BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 1.05

PRODUCTION PROCESS STANDARD

Ram Coin Dimpling Equipment

Issue 18
- This standard supersedes PPS 1.05, Issue 17.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS 1.05 related questions to michael.wright@aero.bombardier.com.
- This PPS is effective as of the distribution date.

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	Quality	

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

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1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the set-up and maintenance of ram coin dimpling equipment.

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 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.2 PPS 1.01 - Dimpling Aluminum Alloys.

3.3 PPS 1.07 - Dimpling Ferrous, Nickel and Titanium Alloys.

3.4 PPS 2.01 - Installation of Solid Rivets.

3.5 PPS 13.26 - General Subcontractor Provisions.

4 Materials and Equipment

4.1 Materials

4.1.1 Grease, MIL-G-3545 (e.g., Areoshell Grease 5).

4.2 Equipment

4.2.1 Stationary dimpler (e.g., CP-450-EA or US150EA).

4.2.2 Portable dimpler (e.g., ZT 2012D).

4.2.3 Control panel (e.g., ZT2409B or Series 560 Barber Colman).

4.2.4 Dimpling dies and punches (e.g., as listed herein).

4.2.5 Heater straps (e.g., ZT1920B15).

5 Procedure

5.1 General

5.1.1 Ram coin dimpling at Bombardier Toronto (de Havilland) is accomplished by using the CP-450-EA or US150EA stationary dimpler (see Figure 1) or the ZT 2012D portable dimpler in conjunction with the ZT 2409B control panel (see Figure 5). Both units have built-in safety features that inhibit the dimpling cycle whenever the punch fails to enter the pilot hole, the temperature of the tools is below that set by the operator or the heater thermocouple circuit is broken in any way.

5.1.2 The ZT 2012D dimpler can be used for cold dimpling without the aid of the control panel. In this case the safety features would be forfeited and the speed of operation is controlled by means of the trigger adjustment.

5.1.3 Before any use of a dimpling tool, ensure that the tool has been certified according to section 10 and validate that the certification has not expired.

5.1.4 Set-up and operate dimpling machines other than those referenced herein according to the manufacturer's instructions.

5.2 Care of Tools

5.2.1 Only use dimpling tools in good condition. Before use, check the tools for wear, damage, pick-up and excessive oxidation. Frequently check the condition of the ram coining ram and if necessary replace the ram. A slight chamfer at the ram face is acceptable provided it does not affect the quality of the dimple.

5.2.2 Take care when removing the punch or the die from the anvil post to prevent any damage to the punch or the die. Ensure that tools are not maltreated and are cleaned, repaired or replaced, as required. Do not use the dimpler without a part or test piece between punch and die.

5.2.3 Only keep the minimum amount of punches and dies necessary for production purposes at the machine. When punches and dies are not in use, store punches and dies on the tool boards provided. If a modification of a standard tool becomes necessary, contact the appropriate department. If the work tends to stick to the punch, it is advisable to apply grease (see para. 4.1.1) to the punch pilot; do not apply grease to the die or ram.

5.2.4 Install heaters on the tools without making contact with the tool posts and clear of the work. When heaters are not used, store the heaters in suitable racks to prevent kinking or damage.

5.3 Set-Up of Equipment For Ram Coin Dimpling

5.3.1 Set-Up of CP-450-EA and US150EA

5.3.1.1 Refer to the Flow Chart 1 for the set-up procedure for cold dimpling.

5.3.1.2 Refer to the Flow Chart 2 for the set-up procedure for hot dimpling.

5.3.2 Set-Up of ZT 2012D and ZT 2409B

5.3.2.1 Refer to the Flow Chart 3 for the set-up procedure for cold dimpling.

5.3.2.2 Refer to the Flow Chart 4 for the set-up procedure hot dimpling.

5.4 Adjustments for CP-450-EA and US150EA Dimpler (see Figure 1)

5.4.1 Ram Height

5.4.1.1 Except when dimpling titanium alloys, adjust the ram height to 0.002" below the face of the die. When dimpling titanium alloys, adjust the ram height to approximately 1/3 of the depth of the dimple below the face of the die.

5.4.1.2 To adjust the ram to the desired setting, turn the graduated ram height adjustment knob (1 graduation = 0.001") to bring the ram flush with the face of the die. Observe the position of the adjustment knob and carefully turn to lower it to the desired height, using the graduations on the nut as a reference.

