BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 2.35

PRODUCTION PROCESS STANDARD

Installation of Bombardier Type Titanium Lockbolts

Issue 13
- This standard supersedes PPS 2.35, Issue 12.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- This PPS is effective as of the distribution date.

Signed original on file. Validation of paper prints is the responsibility of the user.

Approved By:	*Ken Quon*, for	(L.K. John)	May 29, 2015
	Materials Technology		
	Anthony Assivero, for	(David Dawe)	June 10, 2015
	Quality		

Prepared by Michael Wright, Bombardier Toronto (de Havilland), Core Methods.

Table of Contents

Section & Title **Page**

1 Scope . . . 4
2 Hazardous Materials . . . 4
3 References . . . 4
3.1 General . . . 4
3.2 Bombardier Toronto (de Havilland) Specifications . . . 4
4 Materials and Equipment . . . 5
4.1 Materials . . . 5
4.2 Equipment . . . 7
5 Procedure . . . 7
5.1 General . . . 7
5.2 Hole Preparation . . . 8
5.3 Use of Go/No-Go Gauges . . . 10
5.4 Fastener Selection . . . 12
5.5 Installation of Pull Type Lockbolts . . . 13
5.6 Installation of Stump Type Lockbolts . . . 15
5.7 Post Installation Procedure . . . 15
6 Requirements . . . 16
7 Safety Precautions . . . 18
8 Personnel Requirements . . . 20
9 Maintenance of Equipment . . . 20

Figures

Figure 1 - Lockbolt Pin General Description and Part Number Breakdown . . . 6
Figure 2 - Lockbolt Collar Part Number Breakdown . . . 7
Figure 3 - Edge Relief (Edge Break) for Protruding Head Fasteners . . . 9
Figure 4 - Use of Go/No-Go Gauges . . . 11
Figure 5 - Use of Grip Scale . . . 12
Figure 6 - General Description of Model 352 and 245 Installation Guns . . . 13
Figure 7 - Wet Installation of Flush Head Lockbolts . . . 14

Table of Contents

Tables

Table 1 - Bombardier Replacements for Boeing Lockbolts and Collars 5
Table 2 - Recommended Pre-Drill Size 8
Table 3 - Recommended Countersink Diameter. 8
Table 4 - Final Fastener Hole Size 9
Table 5 - Hole Size Verification Sample Requirements 10
Table 6 - Lockbolt Grip Ranges 13
Table 7 - Installation gun nose assemblies. 15
Table 8 - Pin Position and Swage Gauge Selection 18

Flow Charts

Flow Chart 1 - Use of Pin Position & Swage Gauges. 19

1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the installation of Bombardier titanium lockbolt fasteners.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

1.1.3 Procedure or requirements specified in a Bombardier BAPS, MPS, LES or P. Spec. **do not** supersede the procedure or requirements specified in this PPS.

2 Hazardous Materials

2.1 Before receipt at Bombardier Toronto (de Havilland), all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto (de Havilland) Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact the Bombardier Toronto (de Havilland) Environment, Health and Safety Department.

3 References

3.1 General

3.1.1 Unless a specific issue is indicated, the issue of the reference documents specified in this section in effect at the time of manufacture shall form a part of this specification to the extent indicated herein.

3.2 Bombardier Toronto (de Havilland) Specifications

3.2.1 PPS 1.09 - Drilling and Reaming.

3.2.2 PPS 1.32 - Set-Up and Operation of Spacematic Drillmotor Models 1600 and 6000.

3.2.3 PPS 1.33 - Countersinking for Flush Head Fasteners.

3.2.4 PPS 1.37 - Set-Up and Operation of Spacematic & Q-Matic Drillmotors.

3.2.5 PPS 1.41 - Set-Up and Operation of the Craco Automatic Drill Riveter.

3.2.6 PPS 2.16 - Installation of Lockbolt Fasteners.

3.2.7 PPS 13.26 - General Subcontractor Provisions.

3.2.8 PPS 27.05 - Manual Edge Finishing.

3.2.9 PPS 31.17 - Solvent Usage.

3.2.10 PPS 34.02 - Application of Alkyd Zinc Chromate Primer (F1).

3.2.11 PPS 34.08 - Application of Epoxy-Polyamide Primer (F19).

4 Materials and Equipment

4.1 Materials

4.1.1 Unless otherwise specified in this section, use only the materials specified; use of superseding or alternative materials is not allowed.

