which the trolley rides. The purpose of this ballot is to use consistent terminology throughout NOG-1. The definitions provided in CMAA-70 are considered the industry standard. Therefore, only the terms “runway rail” and “bridge rail” are used and the use of ‘trolley rail’ is eliminated.

From CMAA-70 glossary:
Bridge rail: The rail supported by the bridge girders on which the trolley travels
Runway rail: The rail supported by the runway beams on which the bridge travels.

Note each instance of the word “rail” or “rails” was evaluated. Only those pages where a change is required are shown in the ballot material and a callout indicates what the specific change is for each instance. Pages that had the word “rail” or “rails” but do not require changes are shown in a separate file in the background material.

Ballot material follows:


Record 20-1025

No Change

Change "Trolley" to "Bridge"
Fig. 4153.3-1 Typical Four-Wheel Trolley Model for Seismic Analysis

Change "Trolley" to "Bridge"

Fig. 4153.3-2 Typical Four-Wheel Overhead Crane Model for Seismic Analysis

No Change

supports, and hoist ropes. Line elements associated with the trolley and bridge trucks at the wheel locations shall be used to represent the connectivity of the trolley and bridge wheels to their respective supports, upon which the wheels roll. Typical four-wheel trolley and bridge models are shown in Figs. 4153.3-1 through 4153.3-4. Trolleys or bridges with more than four wheels shall be modeled with additional elements that represent components between the trolley or bridge structure and their respective supports. Additional elements may be employed to model boundary conditions as needed.

The loadings resulting from the pendulum motion of the lifted load are insignificant and need not be considered if the crane is not handling a load, the period of motion of the pendulum swing exceeds 3 sec, or the frequency of the pendulum swing is less than 20% of the fundamental horizontal frequencies of the crane.

NOTE: Typically, the horizontal displacement of the lifted load resulting from the pendulum swing is small, but in some cases this movement, combined with the movement of the trolley or bridge sliding on their respective rails, might result in load contact with the leg of a gantry crane, the facility's structure, or other plant equipment, and might require additional evaluation.

(b) For a trolley or bridge using bogie trucks, the trucks and their articulation shall be modeled in a manner that is representative of their structural characteristics. Where various connected structural members of the crane do not have intersecting centroidal axes, stiff line elements shall be used to represent the offset. These elements shall have stiffnesses that are an order of
Fig. 4153.3-3  Typical Four-Wheel Gantry Crane Model for Seismic Analysis

Record 20-1025

Change “Trolley” to “Bridge”

No Change

Fig. 4153.3-4  Typical Four-Wheel Semi-Gantry Crane Model for Seismic Analysis

Change “Trolley” to “Bridge”

No Change
magnitude higher than the most stiff structural member of the crane.

(c) A simplified finite element representation of the trolley structure using stiff line elements may be used for the crane dynamic model, provided it can be shown by rational analyses that the actual trolley structure responding as an uncoupled system has natural frequencies above 33 Hz. The simplified representation of the trolley structure shall be modeled in a manner that will not introduce an artificial stiffening effect between the two girders, but would allow for relative twist of the trolley structure between the two trolley trucks (i.e., torsional stiffness of the trolley elements, connecting the two trolley trucks, should represent the torsional stiffness of the trolley structure). The model used for seismic analysis should be evaluated and revised if required to account for higher frequencies if plant operations induce such frequencies.

4153.4 Location and Number of Dynamic Degrees of Freedom. Dynamic degrees of freedom shall be assigned to a sufficient number of node points, and in such locations that the real mass and stiffness distribution of the crane are simulated. Structural members subject to concentrated loads shall be provided with additional nodes at the points where a concentrated load or its equivalent mass is positioned. Crane components to be modeled as mass points (concentrated loads) shall include, but not be limited to, upper and lower blocks, gear cases, motors, brakes, heavy electrical control cabinets, cab, wheel assemblies, and trunnion pins. The total number of masses, or degrees of freedom, selected shall be considered adequate when additional degrees of freedom do not result in more than a 10% increase in responses. Dynamic coupling shall be accounted for.