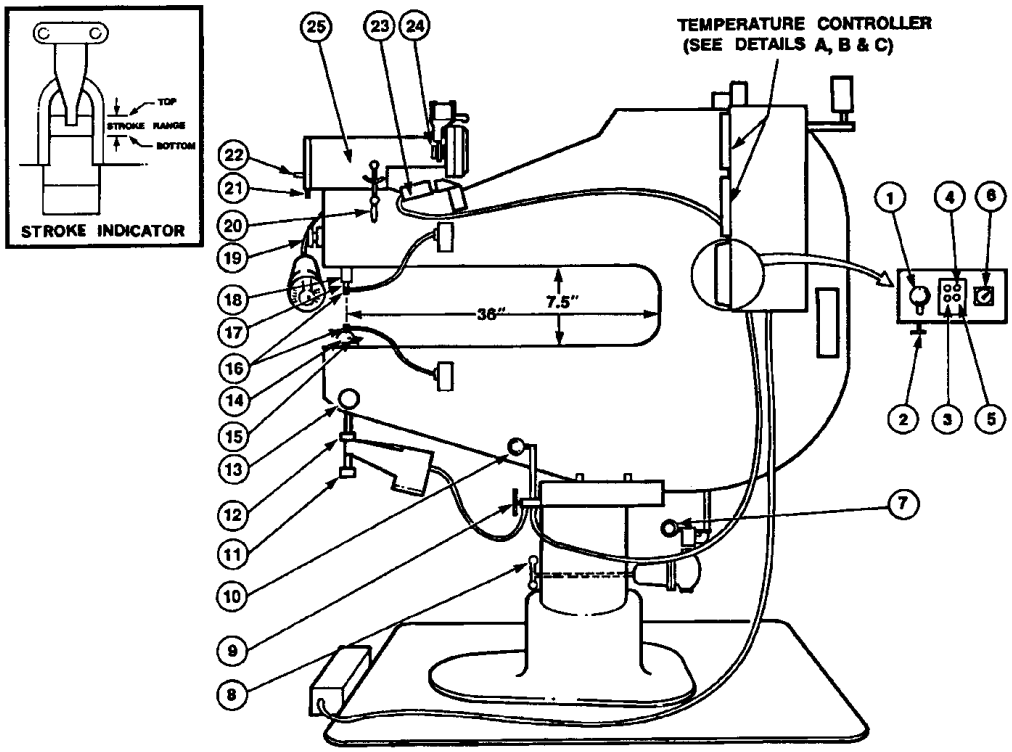
5.4.2 Punch Holder Shank Stroke

5.4.2.1 Adjust the stroke of the punch holder as follows.

Step 1. With the punch and die installed on the machine, place a test strip in the dimpling position and operate the manual return stroke adjustment lever until the punch, test strip and die are in contact with each other. With the lever in this position observe the position of the stroke indicator. The correct setting is indicated when the lower edge of the spring cover plate is halfway between the two upper lines on the stroke indicator (see Figure 1).

Step 2. If the lower edge of the spring cover plate is not halfway between the two upper lines on the stroke indicator, adjust the spring cover plate by loosening the lower post lock and turning the lower post height adjustment knob accordingly to raise or lower the post.

Step 3. After the height adjustment, lock the lower post and set the manual return stroke adjustment lever to result in the minimum space necessary to allow the work material to be easily slipped between the punch and die.



LIST OF COMPONENTS

No.	NAME	No.	NAME
1	Approach Cylinder Pressure Gauge	14	Die
2	Approach Cylinder Pressure Regulator	15	Die Retaining Clip
3	Main Power Switch	16	Heater Unit
4	Selector Switch	17	Punch
5	Heater Control Switch	18	Punch Holder Assembly
6	Dwell Timer	19	Dimpling Pressure Control
7	Main Air Supply Pressure Gauge	20	Manual Return Stroke Adjustment Lever
8	Main Air Supply Pressure Regulator	21	Stroke Indicator
9	Ram Pressure Regulator	22	Spring Cover Plate
10	Ram Pressure Gauge	23	Approach Cylinder
11	Ram Height Adjustment Knob	24	Speed Control Valve
12	LOwer Post Height Adjustment Knob	25	Main Cylinder
13	Lower Post Lock	–	– –

Figure 1 - CP-450-EA/US150EA Dimpler

5.4.3 Temperature Controllers

5.4.3.1 There are two types of temperature controllers: analog and digital.

5.4.3.2 Each dimpler has two temperature controllers on the control panel, one for the punch and the other for the die.

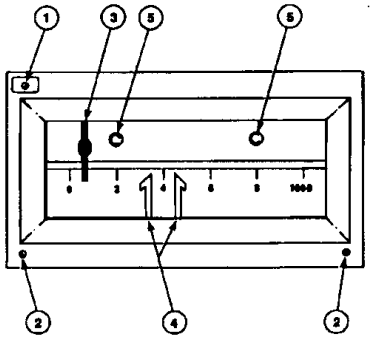
5.4.3.3 After having installed the heater units, set the temperature controllers according to para. 5.4.3.3.1, para. 5.4.3.3.2 or para. 5.4.3.3.3, as applicable.

5.4.3.3.1 Except when using analog temperature controllers with ambient temperature compensating devices, set the black indicators on both analog temperature controllers to approximate room temperature by turning the zero adjustment screws accordingly (see Figure 2 - Detail “A”), to compensate for the amount of heat in the room. Analog temperature controllers with ambient temperature compensating devices do not require the black indicators to be set at room temperature.

Adjust the red limit indicators by turning the temperature setting screws on the control panel (see Figure 2 - Detail “A”).

- For aluminum, ferrous or nickel alloys, the setting for the red indicators is 575°F - 625°F (302°C - 329°C).
- For all titanium parts, except when dimpling F19 primed titanium of thickness 0.025" or less, set the indicators at 675°F - 725°F (357°C - 385°C).
- For F19 primed titanium of thickness 0.025" or less, set the temperature to 575°F - 625°F(302°C - 329°C), and increase the initial dwell time settings as shown in Table 3 by 1 second.

When the indicator lights are lit, consider the punch and die are at the required temperature.

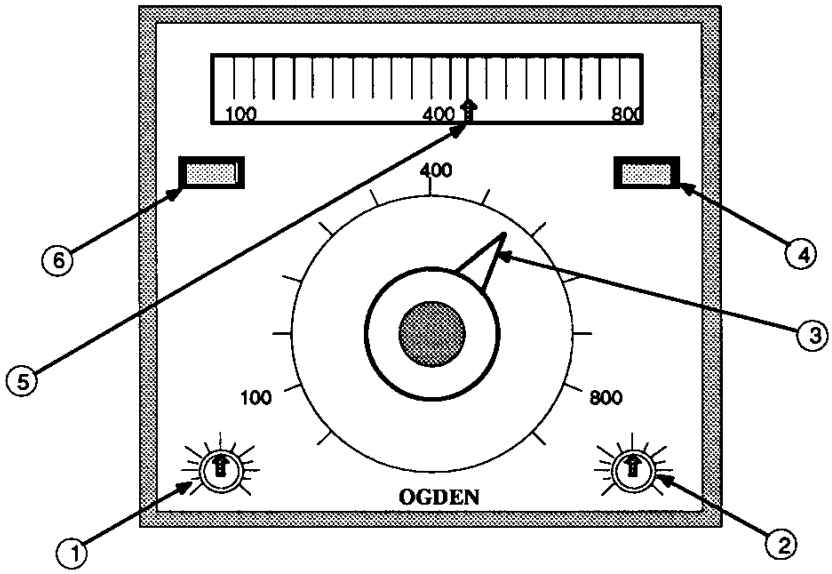


DETAIL "A" – ANALOG TEMPERATURE CONTROLLER (2 per controller)

No.	NAME		No.	NAME
1	Room Temperature Zero Adjustment Screw		4	Red Limit Indicator
2	Temperature Setting Screw		5	Temperature Indicator Lights
3	Temperature Indicator (Black)		–	– –

Figure 2 - Temperature Controller - Detail A

5.4.3.3.2 For analog type temperature controllers (see Figure 3 - Detail “B”), set the setpoint indicator to the required temperature. For finer adjustments turn the temperature reset knob to the required temperature (see Figure 3 - Detail “B”).