4.1.2 Lubricant, Boelube solid (70201) or liquid (70104).

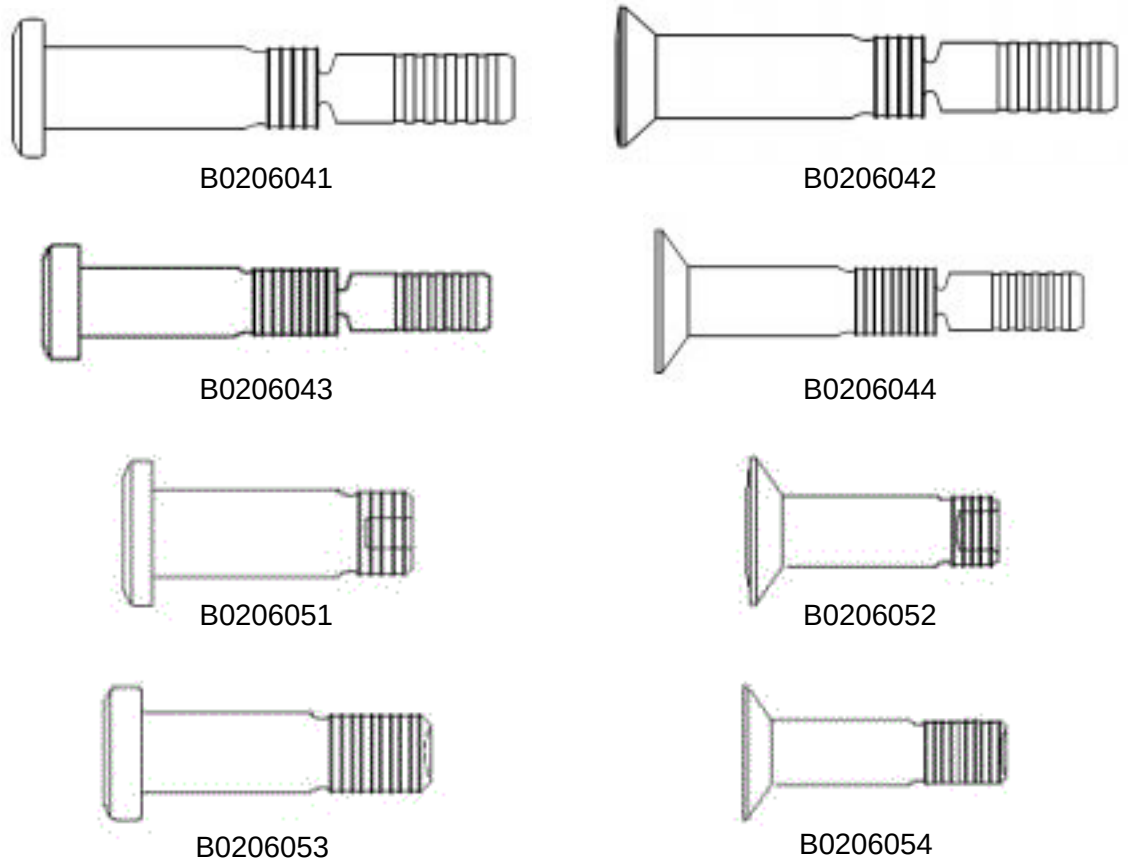
4.1.3 DHMS S3.06 Type I, Class C-80 sealant. DHMS S3.06 Type I sealant supersedes PR1431G sealant. If the engineering drawing specifies PR 1431G Type II or III, use PR1431G Type II or III until depletion and then use DHMS S3.06 Type I, Class C-80 sealant (see EO 7336).

4.1.4 Titanium lockbolt fasteners as specified on the Engineering Drawing. Refer to Table 1 for Bombardier replacements for Boeing BACB30 lockbolts and collars. Refer to Figure 1 for a part number breakdown for lockbolt pins. Refer to Figure 2 for a part number breakdown for lockbolt collars. The pin tips on shear type titanium lockbolts are yellow (tension pins are not colour coded) and the head is marked with the Huck part number.

Table 1 - Bombardier Replacements for Boeing Lockbolts and Collars

SUPERSEDED BOEING LOCKBOLT	SUPERSEDING BOMBARDIER LOCKBOLT		SUPERESEDED BOEING COLLAR	SUPERSEDING BOMBARDIER COLLAR
BACB30VN	B0206041A		BACC30BK	B0206061
BACB30VM	B0206042A			
BACB30VR	B0206051A			
BACB30VP	B0206052A			

Note 1 Superseded lockbolts or collars may be used until existing stock is depleted. After depletion of existing stock use Bombardier lockbolts where BACB lockbolts are specified. However, it is not acceptable to use a BACB lockbolt where a Bombardier lockbolt is specified.



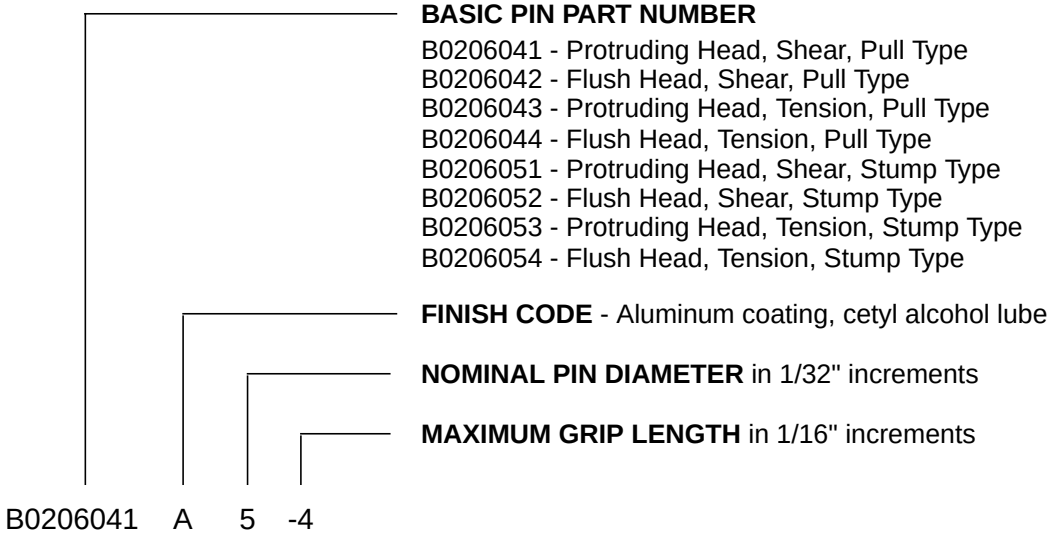


Figure 1 - Lockbolt Pin General Description and Part Number Breakdown

B0206061

B0206062

BASIC COLLAR PART NUMBER
B0206061 (Shear) - Yellow
B0206062 (Tension) - Orange

NOMINAL COLLAR INNER DIAMETER in 1/32" increments

B0206061 -5

Figure 2 - Lockbolt Collar Part Number Breakdown

4.2 Equipment

4.2.1 GO/NO-GO gauges, plug gauges or other hole measuring gauges. Refer to paragraph 5.3 for the procedure for using GO/NO-GO gauges.