4153.5 Decoupling Criteria for the Crane Runway.

The crane and runway shall be evaluated in each of the three orthogonal directions to determine if the crane can be represented as a separate model or a model coupled with the runway in each of the respective directions.

NOTE: Based on this evaluation, the crane model may be required to be coupled to the runway in only one or two of the three orthogonal directions.

For the crane to be considered decoupled from the runway, the criteria of (a) or (b) below shall be met.

(a) If \( R_{m} < 0.01 \), decoupling can be done for any \( R_{f} \).
(b) If \( 0.01 \leq R_{m} \leq 0.1 \), decoupling can be done if \( R_{f} \leq 0.8 \) or if \( R_{f} \geq 1.25 \).
(c) If neither criteria (a) nor (b) is met, then an approximate model of the runway system shall be included with the crane model.

Mass ratio for the horizontal directions (X and Y)

\[
R_{m} = \frac{\text{mass of the crane (without hoist load block or lifted load)}}{\text{mass of the runway system}}
\]

Frequency ratio for each of the three independent orthogonal directions

\[
R_{f} = \frac{\text{fundamental frequency of the crane}}{\text{frequency of the dominant runway motion}}
\]

NOTE: The fundamental frequency of the crane is determined by the runway system, and the frequency of the dominant runway motion is determined by the effective mass of the crane and lifted load.

The purchaser shall determine the mass and frequency characteristics of the crane runway systems in each of the three orthogonal directions.

4153.6 Boundary Conditions at Trolley and Runway Rails.

The boundary conditions for the crane model shall be selected so that the resulting response, displacements, and forces in the crane structure are conservatively determined. Trolleys with four wheels shall be coupled to the bridge at the interface of the trolley wheels and runway rails as shown in Fig. 4153.3-1 and Table 4153.6-1 (unless restraining device requires additional coupling). Overhead, gantry, and monorail cranes with four wheels shall be coupled to the crane runway rails at the interface of the bridge, rails, and runway rails as shown in Figs. 4153.7-2, 4155.3-3, and 4153.3-4, respectively, and Table 4153.6-2 (unless restraining device requires additional coupling). Trolleys or bridges with fewer than four wheels shall be coupled in a manner that is representative of the design being considered. For trolleys or bridges using bogie trucks, all wheels shall be coupled to their respective rail in the vertical (Z) direction, and the "braked" wheels coupled in the direction of truck travel (X direction for the trolley and Y direction for the bridge). If more than one wheel on any rail is "braked," only one wheel per rail shall be coupled to represent the "braked" wheels. For bogie truck assemblies that are guided by means either of reduced wheel flats or by guide (side) rollers, both wheels shall be coupled to the rail in the direction perpendicular to the rail Y direction for the trolley and X direction for the bridge. When closely guided wheels are not used, or when the truck is guided by means of guide rollers at the center of the truck wheelbase, only the midpoint of the truck wheelbase is required to be coupled to the rail in the direction perpendicular to the rail.
### Table 4153.6-1 Boundary Conditions: Trolley Wheels to Trolley Rails

<table>
<thead>
<tr>
<th>Nodes</th>
<th>X Direction Options [Note (1)]</th>
<th>Y Direction Options [Notes (2) and (3)]</th>
<th>Z Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>TX-1</td>
<td>TY-1</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>TX-2</td>
<td>TY-2</td>
<td></td>
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<tr>
<td>A3</td>
<td></td>
<td>TY-3</td>
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<td>B1</td>
<td></td>
<td>TY-4</td>
<td></td>
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<td>B2</td>
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<td></td>
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<tr>
<td>B3</td>
<td></td>
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</tr>
</tbody>
</table>

**GENERAL NOTES:**
(a) The asterisk (*) indicates nodes that are coupled in direction shown, and the tilde (-) indicates nodes that are not coupled (free to translate).
(b) All nodes are to be considered free to rotate.