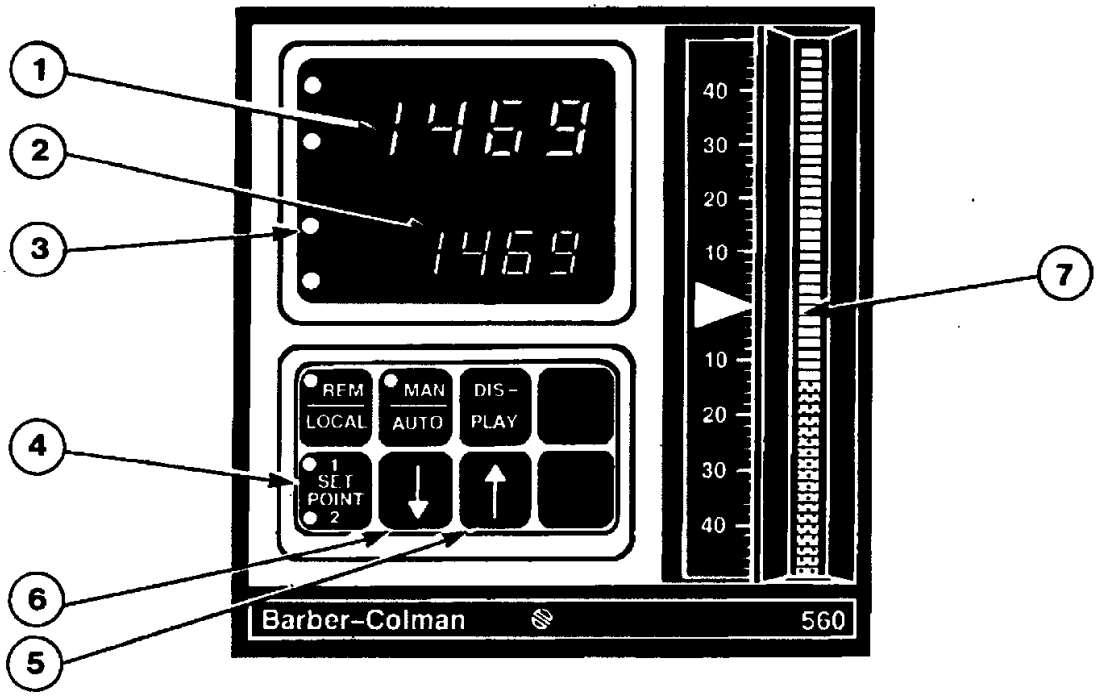
DETAIL "B" – ANALOG TEMPERATURE CONTROLLER (2 per controller)

No.	NAME		No.	NAME
1	Temperature Limit Knob		4	Red Light – Heating in Progress
2	Temperature Reset Knob		5	Temperature Indicator
3	Set Point Indicator		6	Green Light – Heating not in Progress

Figure 3 - Temperature Controller - Detail “B”

5.4.3.3.3 For the digital temperature controllers set the required temperature by pressing the setpoint key and at the same time pressing the up arrow key to increase or the down arrow key to decrease the temperature (see Figure 2, Detail “C”). When the output 1 indicator light is lit, the power has been supplied to the heater unit to maintain the required temperature.

5.4.3.4 Check the temperature controller readings from time to time to establish that the correct temperature is maintained during hot dimpling.



DETAIL "C" – DIGITAL TEMPERATURE CONTROLLER (2 per controller)

No.	NAME	No.	NAME
1	Temperature Indicator	5	Increase Key
2	Temperature Set Point	6	Decrease Key
3	Output 1 Indicator Light	7	Temperature Deviation Bar
4	Set Point Key	–	– –

Figure 4 - Temperature Controller - Detail "C"

5.4.4 Dimpling and Ram Pressures

5.4.4.1 The dimpling pressure is regulated by adjustment of the dimpling pressure control knob. The ram pressure is regulated by adjusting the ram pressure gauge.

5.4.4.2 The pressures are adjusted in two stages. The initial adjustment is an approximate setting and set according to the Table 4. Derive the final settings by dimpling test strips and ensuring that the requirements for ram coin dimpling are met according to PPS 1.01 or PPS 1.07, as applicable. When dimpling titanium alloys, increase the initial settings shown in Table 4 by a factor of 2.

5.5 Adjustments for ZT 2012D and ZT 2409B Dimpling Equipment (see Figure 5)

5.5.1 Ram Height

5.5.1.1 Except when dimpling titanium, set the ram flush with the face of the die. For titanium set the ram approximately 1/3 of the dimple depth below the face of the die.

5.5.1.2 Adjust the ram height by turning the ram height adjustment screw accordingly.

5.5.2 Temperature Controllers

5.5.2.1 The ZT 2409B control panel has two temperature controllers giving it the capability of controlling two heaters. The temperature controller pertaining to heater #2 is only operative when using 2 heaters. Since the ZT 2012D dimpler utilizes only one heater, we shall concern ourselves only with the control unit pertaining to heater #1.

5.5.2.2 For aluminum, ferrous or nickel alloys, set the indicators of the #1 control unit (see Figure 5) at 575°F - 625°F (302°C - 329°C).