4.2.2 Installation guns, (e.g., Huck Models 352 and 225, fitted with Huck nose assemblies as specified in Table 7).

4.2.3 Lockbolt grip scale, (e.g., Huck No. 105093).

4.2.4 Pin position and swage gauges: Huck HG 100, HG 107, HG 110 and HG 113. It is acceptable to use alternative pin position and swage gauges provided that they are capable of checking pin protrusion and swage to the same dimensions and degree of accuracy as the Huck gauges specified herein.

4.2.5 Soft metal faced rivet snap caps (e.g., Bombardier Toronto (de Havilland) SD8853).

5 Procedure

5.1 General

5.1.1 The Boeing and Bombardier titanium lockbolts specified herein are similar in appearance and installation to NAS type lockbolts, as specified in PPS 2.16. The pin tails of Boeing and Bombardier type titanium pull type lockbolts are shorter than NAS titanium pull type lockbolts and therefore require the use of a special nose assembly.

5.1.2 At Bombardier Toronto (de Havilland), Bombardier titanium stump type lockbolts are installed using a Craco automatic drill riveter fitted with an automatic collar feeding device attached to the lower anvil post. Before each production run, prepare a test piece as specified in PPS 1.41 and ensure that the holes meet the final hole limits specified in Table 4.

5.2 Hole Preparation

5.2.1 If the hole locations for lockbolts are determined by pre-drilled holes in one of the components in the assembly, prepare holes as follows:

Step 1. Pre-drill the fastener holes according to PPS 1.09. Refer to Table 2 for the recommended pre-drill size. Ensure that the hole is square to the surface on which the head will seat.

Table 2 - Recommended Pre-Drill Size

NOMINAL LOCKBOLT PIN DIAMETER	-5 (5/32")	-6 (3/16")	-8 (1/4")	-10 (5/16")	-12 (3/8")
PRE-DRILL SIZE	#27 (0.144")	#16 (0.177")	#1 (0.228")	L (0.290")	S (0.348")

Step 2. For flush head fastener installations, use a micro-stop countersink fitted with the correct size pilot according to PPS 1.33 to countersink to the diameter recommended in Table 3.

Table 3 - Recommended Countersink Diameter

FASTENER		COUNTERSINK PILOT DIAMETER	RECOMMENDED COUNTERSINK DIAMETER (100° ANGLE)
PART NUMBER	**NOMINAL DIAMETER**		
B0206042 B0206052 (shear pins)	-5 (5/32")	0.144"	0.261" - 0.271"
	-6 (3/16")	0.177"	0.301" - 0.311"
	-8 (1/4")	0.228"	0.397" - 0.407"
	-10 (5/16")	0.290"	0.477" - 0.487"
	-12 (3/8")	0.348"	0.567" - 0.577"
B0206044 B0206054 (tension pins)	-5 (5/32")	0.144"	0.322" - 0.332"
	-6 (3/16")	0.177"	0.372" - 0382"
	-8 (1/4")	0.228"	0.498" - 0.508"
	-10 (5/16")	0.290"	0.624" - 0.634"
	-12 (3/8")	0.348"	0.751" - 0.761"

Note: The countersink diameters specified in this table are for reference only. Adjust countersink diameter as necessary to ensure installed fasteners meet the protrusion requirements specified in paragraph 6.4.

Step 3. Open the fastener hole to the final size specified in Table 4 according to PPS 1.09.

Table 4 - Final Fastener Hole Size

NOMINAL LOCKBOLT PIN DIAMETER	RECOMMENDED DRILL OR REAMER SIZE	FINAL HOLE DIAMETER LIMITS
-5 (5/32")	0.1610"	0.1610" - 0.1625"
-6 (3/16")	0.1865"	0.1860" - 0.1880"
-8 (1/4")	0.2465"	0.2460" - 0.2480"
-10 (5/16")	0.3090"	0.3085" - 0.3105"
-12 (3/8")	0.3710"	0.3705" - 0.3725"

Step 4. For protruding head fasteners, manually break the edge of the hole 0.010" - 0.020" on the side that the fastener head will seat as shown in Figure 3 according to PPS 27.05.

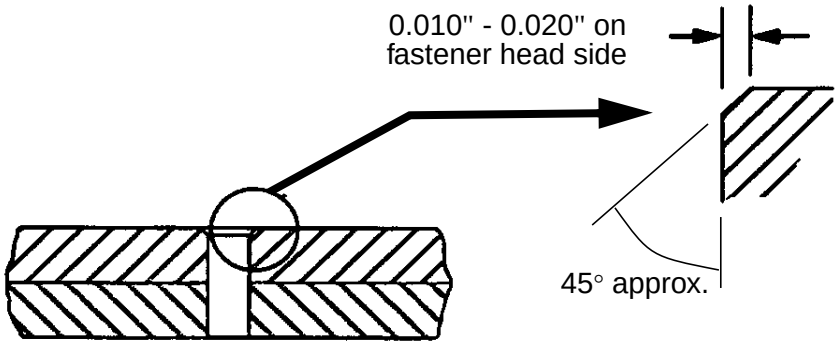


Figure 3 - Edge Relief (Edge Break) for Protruding Head Fasteners

5.2.2 If the hole locations are determined by Spacematic drill templates, prepare holes using Spacematic or Q-Matic drills as follows:

Step 1. After placing the drill template in position, pre-drill the **starting hole** manually according to Table 2.