**NOTES:**
1. Selection of coupled nodes in the X direction depends on the location of the braked wheels (couple only one wheel on each girder if more than one wheel on a rail is a braked wheel).
2. For analysis, trolley coupling options TY-1, TY-2, or TY-3 are acceptable when the trolley is rigid, or is modeled as rigid, in the XY plane. When option TY-1 is used, the addition of fictitious rigid trolley and bridge line elements is required. These elements are only used for coupling in the Y direction. The X location of these elements is approximately at the X location of the trolley centroid.
3. Option TY-4 should be used when the trolley is flexible (and is modeled as such) in the XY plane (i.e., the diagonal distances of the trolley cross-corner nodes are allowed to change as a function of girder distortion and trolley stiffness).

### Table 4153.6-2 Boundary Conditions: Bridge Wheels to Crane Runway Rails

<table>
<thead>
<tr>
<th>Nodes</th>
<th>X Direction Options [Notes (1) and (2)]</th>
<th>Y Direction Options [Notes (1) and (3)]</th>
<th>Z Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>BX-1</td>
<td>BY-1</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>BX-2</td>
<td>BY-2</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>BX-3</td>
<td>BY-3</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>BX-4</td>
<td>BY-4</td>
<td></td>
</tr>
</tbody>
</table>

**GENERAL NOTES:**
(a) The asterisk (*) indicates nodes that are coupled in direction shown, and the tilde (-) indicates nodes that are not coupled (free to translate).
(b) All nodes are to be considered free to rotate.

**NOTES:**
1. For polar cranes, the X and Y directions are defined as the directions perpendicular to and parallel with the tangent of the crane runway rail at the node location, respectively.
2. Selection of the coupling option in the X direction depends on the type of crane being modeled, and if the crane is modeled as being coupled or decoupled from the crane runway system (para. 4153.5).
   (a) Use option BX-1 for overhead cranes that are considered coupled to an approximate model of the crane runway system, and for both gantry cranes and semi-gantry cranes.
   (b) Use option BX-2 for overhead cranes that are modeled as being decoupled from the crane runway system when the bridge lateral (O) displacement is held more tightly on one end of the bridge than the other end; this is normally the case when the crane runway on one end is more rigid in the lateral direction than the other end, or when the bridge wheels are guided more closely on one end of the bridge than the other end, normally by means of limited wheel float or the use of guide rollers.
   (c) Use options BX-2, BX-3, or BX-4 for overhead cranes that are modeled as being decoupled from the crane runway system when the runway system and the bridge design on both ends are similar. When option BX-2 is used, couple the nodes on the end of the bridge that has the higher static load distribution.
3. Selection of coupled nodes in the Y direction depends on the location of the braked wheels (couple only one wheel on each end of the bridge if more than one wheel on a rail is a braked wheel).
of the linear analysis of para. 4153 indicate a slack rope condition, that is, rope going into compression, the nonlinear time-history method of analysis shall be used to determine the maximum rope tension loads resulting from a slack rope condition. These loads shall be used to verify rope compliance with design requirements. Also, these rope loads may be used as an alternate to the rope loads from the linear analysis results, in sizing of the hook, lower load block, upper sheave nest, hoist machinery components (gears, shafts, keys, couplings, etc.), or other components that are primarily affected only by the rope load and have no significant influence on the response.

Nonlinear analysis concerns the performance of a dynamic analysis of the crane, when subjected to earthquake-induced forces, taking into account the nonlinear properties (for example, tension only of the hoist ropes). To perform such an analysis, computer programs are available to solve the equations of motion via direct integration techniques at discrete time intervals over the time history of the earthquake.

4154.1 Crane Mathematical Model. The crane finite element model shall be similar to the one described in para. 4153.3 for the linear analysis, except that the crane trolley and bridge geometry may be simplified if justification can be provided that the coupling effects of those degrees of freedom that are omitted from the three-dimensional model are not significant. A nonlinear spring (tension member only) shall be used to represent the hoist ropes.

4154.2 Location and Number of Dynamic Degrees of Freedom. Dynamic degrees of freedom shall be assigned to a sufficient number of node points and in such locations that the real mass and stiffness distribution of the crane is simulated. An important consideration for modeling the crane for the nonlinear analysis is that the fundamental frequency of the crane system in its unloaded (no load on the hook) configuration approximates that determined by the linear analysis.