5.5.2.3 For all titanium parts, except when dimpling F19 primed titanium of thickness 0.025" or less, set the indicators at 675°F - 725°F(357°C - 385°C). For F19 primed titanium of thickness 0.025" or less, set the temperature at 575°F - 625°F (302°C - 329°C), and increase the initial dwell time settings as shown in Table 3 by 1 second.

5.5.3 Pre-Form Pressure

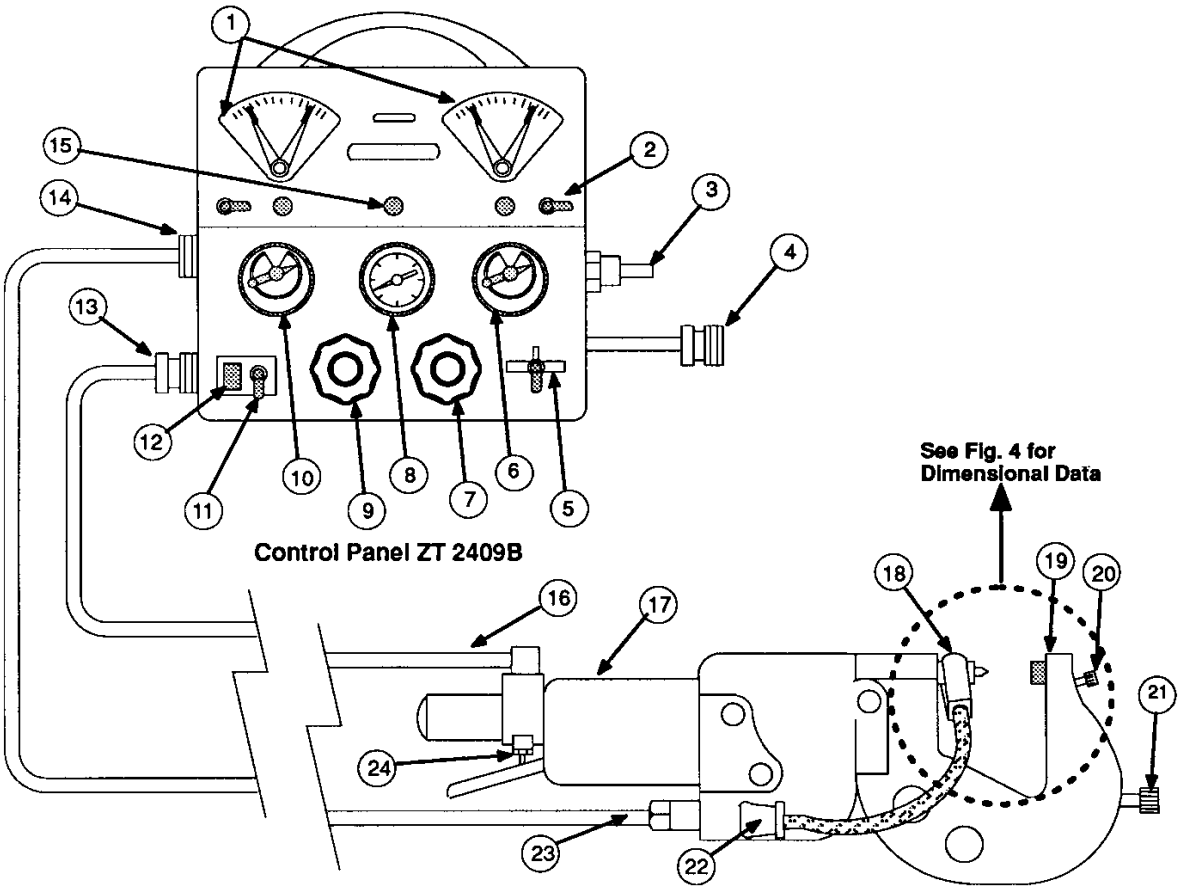
5.5.3.1 The pre-form pressure regulator is used to set the intermediate pressure required to pre-form a dimple in the dwell heating stage. To obtain the proper intermediate pressure, adjust intermediate pressure as follows:

Step 1. Set the dwell timer to maximum time (15 seconds).

Step 2. With the test strip in position, squeeze the trigger on the dimpler.

Step 3. As soon as the punch, test strip and die are in contact with each other the dwell timer starts, adjust the pre-form pressure regulator to obtain enough pressure to form 1/4 to 1/3 of the final dimple depth. Take care not to use excessively high pressure at this stage as it will cause cracking in the material.

Step 4. After completing the adjustment, squeeze the trigger on the dimpler and observe the sequence of pressure on the low pressure gauge to ensure proper setting.



LIST OF COMPONENTS

NO.	NAME	NO.	NAME
1	Temperature control meters	13	Portable Dimpler Outlet
2	Heater switches	14	Single Heater Outlet
3	Air–in connector	15	Equipment Operative Light
4	Power cable	16	Air Hose
5	Equipment selector switch	17	Dimpling Pressure Regulator
6	Dimpling timer	18	Heater
7	Pre–Form Pressure Regulator	19	Die Set Screw
8	Low Pressure Gauge	20	Ram Height Adjustment Screw
9	Low Pressure Regulator	21	Ram Pressure Adjustment Screw
10	Dwell Timer	22	Heater receptacle
11	Main Power Switch	23	Electrical Cable
12	Main Power Indicator Light	24	Trigger Adjustment