Step 2. Open the **starting hole** manually to the final size specified in Table 4 for the type of fit (interference or transition) specified on the Engineering Drawing.

Step 3. Check the first drilled hole for conformance to the hole limit requirements of Table 4 using a GO/NO-GO gauge, a plug gauge or other hole measuring gauge.

Step 4. Insert the collet of the drillmotor into the starting hole and the template boss into the next hole in the template.

Step 5. Drill all holes to the sizes specified in Table 4 according to the procedure specified in PPS 1.32 or PPS 1.37, as applicable.

Step 6. Remove the drill template.

Step 7. For flush head fasteners, countersink the starting hole and other holes, as applicable, using a micro-stop countersink according to PPS 1.33 to the countersink diameter recommended in Table 3.

Step 8. For protruding head fasteners, manually break the edge of the hole 0.010" - 0.020" on the side on which the fastener head will seat as shown in Figure 3 according to PPS 27.05.

5.2.3 On a sample basis, check at random (across the entire pattern) the number of holes specified in Table 5 for conformance to the hole limit requirements of Table 4 using a go/no-go gauge or other hole measuring gauge. If any oversize holes are found in the sample, check every hole in the pattern. Refer all oversize holes to Bombardier Toronto (de Havilland) MRB or Bombardier Toronto (de Havilland) delegated MRB for disposition.

5.2.3.1 While checking holes using a GO/NO-GO gauge or other hole measuring gauge, also check visually for hole ovality. For holes with a visually evident oval or out of round shape, check the hole diameter at several positions using suitable hole measurement equipment (e.g., vernier calliper, hole micrometer, etc.) to determine the minor and major diameters of the hole. The minor and major diameters of the hole must be within the minimum and maximum hole diameter tolerances, respectively. If the minor or major diameters of any oval hole in the sample are not within the minimum and maximum hole diameter tolerance, check every hole in the pattern for conformance to the hole limit requirements and visually for ovality as specified herein. Refer all non-conforming holes to Bombardier Toronto (de Havilland) MRB or Bombardier Toronto (de Havilland) delegated MRB for disposition.

Table 5 - Hole Size Verification Sample Requirements

NUMBER OF HOLES IN PATTERN	REQUIRED SAMPLE SIZE
5 or less	all
6 - 50	5
51 - 90	7
91 - 150	11

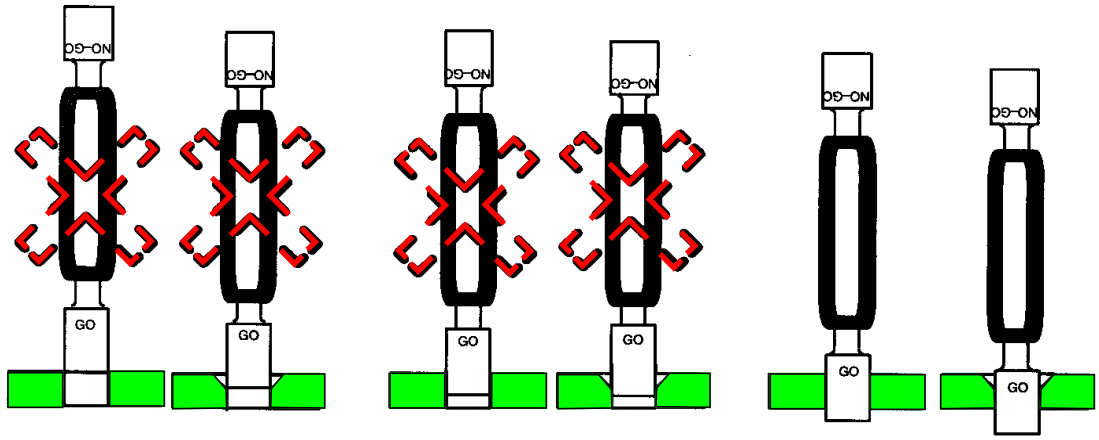
NUMBER OF HOLES IN PATTERN	REQUIRED SAMPLE SIZE
151 - 280	13
281 - 500	16
more than 500	19

5.3 Use of Go/No-Go Gauges

5.3.1 Check selected fastener holes for conformance to the requirements of Table 4 using the applicable go/no-go gauge as follows:

Step 1. Taking care not to force or rotate the gauge, lightly insert the GO end of the gauge into the fastener hole. If the GO end of the gauge does not go completely into the hole (see Figure 4), the hole is undersize and should be opened to the correct size.

Step 2. Again taking care not to force or rotate the gauge, lightly insert the NO-GO end of the gauge into the fastener hole. If the NO-GO end of the gauge goes completely into the hole (see Figure 4), the hole is oversize. Refer oversize holes to Bombardier Toronto (de Havilland) MRB or Bombardier Toronto (de Havilland) delegated MRB for disposition.

