NF-4700 REQUIREMENTS FOR BOLTED CONSTRUCTION

NF-4710 BOLTING AND THREADING

NF-4711 Thread Engagement

The threads of all bolts or studs shall be engaged for the full length of thread in the load carrying nut unless otherwise specified in the Design Documents.

NF-4712 Thread Lubricants

Any lubricant or compound used in threaded joints shall be suitable for the service conditions and shall not react unfavorably with any support element material. Contact surfaces within friction-type joints shall be free of lubricants.

NF-4713 Removal of Thread Lubricants

All threading lubricants or compounds shall be removed from surfaces which are to be welded.

NF-4720 BOLTING

NF-4721 Bolt Holes

For the purpose of this Article, high-strength bolts shall be considered those with specified minimum yield strength greater than 80 ksi (550 MPa). Bolt holes shall meet the requirements of (a) through (e).

(a) Holes for nonfitted bolts shall meet the requirements of Table NF-4721(a)-1. For anchor bolts set in concrete or concrete expansion anchor, the hole sizes indicated in this Subsection may be increased by $\frac{3}{16}$ in. (1.5 mm). When the bolt hole size is $\frac{7}{8}$ in. (3 mm) larger than the bolt, and the bolt is $\frac{1}{2}$ in. (13 mm) or smaller, standard washers shall be used.

Table NF-4721(a)-1

<table>
<thead>
<tr>
<th>Bolt Size</th>
<th>Hole Size</th>
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<tbody>
<tr>
<td>≤1 in. (25 mm)</td>
<td>Bolt diameter plus $\frac{3}{16}$ in. (1.5 mm)</td>
</tr>
<tr>
<td>1$\frac{1}{8}$ in. to 2 in. (28 mm to 50 mm)</td>
<td>Bolt diameter plus $\frac{1}{8}$ in. (3 mm)</td>
</tr>
<tr>
<td>&gt;2 in. (50 mm)</td>
<td>Bolt diameter plus $\frac{3}{16}$ in. (5 mm)</td>
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</tbody>
</table>

(b) Oversized or slotted bolt holes may be used with high-strength bolts $\frac{7}{8}$ in. (13 mm) in diameter and larger, except as restricted in (1), (2), and (3).

(1) Oversized holes shall not exceed the requirements of Table NF-4721(b)-1. They may be used in any or all plies of friction-type connections. Hardened washers shall be installed over exposed oversized holes.

(2) Short-slotted holes shall not be wider than permitted by (a) and shall not have a length exceeding the oversize diameter allowed in (1) by more than $\frac{3}{16}$ in. (1.5 mm). They may be used in any or all plies of friction-type or bearing-type connections. The slots may be used without regard to direction of loading in friction-type connections, but shall be normal to the direction of the load in bearing-type connections. Hardened washers shall be installed over exposed short-slotted holes.

(3) Long-slotted holes shall not be wider than permitted by (a) and shall not have a length which exceeds $2 \frac{1}{2}$ times the bolt diameter. In friction-type connections, the long-slotted holes may be used without regard to direction of loading, provided the stress on the bolts does not exceed 75% of the allowable working stress given in Article NF-3000. In bearing-type connections, the long diameter of the slot shall be normal to the direction of loading. Long-slotted holes may be used in one of the connected parts of either a friction-type or bearing-type connection at an individual faying surface. Structural plate washers or a continuous bar not less than $\frac{5}{16}$ in. (8 mm) in thickness shall be used to cover long slots that are in the outer plies of joints. These washers or bars shall have a size sufficient to cover the slot completely after installation and shall meet the requirements of Article NF-3000.

(c) Except as specified in (d), holes may be punched, provided the thickness of the material is not greater than the nominal diameter of the bolt plus $\frac{1}{8}$ in. (3 mm). When the thickness of the material is greater than the nominal diameter of the bolt plus $\frac{1}{8}$ in. (3 mm), holes shall be drilled, subpunched, and reamed, or thermally cut. Thermal cutting shall not be used unless the load-bearing surfaces are machined or ground smooth. For subpunched holes, the die shall be at least $\frac{1}{8}$ in. (1.5 mm) smaller than the nominal diameter of the bolt.

(d) Bolt holes in material over $\frac{1}{2}$ in. (13 mm) thick having a specified minimum yield strength greater than 80 ksi (550 MPa) shall be drilled.

(e) For bolts not subjected to shear, the limits for oversized and slotted holes in (a) may be increased if structural plate washers or continuous bars which meet the requirements of Article NF-3000 are provided.

NF-4722 Bolted Connections

(a) Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where