Figure 5 - ZT 2012D Dimpler and ZT 2409B Control Panel

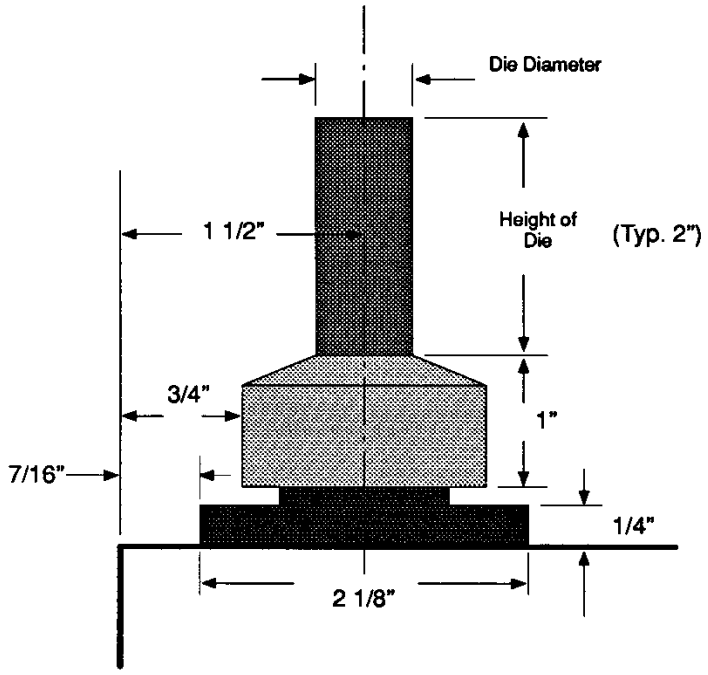


Figure 6 - Dimensional Data for CP-450-EA Dimpler

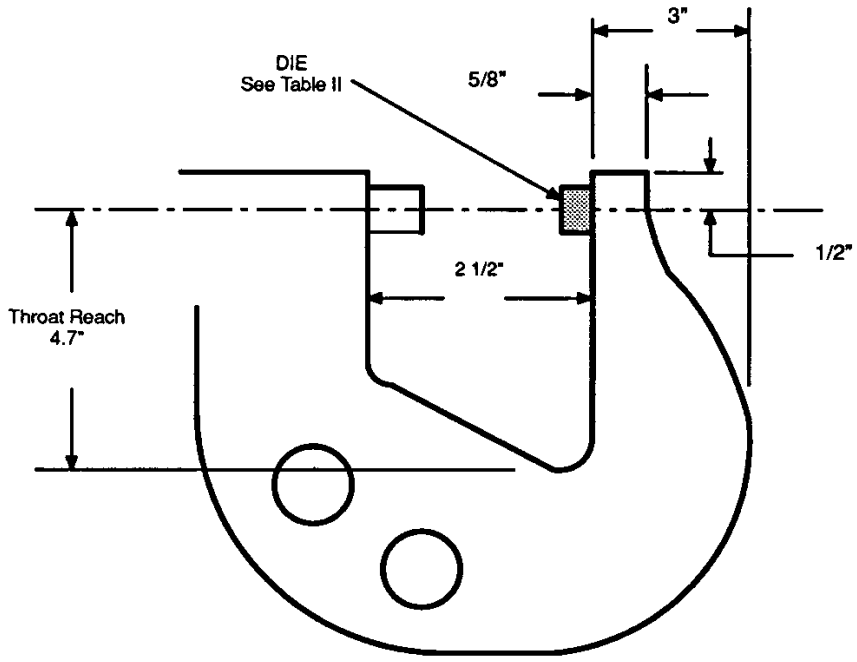


Figure 7 - Dimensional Data for ZT-2012D Dimpler

5.5.4 Dimpling Timer

5.5.4.1 The dimpling timer controls the interval during which full line pressure is introduced to the machine to complete the dimple.

5.5.4.2 The desired setting is to adjust the timer to time out just after the pop-off of the pressure regulator in the dimpler. This enables full line pressure to be used to return the squeezer cam to position for the next dimpling cycle. If the dimpling timer cycles out before the pop-off of the regulator on the dimpler, flip the main switch to OFF and back ON and increase the dimpling time until the proper setting is acquired.

5.5.5 Dimpling and Ram Pressures

5.5.5.1 Obtain the right dimpling and ram pressures by dimpling test strips and ensuring that the requirements for ram coin dimpling are met according to PPS 1.01 or PPS 1.07, as applicable.

5.5.5.2 If required, make adjustments by turning the dimpling pressure regulator valve or the ram pressure adjustment screw accordingly.

6 Requirements

6.1 For each production run, the operator must prepare a test strip according to PPS 1.01 or PPS 1.07, as applicable.

6.2 Check test strips according to PPS 1.01 or PPS 1.07, as applicable.

7 Safety Precautions

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

7.2 Disconnect the air line from the portable dimpler while installing or changing punches.

7.3 Ensure that the main power switch is in the OFF position when replacing punches and dies on the stationery dimpling machine.

7.4 When hot dimpling, allow dimpling dies to cool for 10 minutes before removal from the dimpling machine. Wear cotton gloves when removing heated dies.

8 Personnel Requirements

8.1 Personnel 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 general equipment maintenance be performed according to the manufacturer's instructions on a regularly scheduled basis. It is also recommended that daily machine maintenance be performed as follows.

Step 1. If required buff the punch and die faces using a fine grade scotch-brite abrasive pad to remove pick-up and oxide. Do not use emery cloth or crocus paper.

Step 2. Check the airline filter/water trap and drain as required.

Step 3. Check the oil level in air line lubricator and refill, as necessary, with 10W non-detergent oil.

9.2 Rework dimpling tools exhibiting signs of wear or damage. Discard excessively damaged or worn tools.

10 Machine Certification

10.1 Certify or re-certify ram coin dimpling machines after installation of a new machine and after service or repair of an existing machine. Also, ensure that ram coin dimpling machines are re-certified at least once a year (in the event no service or repair is required). Certify or re-certify each ram coin dimpling machine used in production as follows:

Step 1. Prepare 6 lap joint shear test strips as shown in Figure 8-A.

Step 2. Dimple the holes in each test strip according to PPS 1.01.

Step 3. Visually examine the dimples as specified in PPS 1.01. If any of the dimples are unacceptable, determine the cause of failure, take corrective action, prepare another 6 lap joint shear test strips and re-test as specified herein.

Step 4. Rivet the test strips together with two BACR15BA4AD4 or B0205017AD4-4 rivets according to PPS 2.01 to form 3 lap joint shear test assemblies as shown in Figure 8-B.