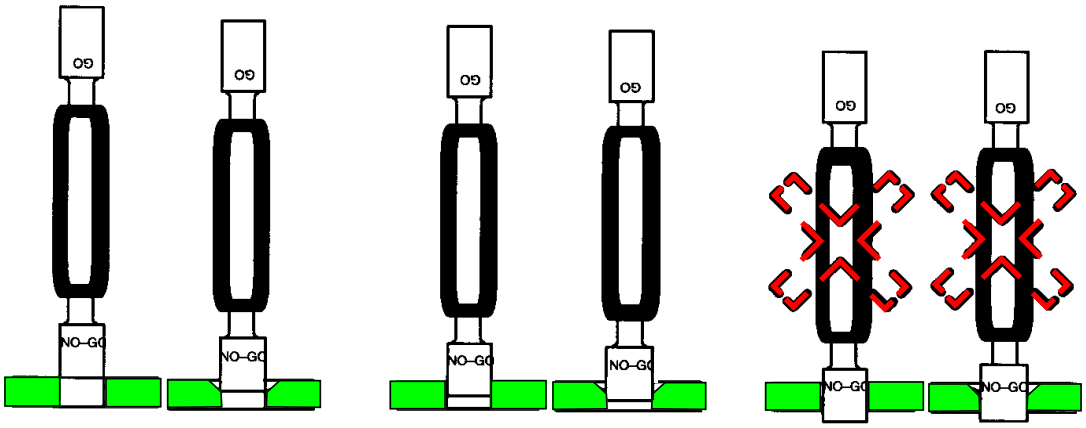


Does not go in.
UNDERSIZE HOLE

Goes only partially in.
UNDERSIZE HOLE

Goes in completely.
ACCEPTABLE

USE OF GO END



Does not go in.
ACCEPTABLE

Goes only partially in.
ACCEPTABLE

Goes in completely.
OVERSIZE HOLE

USE OF NO-GO END

Figure 4 - Use of Go/No-Go Gauges

5.4 Fastener Selection

5.4.1 The fastener grip length specified on the engineering drawing, work order or assembly manual is only a reference length. To verify that the grip length specified is correct, measure the material thickness by inserting a grip scale into the prepared hole and reading the number on the GROUP I side of the scale. The numbers shown on the grip scale coincide with the lockbolt dash number. Ensure that the sheets are pulled up tight so that there is no gap between the sheets. Always read to the next higher number as shown in Figure 5 (i.e., if the reading is past the **end** of the -3 marking, then use of a -4 fastener is indicated). If a tapered sheet condition exists, use the grip length indicated for the thickest section.

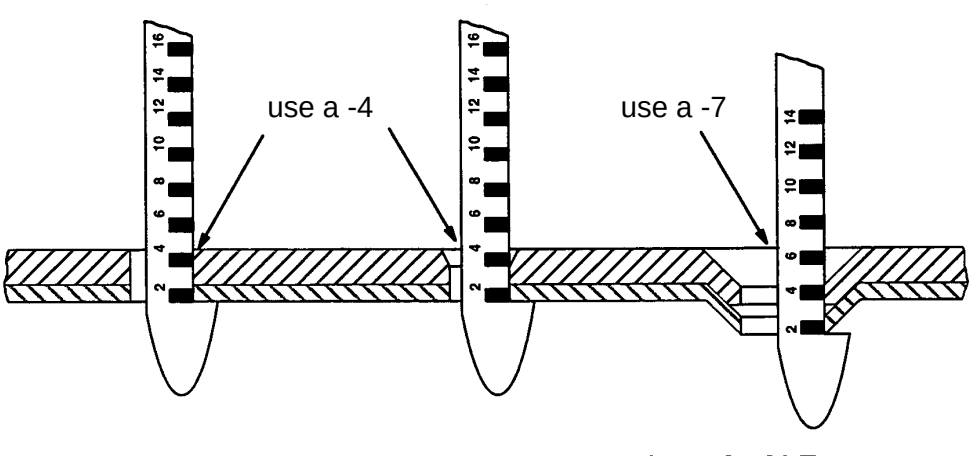


Figure 5 - Use of Grip Scale

5.4.2 Refer to Table 6 for a listing of the design grip and extended grip ranges for each grip dash number. For lockbolts as specified herein only, installation within the extended grip range will result in an acceptable installation. Therefore, if a lockbolt of the correct design grip length is not available, it is acceptable to use a lockbolt within the extended grip range (e.g., if the material stack-up is 0.130" and a -3 grip length lockbolt is not available, it is acceptable to install a lockbolt with a -2 grip length). If neither a lockbolt of the correct design grip length nor the extended grip length is available, refer to Bombardier Toronto (de Havilland) MRB or Bombardier Toronto (de Havilland) delegated MRB for written authority (e.g., fastpath RNC) to use the next longer pin length and shim to the correct length using washers.

