

Sheet Metal Joint Design Guide

1. SCOPE

1.1 This design guide relates to joining sheet metal members using threaded fasteners. This type of joint clamps metal sheet or thin metal members whose thickness is generally 3/16" or less.

2. RELATED SPECIFICATIONS

2.1 REFERENCE STANDARDS

86505599 (FNHA-1-B-390.00)—Hex Lock Nuts
Grade B, All-Metal, ZnCr Plated
86531984 (FNHA-1-B-405.00)—Flanged Lock
Nuts, Grade F, All Metal, ZnCr Plated
86505611 (FNHA-1-B-060.00)—Hex Flange
Screws, Grade 5, ZnCr Plated
86505674 (FNHA-1-A-050.00)—Cap Screw Flange
Head Class 8.8 ZnCr Plated
86505590 (FNHA-1-B-110.00)—Round Head Short
Square Neck Bolt, Grade 5, ZnCr Plated
86512405 (FNHA-1-A-075.00)—Round Head Short
Square Neck Bolt, Class 8.8, ZnCr Plated
3505624 (FNHA-1-B-360.00)—Hex Flange Nuts,
Grade 5, ZnCr Plated
86505682 (FNHA-1-A-350.00)—Hex Flange Nut,
Class 8, ZnCr Plated
86505600 (FNHA-1-B-430.00)—Hex Weld Nuts—
Long and Short Pilot, UNC, Plain
86505666 (FNHA-1-A-540.00)—Lockwasher,
Belleville Spring Type, ZnCr
86529193 (FNHA-3-A-105.00)—Tool Clearance—
Hex Bolt Spacing
86529502 (FNHA-3-A-006.00)—Bend Allowance
and Set Back Values
86516363 (FNHA-3-A-002.00)—Bend Radii
86529681 (FNHA-3-A-008.00)—Torques for
Standard Hardware
86536331 (FNHA-3-A-800.00)—Structural Joint
Design Guide

NA2.02.15—Self Tapping Screw, Type B
ANSI B18.6.4—Thread Forming and Thread
Cutting Tapping Screws
DIN 6796—Conical Spring Washers for Bolt/Nut
Assemblies
DIN 2093—Disc Springs; Dimensions and Quality
Applications
Fiat 10187 Parts 1 & 2—Conical Spring Washers
IFI 100/107—Prevailing-Torque Type Steel Hex
and Hex Flange Nuts
IFI 124—Test Procedures for Performance of
Nonmetallic Resistant Element Prevailing-
Torque Screws
IFI 125—Test Procedure for Prevailing Torque
Performance of Chemical Coated Screws
IFI 524—Test Procedure for Performance of Metric
Nonmetallic Resistant Element Prevailing-
Torque Screws
IFI 525—Test Procedure for Prevailing Torque
Performance of Metric Chemical Coated
Screws

3. SHEET METAL JOINT SUMMARY

3.1 JOINT DESIGN

Basic sheet metal joints are covered by this guide. They are typically bolted or screwed connections. Joint grip lengths are short, because of the thin joint material. This results in small bolt stretch values and potential preload loss problems. Minimizing bolt preload loss after assembly is critical for proper functioning of the joint over its service life.

3.2 HARDWARE

Standard Grade 5 or Class 8.8, plated flange bolts, Belleville lockwashers, and flanged nuts are preferred. Carriage bolts, self-tapping screws, and weld nuts are also used.

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TABLE 1—Standard Hardware for Sheet Metal Fastening

Hardware Item	Strength	Standard	Sizes
Recommended			
Hex Flg. Screw	Grade 5	86505611 (FNHA-1-B-060.00)	0.312", 0.375"
	Class 8.8	86505674 (FNHA-1-A-050.00)	M8, M10
Hex Flg. Nut	Grade B	86505624 (FNHA-1-B-360.00)	0.312", 0.375"
	Class 8	86505682 (FNHA-1-A-350.00)	M8, M10
BV Lockwasher	Class 8	86505666 (FNHA-1-A-540.00)	M8, M10
Alternate			
SSQ Neck Bolt	Grade 5	86505590 (FNHA-1-B-110.00)	0.312", 0.375"
	Class 8.8	86512405 (FNHA-1-A-075.00)	M8, M10
Hex Flg. Locknut	Grade F	86531984 (FNHA-1-B-405.00)	0.312", 0.375"
	Class 8	N.A.	M8, M10
Hex Weld Nut	Grade 5	86505600 (FNHA-1-B-430.00)	0.312", 0.375"
	Class 8	N.A.	M8, M10

Shaded areas are metric.