Step 5. Perform ultimate shear strength testing on the 3 lap joint shear test assemblies. If the ultimate shear strength of any of the shear test assemblies is less than 825 lbs determine the cause of failure, take corrective action, prepare another 6 lap joint shear test strips and re-test as specified herein. Ultimate shear strength testing must be performed by the Bombardier Toronto (de Havilland) Materials Laboratory or a Materials Laboratory approved according to BAERD GEN-018.

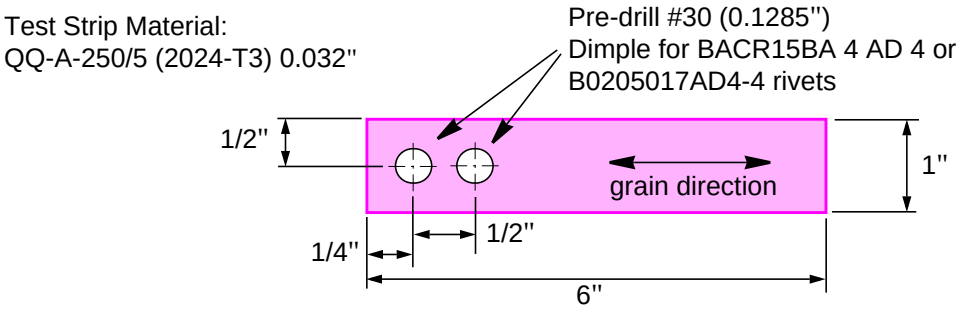


Fig. 8-A - Lap Joint Shear Test Strip

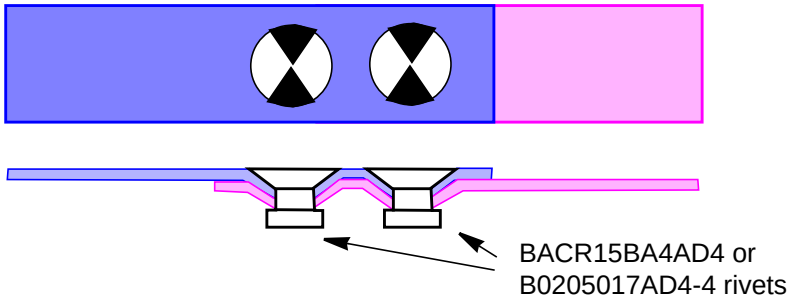


Fig. 8-B - Lap Joint Shear Test Assembly

Figure 8 - Lap Joints Shear Test Specimen

Table 1 - Ram Coin Dimpling Tools for CP-450-EA and US150EA Dimpler

FASTENER DESCRIPTION			PUNCH PILOT DIA.	PUNCH (TOOL NO.)	DIE (TOOL NO.)	RAM EXTENSION (NOTE 5)
TYPE	SIZE					
	DIA.	DASH NO.				
BOLTS & SCREWS (NOTE 1)						
AN509 type head (100°)	#8	n/a	#29	ZT1867-8	ZT1846-8	ZT185605
	#10	n/a	#24	ZT1867-10	ZT1846-10	
	1/4"	n/a	#6	ZT1867-1/4-28	ZT1868-1/4-28	n/a
	5/16"	n/a	1/4"	ZT1867-5/16-24	ZT1868-5/16-24	

Note 1. Pilot hole is undersize and must be drilled out to final size after dimpling.
Note 2. For stud installation without a grommet.
Note 3. For stud installation with a grommet.
Note 4. Although the punch/die will produce a 100 dimple (whereas screws are 82) they may be used for non-structural applications (i.e., decorative trim, etc.).
Note 5. Use a ram extension for all cutaway or modified dies.

Table 1 - Ram Coin Dimpling Tools for CP-450-EA and US150EA Dimpler

FASTENER DESCRIPTION			PUNCH PILOT DIA.	PUNCH (TOOL NO.)	DIE (TOOL NO.)	RAM EXTENSION (NOTE 5)
TYPE	SIZE					
	DIA.	DASH NO.				
AN 521 and NAS 388 (82° head) (Note 4)	#4	n/a	#40	ZT1751-1/8	ZT1754-1/8	ZT185605
	#6	n/a	#30	ZT1751-5/32	ZT1754-5/32	
	#8	n/a	#19	ZT1748-#6	ZT1747-#6	n/a
	#10	n/a	#24	ZT1867-10	ZT1846-10	
NAS 4703, 4803 & 4903 series (100° Hi-Shear type head)	#10	n/a	#17	ZT1877-3/16	ZT1876-3/16	ZT185605
	1/4"	n/a	#1	ZT1877-1/4	ZT1876-1/4	
	5/16"	n/a	9/32"	ZT1877-5/16	ZT1876-5/16	n/a
CAMLOC FASTENERS (NOTE 1)						
2700 Stud	n/a	n/a	#5	ZT2833-2700	ZT2834-2700	n/a
4002G	n/a	n/a	15/32"	ZT2833-4002G	ZT2834-4002G	
PBF Receptacle	n/a	n/a	17/64"	ZT1710	ZT1709	
DZUS FASTENERS (NOTE 1)						
Panel Type (Note 1)	7/32"	F3 1/2	#24	ZT1867-10	ZT1846-10	ZT185605
Supersonic Type	5/16"	F5	19/64"	ZT2831-5	ZT2832-5	n/a
	3/8"	F6	23/64"	ZT2105-#5	ZT2106-#5	
Standard Type (Note 1)	1/4"	F4 (Note 2)	#6	ZT1710	ZT1709	n/a
	5/16"	F4 (Note 3)	#6	ZT1715	ZT1716	
Universal Type	n/a	UF5	19/64"	ZT2831-5	ZT2832-5	n/a
HI-LOK & HI-LITE BOLTS - HI-SHEAR TYPE HEAD (NOTE 1)						
HL 11 HL329 HST 11	5/32"	-5	#30	ZT1877-5/32	ZT1876-5/32	ZT185605
	3/16"	-6	#17	ZT1877-3/16	ZT1876-3/16	
	1/4"	-8	#1	ZT1877-1/4	ZT1876-1/4	
	5/16"	-10	9/32"	ZT1877-5/16	ZT1878-5/16	n/a

Note 1. Pilot hole is undersize and must be drilled out to final size after dimpling.
Note 2. For stud installation without a grommet.
Note 3. For stud installation with a grommet.
Note 4. Although the punch/die will produce a 100 dimple (whereas screws are 82) they may be used for non-structural applications (i.e., decorative trim, etc.).
Note 5. Use a ram extension for all cutaway or modified dies.