Table 6 - Lockbolt Grip Ranges

GRIP DASH NUMBER	DESIGN GRIP RANGE	EXTENDED GRIP RANGE
2	0.063" - 0.125"	0.047" - 0.141"
3	0.126" - 0.188"	0.109" - 0.203"
4	0.189" - 0.250"	0.172" - 0.266"
5	0.251" - 0.312"	0.234" - 0.328"
6	0.313" - 0.375"	0.297" - 0.391"
7	0.376" - 0.438"	0.359" - 0.453"
8	0.439" - 0.500"	0.422" - 0.516"
9	0.501" - 0.562"	0.484" - 0.578"
10	0.563" - 0.625"	0.547" - 0.641"

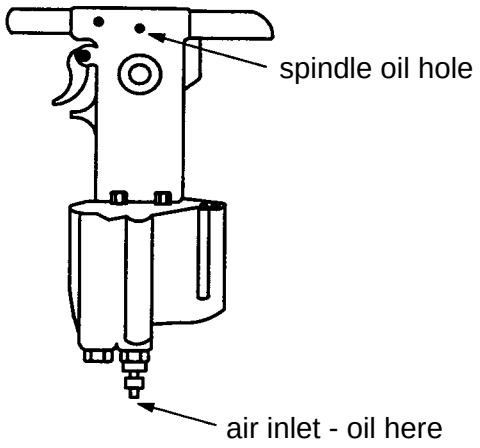
GRIP DASH NUMBER	DESIGN GRIP RANGE	EXTENDED GRIP RANGE
11	0.626" - 0.688"	0.609" - 0.703"
12	0.689" - 0.750"	0.672" - 0.766"
13	0.751" - 0.812"	0.734" - 0.828"
14	0.813" - 0.875"	0.797" - 0.891"
15	0.876" - 0.938"	0.859" - 0.953"
16	0.939" - 1.000"	0.922" - 1.016"
17	1.001" - 1.062"	0.984" - 1.078"
18	1.063" - 1.125"	1.047" - 1.141"

5.5 Installation of Pull Type Lockbolts

5.5.1 Prepare installation guns for installation of pull type lockbolts as follows:

Step 1. Lubricate the spindle with a few drops of light machine oil (see Figure 6).

Step 2. Check the air line connectors to ensure they are free of contamination. Inject a few drops of light machine oil into the air inlet of the gun and connect the air line (see Figure 6).



352 GUN

Figure 6 - General Description of Model 352 and 245 Installation Guns

Step 3. Keep hose lines as short as possible. Do not connect too many air lines to the same outlet.

Step 4. Depress and release the trigger to check the gun action.

5.5.2 Except when wet installing lockbolts, prime all countersinks for flush head pins with F1 zinc chromate primer according to PPS 34.02 or F19 Type 2 epoxy-polyamide primer according to PPS 34.08. If the engineering drawing specifies wet installation, apply DHMS S3.06 Type I sealant to the underside of flush head pins as shown in Figure 7 (priming of the countersink is not required).

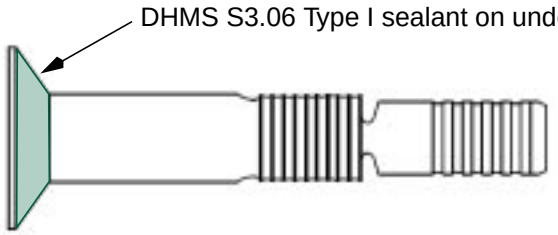


Figure 7 - Wet Installation of Flush Head Lockbolts

5.5.3 Fully insert pull type lockbolts into prepared holes so that the head is seated against the structure.

- Insertion may be aided by applying a light coating of Boelube lubricant to the shank of the lockbolt. Ensure that the locking grooves remain free of lubricant.
- It is recommended that pull type pins be seated using an installation gun fitted with a self releasing nose assembly as specified in Table 7.

5.5.4 Swage the collar onto seated pull type lockbolts as follows:

Step 1. Immediately before slipping the collar over the locking grooves of the pin, solvent wipe the locking grooves and pulling grooves thoroughly according to PPS 31.17.

Step 2. Slip the collar over the locking grooves of the pin. Collars for titanium lockbolts may be placed on the pin with either end up.

Step 3. Position the nose assembly specified in Table 7 over the pin tail, holding the gun in alignment with the fastener.

Step 4. Pull the trigger and the gun will apply the necessary force to swage the collar and break off the pin tail.

Table 7 - Installation gun nose assemblies

FASTENER		PULL IN NOSE ASSEMBLY (SHEAR OR TENSION PIN)	SWAGE NOSE ASSEMBLY	
NOMINAL DIAMETER	PART NUMBER		SHEAR PIN	TENSION PIN
5/32"	B02060xx-5	99-1833	99-1700	99-1703
3/16"	B02060xx-6	99-1834	99-1701	99-1704
1/4"	B02060xx-8	99-1835	99-1702	99-1705
5/16"	B02060xx-10	99-1836	99-1719	99-1720
3/8"	B02060xx-12	99-1837	99-2522	99-2570

Note 1. "xx" denotes the type of head and identifies pull or stump type for Bombardier fasteners. See Figure 1 for a part number breakdown.
Note 2. At Bombardier Toronto (de Havilland), Bombardier stump type titanium lockbolts are installed using automated equipment.

5.6 Installation of Stump Type Lockbolts

5.6.1 At Bombardier Toronto (de Havilland), install stump type lockbolts automatically using a Craco Automatic Drill Riveter equipped with an automatic collar feeder. Subcontractors may install stump type lockbolts using alternative installation equipment provided that the requirements specified in section 6 are met.

5.6.2 Set-up and operate the Craco automatic drill riveter according to PPS 1.41. Use an upper anvil with a diameter slightly smaller than the fastener head when installing flush head fasteners.