4154.3 Boundary Conditions at Trolley and Runway Rails. Boundary conditions for the crane model shall be consistent with those specified in para. 4153.6.

4154.4 Trolley Locations and Hoist Positions. A combined trolley and loaded hook position shall be selected so as to result in a crane system frequency that produces the severest slack rope conditions. Trolley locations and hoist positions specified in para. 4153.7 shall be considered.

4154.5 Damping Values. A critical damping ratio of 7% shall be used for the rope for determining the damping parameters required to form the damping matrix. Higher values may be used with adequate justification.
girder and the girder span of a semigantry crane is the distance from the upper crane rail to the center of the leg at its connection to the girder.

(b) The total vertical deflection of the girder cantilever shall not exceed $\frac{1}{300}$ of the cantilever length for the rated live load plus trolley $(P_{lb} + P_{tr})$ when the deflection is calculated as a fixed end cantilever beam.

(c) Side thrust at the runway rail due to gantry leg spreading caused by girder span or cantilever deflection or thermal movement shall be held at an acceptable level by providing adequate clearance between the runway rail and the wheel flanges, or by means of other design features incorporated into the gantry structure.

4350 Fatigue Requirements

Cranes used for nuclear power plants are normally used relatively few times during the entire life of the plant, as compared to typical structural fatigue criteria. The number of times a typical crane is cycled from no live load to full capacity load seldom exceeds 20,000 cycles during the entire life of the crane. Because of the combined effect of low full-load cycles and low allowable stresses during normal operation, the allowable stresses for the structural members, as specified in para. 4310, need not be reduced due to fatigue.

If the purchaser determines that greater than 20,000 full-load cycles are required, the purchaser shall then specify the cycles and load class per CMAA 70. The allowable stresses for the appropriate service level in CMAA 70 shall be used, but shall not exceed the basic operating stress allowable specified in para. 4310.

4400 COMPONENT DESIGN

4410 General

4411 Venting. Closed sections used in structures that are subject to changes in pressure shall be vented. If used, vent openings shall be sized to equalize the internal closed section (or compartment) pressure with its external environmental pressure. Pressure rate of change tables or graphs may be required to determine maximum flow requirements. Where internal full depth diaphragms extend from the top flange to the bottom flange, the compartment formed by a pair of diaphragms shall be vented.

4412 Drainage. Box sections when required by environmental conditions shall be drained to prevent moisture from accumulating. Where internal full depth diaphragms extend from the top flange to the bottom flange, the compartment formed by a pair of diaphragms shall be drained. Holes shall be provided in the bottom flange of the box girder for draining the whole box girder or each compartment formed by the diaphragms.

4413 Stress Concentrations. Consideration shall be given to points where high stresses might be encountered, such as (but not limited to) at ends of stiffeners, intermittent welds, points of attachment, cutouts, and reentrant corners. All reentrant corners shall be shaped notch free to a radius of at least $\frac{1}{2}$ in. Sharp corner cuts are to be avoided, as are abrupt changes in section properties. Cutouts, where necessary, shall be made with rounded corners, and their edges shall be analyzed for reinforcement.

4470 Bridge Girders

4421 General. The crane girders (bridge girders) shall be fabricated of structural steel. Structural steel materials shall comply with the requirements of para. 4210. Construction of the crane girders can be of several types, namely, welded plates to form box sections, box sections fabricated from rolled shapes with or without plates, single-rolled shapes, or built-up single web plate girders.

4422 Loading Criteria. Bridge girders shall be designed to resist the load combinations specified in para. 4140. When bridge girders and end ties are moment-connected in the horizontal plane, the assembly shall be analyzed as a rigid frame for the transverse horizontal loads.

4423 Fabricated Box Girders

4423.1 Proportions. Proportions for fabricated box girders shall be as specified in para. 4333.

4423.2 Stiffeners. The requirements of longitudinal and vertical stiffeners are given in para. 4330. Internal full depth diaphragms are required at machinery attachment points, bridge drive supports, and line shaft bearing supports.

The diaphragms may also be considered to meet the requirements of the vertical stiffeners. External stiffeners adjacent to the diaphragms may be required to transmit forces to the attachments into the girder.