Table 1 - Ram Coin Dimpling Tools for CP-450-EA and US150EA Dimpler

FASTENER DESCRIPTION			PUNCH PILOT DIA.	PUNCH (TOOL NO.)	DIE (TOOL NO.)	RAM EXTENSION (NOTE 5)
TYPE	SIZE					
	DIA.	DASH NO.				
HI-LOK & HI-LITE BOLTS - AN509 TYPE HEAD (NOTE 1)						
HL 327 HST 13	5/32"	-5	#29	ZT1867-8	ZT1846-8	ZT185605
	3/16"	-6	#24	ZT1867-10	ZT1846-10	
	1/4"	-8	#6	ZT1867-1/4-28	ZT1868-1/4-28	n/a
	5/16"	-10	1/4"	ZT1867-5/16-24	ZT1868-5/16-24	
HI-LOK BOLTS - AN529 TYPE HEAD (NOTE 1)						
HL 325	5/32"	-5	#30	ZT1751-5/32	ZT1754-5/32	ZT185605
	3/16"	-6	#20	ZT1751-3/16	ZT1754-3/16	
	1/4"	-8	#10	ZT2811-1/4	ZT2812-1/4	n/a
HI-SHEAR RIVETS (NOTE 1)						
HS 47 (100°) NAS 525	1/8"	-4	#40	ZT1877-1/8	ZT1876-1/8	ZT185605
	5/32"	-5	#30	ZT1877-5/32	ZT1876-5/32	
	3/16"	-6	#17	ZT1877-3/16	ZT1876-3/16	
	1/4"	-8	#1	ZT1877-1/4	ZT1876-1/4	
	5/16"	-10	9/32"	ZT1877-5/16	ZT1878-5/16	n/a
JO-BOLTS (NOTE 1)						
FF & PLT 110 (AN509 type head)	5/32"	164/ -5	#29	ZT1867-8	ZT1846-8	ZT185605
	3/16"	200/ -6	#24	ZT1867-10	ZT1846-10	
	1/4"	260/ -8	#6	ZT1867-1/4-28	ZT1868-1/4-28	n/a
	5/16"	312/ -10	1/4"	ZT1867-5/16-24	ZT1868-5/16-24	

Note 1. Pilot hole is undersize and must be drilled out to final size after dimpling.
Note 2. For stud installation without a grommet.
Note 3. For stud installation with a grommet.
Note 4. Although the punch/die will produce a 100 dimple (whereas screws are 82) they may be used for non-structural applications (i.e., decorative trim, etc.).
Note 5. Use a ram extension for all cutaway or modified dies.

Table 1 - Ram Coin Dimpling Tools for CP-450-EA and US150EA Dimpler

FASTENER DESCRIPTION			PUNCH PILOT DIA.	PUNCH (TOOL NO.)	DIE (TOOL NO.)	RAM EXTENSION (NOTE 5)
TYPE	SIZE					
	DIA.	DASH NO.				
FAA & PLT 130 (AN 426 type head)	5/32"	164/ -5	#30	ZT1751-5/32	ZT1754-5/32	ZT185605
	3/16"	200/ -6	#20	ZT1751-3/16	ZT1754-3/16	
	1/4"	260/ -8	#10	ZT2811-1/4	ZT2812-1/4	n/a
LOCKBOLTS - HI-SHEAR TYPE HEAD (NOTE 1)						
NAS 1436	3/16"	n/a	#17	ZT1877-3/16	ZT1876-3/16	ZT185605
NAS 1438	1/4"	n/a	#1	ZT1877-1/4	ZT1876-1/4	
NAS 1440	5/16"	n/a	9/32"	ZT1877-5/16	ZT1878-5/16-24	n/a
LOCKBOLTS - AN 509 TYPE HEAD (NOTE 1)						
NAS 1456 & 1516	3/16"	n/a	#24	ZT1867-10	ZT1846-10	ZT185605
NAS 1476 & 1518	1/4"	n/a	#6	ZT1867-1/4-28	ZT1868-1/4-28	n/a
NAS 1460 & 1520	5/16"	n/a	1/4"	ZT1867-5/16-24	ZT1868-5/16-24	
LOCKBOLTS - AN 426 TYPE HEAD (NOTE 1)						
NAS 1475 & 1535	5/32"	n/a	#30	ZT1751-5/32	ZT1754-5/32	ZT185605
NAS 1476 & 1536	3/16"	n/a	#20	ZT1751-3/16	ZT1754-3/16	
NAS 1478 & 1538	1/4"	n/a	#10	ZT2811-1/4	ZT2812-1/4	n/a

Note 1. Pilot hole is undersize and must be drilled out to final size after dimpling.
Note 2. For stud installation without a grommet.
Note 3. For stud installation with a grommet.
Note 4. Although the punch/die will produce a 100 dimple (whereas screws are 82) they may be used for non-structural applications (i.e., decorative trim, etc.).
Note 5. Use a ram extension for all cutaway or modified dies.