5.6.3 Refer to Table 3 for the recommended countersink diameter and Table 4 for final hole limits.

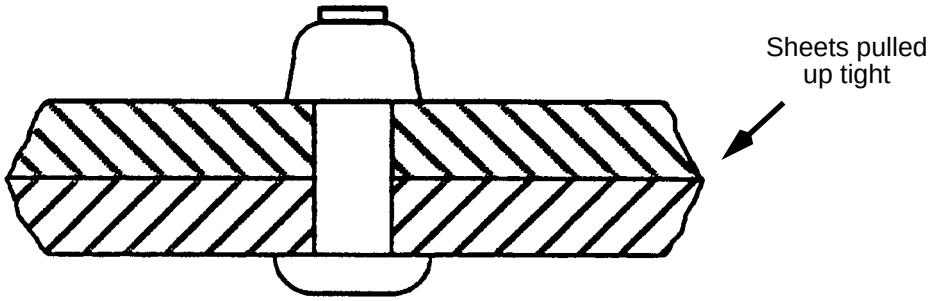
5.7 Post Installation Procedure

5.7.1 After swaging the collar on wet installed lockbolts, remove excess sealant from the lockbolt and surrounding area by solvent wiping according to PPS 31.17.

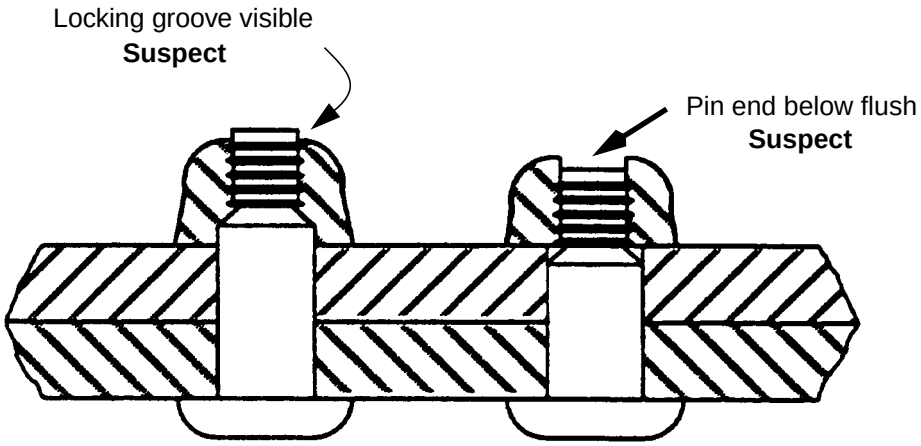
5.7.2 If necessary, remove lockbolts according to PPS 2.16.

6 Requirements

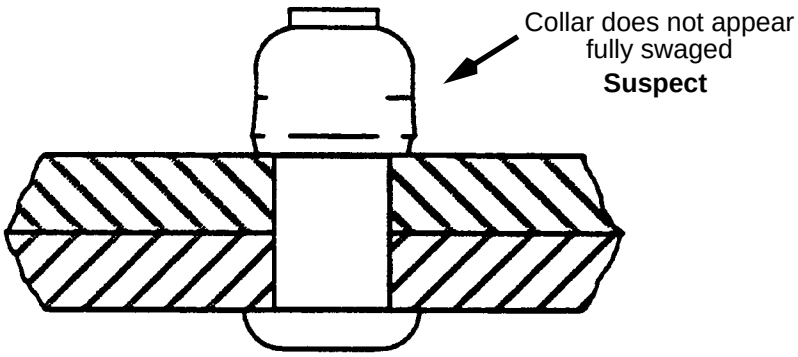
6.1 Ensure that the sheets are drawn up tightly as shown below:



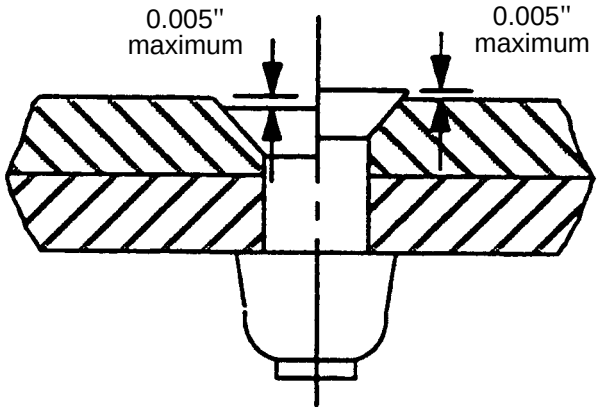
6.2 If a locking groove is visible or the end of the pin is below flush with top of the collar as shown below, check the pin protrusion using the pin position and swage gauge specified in Table 8.



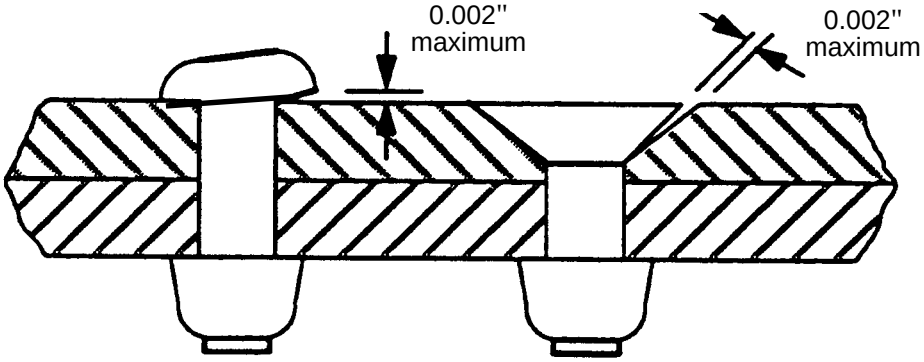
6.3 If the collar does not appear to be fully swaged (see example below), check the swage using the pin position & swage gauge specified in Table 8.