4423.3 Diaphragms. All internal diaphragms shall be fitted to clear against the top cover plate to support the trolley rail and shall be welded to the web plates to transfer the load directly to the box girder webs.

4423.4 Diaphragm Spacing. Short diaphragms shall be placed between full depth diaphragms so that the maximum distance between adjacent diaphragms will limit the maximum bending stress without impact in the trolley rail.

$$\sigma_{lb} = \frac{\text{trolley wheel load, lb}}{6 \left(90^2 \text{distance between diaphragms, in.} \right)}$$

For operating and construction loading, $\sigma_{lb} = 18,000$ psi. For severe environmental loads, $\sigma_{lb} = 24,000$ psi. For extreme environmental loads, $\sigma_{lb} = 32,400$ psi.
4424 Single Web Girders. Single web girders may be standard rolled beams or plate girders, reinforced with angles, channels, or plates. Where necessary, auxiliary girders shall be used to support overhanging loads to minimize torsional moments and lateral deflections on the single web girder. The analysis required for single web girders shall be the same as required for the plate box girder in para. 4425. The design shall be in accordance with the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, but with the allowable stresses set forth in para. 4310.

4430 Trolley Frames

4431 Construction. The trolley frame shall be constructed of structural steel. If field assembly of the trolley structure is required, the connections shall be designed to ensure proper alignment of the components.

4432 Design

4432.1 Trolley Frame. The trolley frame shall be designed to resist all loading imposed by the motor, gearing, lifted load, and the load combinations specified in para. 4140.  

4432.2 Load Girt. The load girt(s) shall be designed to carry the load to the side frames. Care shall be taken that the load girt deflections do not adversely affect the machinery alignment.

4433 Axle Failure. Provisions shall be made to prevent a drop of more than 1 in. in case of an axle failure.

4440 End Trucks and End Ties

4441 End Trucks

4441.1 General. The end truck is the assembly consisting of wheels, bearings, axles, and structural frame that supports the crane bridge.

4441.2 Construction. The end trucks shall be constructed of structural steel.

4441.3 Design. The end truck shall be designed to support the maximum crane end reactions for the load combinations specified in para. 4140.

4441.4 Axle Failure. Provisions shall be made to prevent a drop of more than 1 in. in case of an axle failure.

4445 Wheel Base. The wheel base of the end trucks of four-wheel cranes, or center-to-center of outermost wheels of multiple end trucks for cranes with more than four wheels, shall be not less than one-seventh of the girder span.

4445.1 Rail Sweeps. A rail sweep shall be provided in front of each outside wheel. The rail sweep shall project below the top of the bridge runway rail.

4450 Gantry Frames

4451 General. Gantry frames shall be fabricated of structural steel. The structural members assembled to form the gantry frame may include, but are not limited to, the following: girders, end ties, legs, trucks, sills, struts, saddles, and equalizer beams. Structural steel materials used in the gantry frame members shall comply with the requirements of para. 4210.

4452 Loading Criteria. Gantry frames shall be designed to resist the load combinations specified in para. 4140. The gantry frame assembly shall be analyzed as a three-dimensional structure.

4453 Gantry Legs. Gantry legs shall be designed to withstand the load combinations specified in para. 4140. The legs shall be constructed of structural steel, and their configuration may vary according to the clearance and overall crane geometry required. Gantry legs constructed of box sections shall be provided with diaphragms to maintain the leg geometry. The legs shall be stiffened to meet the requirements of para. 4330.
4454 Struts and Sills. Struts and sills are used to connect the legs and joining members. They shall be designed to resist the load combinations specified in para. 4140. Struts and sills shall be constructed of structural steel.

4455 Saddles and Equalizer Beams. Saddles and equalizer beams are used to support the crane structure and are themselves supported by the gantry trucks. Their purpose is to distribute the loading at one corner of the crane equally to the bridge wheels at that corner. They shall be constructed of structural steel. Saddles and equalizer beams shall be designed for the load combinations specified in para. 4140.