4. HARDWARE SELECTION

4.1 GENERAL GUIDELINES FOR HARDWARE

The recommended fastener hardware is to be selected from the reference listing of the New Holland Standards. Table 1 is a quick reference to the preferred sizes, standard hardware and standards.

For sheet metal joints, the following rules apply for hardware:

1. Grade 5 (Class 8.8) flanged bolts and nuts and Belleville lockwashers are preferred wherever possible.
2. Where loosening is a major consideration, locknuts and other thread locking devices are recommended.
3. Nut strengths should be compatible with the bolt strength; i.e., use Grade B (Class 8) nuts with Grade 5 (Class 8.8) bolts.

4. Thread forming screws may be used where the metal thickness allows, in areas where a nut cannot be used.

5. Weld nuts are used where a nut would be not accessible, or the sheet metal is thin and the hole cannot be tapped.

4.2 BOLTS AND NUTS

Grade 5 or Class 8.8 flanged bolts and nuts with coarse threads are recommended for general sheet metal joint applications.

Short square neck bolts are also specified for applications where the fastener is not accessible for assembly, where crop flow must not be restricted, or where appearance is a consideration. Carriage bolts are used for these same reasons where greater metal thickness warrants their use.

Serrated flanged hardware is not recommended due to corrosion problems caused by painted surfaces damaged by the serrations.

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FNHA-3-A-795.00

3 WASHERS

Hardened washers are used to distribute the bolt load and to span oversize holes. These washers may not be necessary in many cases since flanged hardware provides optimum bearing pressure conditions on the joint surface. Washers (preferably hardened type) should be used on slots where adjustments are required. Conical washers are used with short bolts to minimize bolt load loss due to relaxation. Thick washers are sometimes used as spacers to allow longer bolts to be employed.

There are five classes of steel washers:

1. Standard Belleville Lockwashers—commonly used to optimize the bolt load retention of short grip length bolts. These lockwashers are designed to operate in the preload range of Grade 5 or Class 8.8 fasteners. These washers are ribbed and help to maintain the bolt load by resisting rotational loosening due to vibration. They are designed for use with short bolts subject to vibratory forces.

Recent compression tests have shown that the spring action of Belleville lockwashers is limited because they flatten at low loads (as low as 1/3 of the bolt proof load). During unloading, the spring back action occurs at even lower loads due to hysteresis.

2. Conical Spring Washers—similar to standard Belleville lockwashers but do not have a ribbed seating surface. The plain conical spring washer is also used to improve the performance of short bolts by limiting preload loss. These are designed for bolt/nut assemblies of both Class 8.8 and 10.9 properties. The spring behavior is intended to offset the effects of joint relaxation. Current standards governing these washers are DIN 6796, DIN 2093, and Fiat Standard 10187 Parts 1 and 2.

Similarly dimensioned, thicker conical washers are in use. By varying washer thickness and height, these conical washers are designed to carry high bolt loads before

flattening. Testing has shown that these washers reduced preload loss in joints assembled from pre-painted components, resulting in higher test joint loads before slippage occurs.

3. Through Hardened (medium carbon steel) Flat Washers—used to support fastener loads without deforming (e.g., over a slot or oversize hole) and to provide wear resistance for the washer surface.
4. Unhardened Flat Washers—used where the washer will support the fastener contact stresses without embedding and its strength is sufficient to support the fastener load without washer deformation.
5. Case Hardened Washers—used where loads are low and wear resistance is the only concern.

NOTE: For pre-painted surfaces, it is recommended that the Belleville washer be seated on a hardened flat washer to prevent chipping damage to painted surfaces.

4.4 WELD NUTS

Weld nuts are usually of the hex, piloted, projection type that are resistance welded only to cold rolled steel or pickled and oiled surfaces. In robotic welding, round piloted projection nuts are used. Weld nuts are available in Grade B (inch) and Class 9 (metric). Figure 1 shows examples of various types of weld nuts used.

In some cases, weld nuts and heavy hex nuts are tack-welded (on two flats) to the joint surface. Since these nuts are not plated, they are usually used inside the machine or are painted to provide corrosion protection.

There are certain problems that the designer should be aware of when specifying weld nuts:

1. Weld spatter can get on threads & the nut may have to be tapped to remove the interference;



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