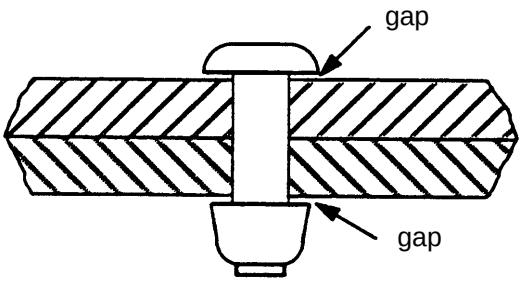
6.4 Ensure that the head of flush head lockbolts is within 0.005" of flush with the surface as shown below:



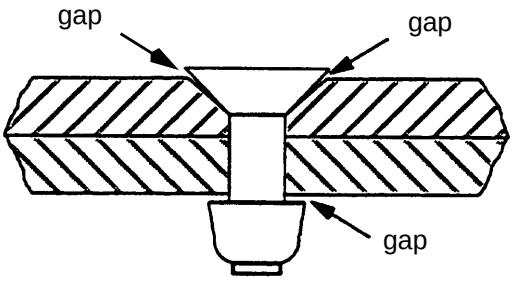
6.5 Ensure that any gap under the head of any installed lockbolt is on one side of the head only, is less than 0.002" (i.e., a 0.002" feeler gauge cannot fit into the gap), and does not extend to the shank of the lockbolt (see following example).



6.6 A lockbolt installation is unacceptable and must be replaced if any gap extends all the way around under the head or collar of an installed lockbolt as shown below:



Unacceptable



Unacceptable

6.7 A lockbolt installation is unacceptable and must be replaced if there are any cracks (see example below) in the lockbolt collar visible to the naked eye (i.e., without magnification).

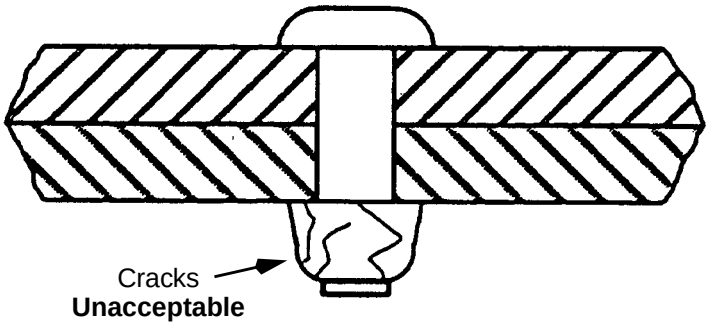


Table 8 - Pin Position and Swage Gauge Selection

LOCKBOLT	PIN POSITION & SWAGE GAUGE		LOCKBOLT	PIN POSITION & SWAGE GAUGE
B0206041-( )	HG 110-( )		B0206051-( )	HG 113-( )
B0206042-( )	HG 110-( )		B0206052-( )	HG 113-( )
B0206043-( )	HG 100-( )		B0206053-( )	HG 107-( )
B0206044-( )	HG 100-( )		B0206054-( )	HG 107-( )

Note 1. Refer to Flow Chart 1 for the use of pin position & swage gauges.
Note 2. Suffix letters on Huck gauge after the dash numbers are for Huck Manufacturing Company use only and have no bearing on the use of gauges.

7 Safety Precautions

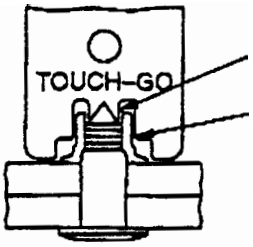
7.1 The safety precautions specified herein are specific to Bombardier Toronto to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is recommended that other facilities consider these safety precautions; however, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.

7.2 Observe general shop safety precautions when performing the procedure specified herein.

7.3 Ensure that the rubber pin tail deflector is properly fitted on the rear of the installation gun to avoid the ejected pin tails from causing personal injury or damage to structures.

Flow Chart 1 - Use of Pin Position & Swage Gauges

Check with TOUCH-GO end

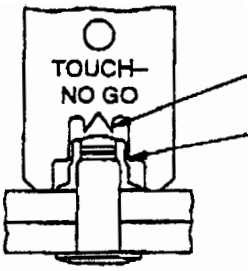


UNACCEPTABLE - if points A **do not** touch pin end - indicates that the pin length is too short.

ACCEPTABLE - if points A **touch** pin end and points B **do not** touch the swaged collar.

UNACCEPTABLE - if points B (if any) **touch** the swaged collar - indicates that the collar is not swaged enough

Check with TOUCH-NO GO end



UNACCEPTABLE - if points A **touch** pin end - indicates that the pin length is too long.

ACCEPTABLE - if points A **do not** touch pin end and points B **do not** touch the swaged collar.

UNACCEPTABLE - if points B **touch** the swaged collar - indicates that the collar is not swaged enough

8 Personnel Requirements

8.1 Personnel responsible for installation of Bombardier titanium lockbolt fasteners must have a good working knowledge of the applicable procedure and requirements as specified herein and must have exhibited their competency to their supervisor.

9 Maintenance of Equipment

9.1 It is recommended that installation tools be kept clean and dry with moving parts lightly oiled or greased and that a few drops of light machine oil be injected daily into the air inlet of pneumatic tools.

9.2 It is recommended that installation tools be checked at suitable intervals and that tools with damaged or badly worn parts be repaired or replaced.

9.3 Do not alter or rework installation tools or accessories without suitable authorization.

9.4 Check nose piece chuck jaws periodically and ensure jaw grooves are cleaned thoroughly.