Plates or hubs used in saddles or equalizer beams to support trunnions and rotating pins shall be designed to meet the bearing stress specified in Section 5000.

4456 Gantry Wheel Base. The wheel base of the end trucks of four-wheel gantry cranes, or center-to-center of extreme wheels of multiple end trucks for gantry cranes with more than four wheels, may be required to exceed that ratio specified in para. 4441.5. The gantry structure height may necessitate an increased wheelbase in order to gain gantry stability and to reduce gantry skewing.

4457 Gantry Stability. The gantry crane shall have a safety factor of not less than 1.5 against overturning when used in the unrestrained operating condition and subjected to the load combinations specified in para. 4140. During severe environmental, extreme environmental, or abnormal event loading, the gantry crane shall have a safety factor of not less than 1.1 against overturning. Restraints may be used to prevent overturning.

4460 Rails

4461 Requirements. All bridge and trolley rails required to transmit vertical down and horizontal loads due to normal and construction loads only shall conform to the ASCE, ARA, or AREA specifications. When these rails are used on Types I and II cranes, secondary restraints that are not necessarily in contact under normal loading conditions shall be provided to resist the vertical up and horizontal loads due to severe environmental and extreme environmental loading conditions. Rails required to transmit vertical up and/or horizontal loads due to severe environmental and extreme environmental loading conditions shall meet all of the requirements of a structural steel member as covered in paras 4200 and 4300.

4462 Fastening. Bridge and trolley rails shall be joined by standard joint bars or welded. For other than polar crane runway rails, provision shall be made to prevent creeping of the rails by means of a positive stop at the ends of the rails. Rails shall be securely fastened in place to maintain center-to-center distance of rails.
Fig. 7521.2-1 Inspection for Wheel Wear

**GENERAL NOTES:**

(a) Wheels should be replaced when wheel flanges become thin and visible curling begins to appear at A.

(b) When crane or trolley tends to run out of square as evidenced by persistent wheel flanging, check track diameter B of all mechanically interconnected wheels. If the circumferences are mismatched by more than \( \frac{1}{6} \) in. at the center of the track, wheels should be replaced.

Ensure that the inspection requirements as delineated within this Section are accomplished and documented by qualified personnel. These requirements are minimums and may be added to after review of construction use records if applicable. Discrepancies shall be corrected and reinspected in accordance with this Standard.

**7521.1 General**

(a) Prior to making mechanical and electrical inspections, the construction use logs shall be reviewed as required by para. 7510 of this Standard. Special attention shall be given to inspection of problem areas as noted in construction use logs.

(b) Cranes shall be checked for cleanliness. Dirt and foreign material shall be removed prior to inspection.

**7521.2 Mechanical Inspection**

(a) Inspection covers shall be cleaned and opened, and exposed components shall be inspected for physical damage.

(b) Oil in reservoir shall be visually inspected for cleanliness, filling to proper level, and foreign material.

(c) Gears shall be rotated so that all teeth on all gears can be inspected for pitting, featheredges at the tips of teeth, and misalignment.

(d) Bolts shall be inspected for tightness.

(e) Couplings shall be inspected for tight bolts, elongation of bolt holes, and tightness of keys in keyways.

(f) Bridge and trolley drive and idler wheels shall be inspected for excessive flanging and flat spots. See Fig. 7521.2-1.

(g) External welds listed in Tables 7210-1 and 7210-2 shall be visually examined.

(h) All structural members shall be visually inspected by a qualified person for damage resulting from abuse or neglect.

(i) Verify camber and compare with recording made per para. 7416(f).

(j) Sheaves shall be inspected for wear and defects that could damage wire rope.

(k) Bumpers and stops shall be verified as intact and operable.

(l) Bearing housings shall be inspected for integrity, lubrication, and cleanliness.

(m) Trolley rail clips and trolley rail shall be inspected for tightness, excessive wear, and alignment.

(n) Cab glass shall be inspected and replaced as necessary.

(o) Wire rope shall be inspected for broken wire, strands, twists, kinks, or signs of wear.

(p) Capacity signs shall be inspected for visibility from the operating floor.

(q) Hoist drums shall be inspected for wear and defects that could damage wire rope. If groove root diameter is worn in excess of one-fourth the rope diameter, drum shall be replaced.

(r) Hook shall be inspected in accordance with ASME B30.10. Hook dimensions shall be verified. A record of this validation shall be maintained in accordance with para. A-7630.

(s) Top nut on hook shank shall be verified to be secure and not turned on shank.

(t) Hook shall be inspected to see that it swivels easily and that thrust bearing is lubricated and in good condition.

(u) All hydraulic and pneumatic systems shall be inspected for leaks and damage.

**7521.3 Electrical Inspection (Visual) While Crane Is Immobile.** A qualified electrician shall be assigned to the electrical inspection. All electrical power to the crane is to be locked out and under the control of the inspector.

(a) **Motors**

(1) Inspect all brushes for wear, even contact, and damage.

(2) Inspect springs for tension on brushes.

(3) Inspect slip rings for pitting and wear.

(4) Inspect wires and terminals for tightness.

(5) Inspect insulation on wires for cracks or brittleness.

(6) Verify that motor bearings are properly lubricated.

(b) **Other Electrical Components**

(1) Inspect connections for tightness.

(2) Inspect collector system for physical damage.

(3) Inspect insulators for cracks.

(4) Inspect contactor and relay contacts for wear, pitting, and burning (does not apply to sealed relay contacts).

(5) Verify that timers are functioning and properly set.
### Table II-1  Criteria Required For Structural Qualification of an Existing Crane Bridge for Use With an ASME NOG-1 Type I Hoist and Trolley (Cont'd)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Subtopic</th>
<th>Criteria</th>
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| (2) Bridge cold-proof load testing | | Cold-proof testing, where the crane bridge is given a 125% load test at a temperature that will become the minimum operating temperature for the crane, is required, unless one of the following criteria is met:  
(a) Bridge load-supporting structural materials meet the fracture toughness criteria of para. 4200 of this Standard.  
(b) The crane will only be operated at a temperature of 70°F or higher, as discussed in NUREG-0612, Nonmandatory Appendix C.  
See Item C.(1)(b) for weld inspection criteria if cold-proof testing is required. |
| F. Bridge modifications (if required) | (1) As required to meet CMAA 70 criteria | Structural modifications if required by Item B.(3), to provide compliance with CMAA Spec. No. 70, shall require all new materials and connections to be per para. 4200 of this Standard, with testing and inspections for all new materials and connections being per Section 7000 of this Standard. |
| | (2) As required to meet seismic criteria | Structural modifications if required by Item B.(4), to provide seismic compliance, shall require all new materials and connections to be per para. 4200 of this Standard, with testing and inspections for all new materials and connections being per Section 7000 of this Standard. |
| | (3) As required to address other loading criteria | Structural modifications if required by Item B.(5), to address design (stored) wind loads, tornado loads, or load hang-up loads, shall require all new materials and connections to be per para. 4200 of this Standard, with testing and inspections for all new materials and connections being per Section 7000 of this Standard. |

**NOTES:**  
(1) The 1971 and 1975 issues of CMAA Spec. No. 70 shall be considered equivalent.  
(2) As stated above, the runway and runway support structure, which is not covered by this Mandatory Appendix, must also be seismically qualified for the case where the crane is lifting the maximum credible critical load.  
(3) For this Mandatory Appendix, a structural member shall consist of plates and shapes, as well as any connecting welds, bolts, nuts, pins, or rivets.  
(4) The critical load path for the bridge (from the bridge wheels to and including the trolley [rails] is that area of the bridge that should a failure occur, the bridge would no longer be able to support the hoist and trolley.  
(5) If a current MT or PT surface examination is required and this examination indicates a possible issue with weld quality, then these welds shall be 100% volumetrically inspected per para. 7100.  
(6) The 125% rated load test as addressed here meets the static load test criteria of NUREG-0554.  
(7) Requirements of this Mandatory Appendix do not address load testing of the new Type I trolley and hoist, where such tests may be performed in either the shop or the field once installed on the existing bridge.

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**Change**  
"Trolley" to "Bridge"