Table 1 - Ram Coin Dimpling Tools for CP-450-EA and US150EA Dimpler

FASTENER DESCRIPTION			PUNCH PILOT DIA.	PUNCH (TOOL NO.)	DIE (TOOL NO.)	RAM EXTENSION (NOTE 5)
TYPE	SIZE					
	DIA.	DASH NO.				
RIVETS - SOLID						
B0205013, B0205015 & B0205017	1/8"	-4	#30	ZT1855-1/8	ZT1856-1/8	ZT185605
	5/32"	-5	#20	ZT1855-5/32	ZT1856-5/32	
	3/16"	-6	#11	ZT1855-3/16	ZT1856-3/16	
	1/4"	-8	F	ZT1855-1/4	ZT1856-1/4	n/a
B0205018 (Note 1)	1/8"	-4	#40	ZT1877-1/8	ZT1876-1/8	ZT185605
	5/32"	-5	#27	ZT1877-5/32	ZT1876-5/32	
	3/16"	-6	#17	ZT1877-3/16	ZT1876-3/16	
BACR15BA (AN 426 type head) (non-fluid tight)	1/8"	-4	#30	ZT1855-1/8 or TS.412.22.13 MK 1	ZT1856-1/8 or TS.412.22.14 MK 1	ZT185605
	5/32"	-5	#20	ZT1855-5/32	ZT1856-5/32	
	3/16"	-6	#11	ZT1855-3/16	ZT1856-3/16	
	1/4"	-8	F	ZT1855-1/4	ZT1856-1/4	n/a
BACR15CE (NAS 1097 type head) (Note 1)	1/8"	-4	#40	ZT1877-1/8 or TS.412.22.13 MK 3	ZT1876-1/8 or TS.412.22.14 MK 3	ZT185605
	5/32"	-5	#30	ZT1877-5/32	ZT1876-5/32	
	3/16"	-6	#17	ZT1877-3/16	ZT1876-3/16	
MS20426 & MS20427 (AN 426 type head)	3/32"	-3	#40	ZT1855-3/32 or TS.412.22.13 MK 2	ZT1856-3/32 or TS.412.22.14 MK 2	ZT185605
	1/8"	-4	#30	ZT1855-1/8 or TS.412.22.13 MK 1	ZT1856-1/8 or TS.412.22.14 MK 1	
	5/32"	-5	#20	ZT1855-5/32	ZT1856-5/32	
	3/16"	-6	#11	ZT1855-3/16	ZT1856-3/16	
	1/4"	-8	F	ZT1855-1/4	ZT1856-1/4	

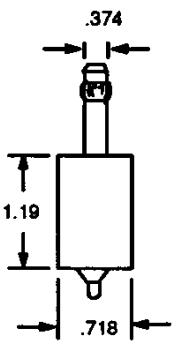
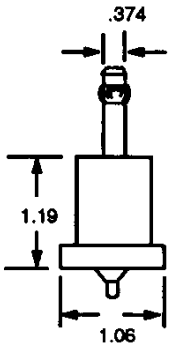
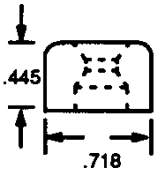
Note 1. Pilot hole is undersize and must be drilled out to final size after dimpling.
Note 2. For stud installation without a grommet.
Note 3. For stud installation with a grommet.
Note 4. Although the punch/die will produce a 100 dimple (whereas screws are 82) they may be used for non-structural applications (i.e., decorative trim, etc.).
Note 5. Use a ram extension for all cutaway or modified dies.

Table 1 - Ram Coin Dimpling Tools for CP-450-EA and US150EA Dimpler

FASTENER DESCRIPTION			PUNCH PILOT DIA.	PUNCH (TOOL NO.)	DIE (TOOL NO.)	RAM EXTENSION (NOTE 5)
TYPE	SIZE					
	DIA.	DASH NO.				
NAS 1097 & NAS 1200 (Hi-Shear type head) (Note 1)	1/8"	-4	#40	ZT1877-1/8 or TS.412.22.13 MK 3	ZT1876-1/8 or TS.412.22.14 MK 3	ZT185605
	5/32"	-5	#30	ZT1877-5/32	ZT1876-5/32	
	3/16"	-6	#17	ZT1877-3/16	ZT1876-3/16	
	1/4"	-8	#1	ZT1877-1/4	ZT1876-1/4	
RIVETS - BLIND (NOTE 1)						
Cherry Lockspindle, CherryMax & Cherry (AN 426 type head)	1/8"	-4	#40	ZT1751-1/8	ZT1754-1/8	ZT185605
	5/32"	-5	#30	ZT1751-5/32	ZT1754-5/32	
	3/16"	-6	#20	ZT1751-3/16	ZT1754-3/16	
	1/4"	-8	#10	ZT2811-1/4	ZT2812-1/4	n/a
Cherry Lockspindle & CherryMax (NAS 1097 type head)	1/8"	-4	#40	ZT1877-1/8 or TS.412.22.13 MK 3	ZT1876-1/8 or TS.412.22.14 MK 3	ZT185605
	5/32"	-5	#30	ZT1877-5/32	ZT1876-5/32	
	3/16"	-6	#17	ZT1877-3/16	ZT1876-3/16	
	1/4"	-8	#1	ZT1877-1/4	ZT1876-1/4	
RIVNUTS (NOTE 1)						
All alloy & steel (100°)	#6	n/a	#19	ZT1748-#6	ZT1747-#6	n/a
	#8	n/a	#8	ZT1748-#8	ZT1747-#8	
	#10	n/a	#1	ZT1748-#10	ZT1747-#10	

Note 1. Pilot hole is undersize and must be drilled out to final size after dimpling.
Note 2. For stud installation without a grommet.
Note 3. For stud installation with a grommet.
Note 4. Although the punch/die will produce a 100 dimple (whereas screws are 82) they may be used for non-structural applications (i.e., decorative trim, etc.).
Note 5. Use a ram extension for all cutaway or modified dies.

Table 2 - Ram Coin Tools for ZT 2012D Dimpler (Note 2)

FASTENER DESCRIPTION				PUNCH		DIE ASSEMBLY (Note 3)
Type	Size		Pilot Diameter			
	Dia.	Dash No.		Standard Punch No.	Flanged Punch No.	Standard Die Assembly No.
SCREWS (Note 1)						
AN &NAS (100° Head)	#10	—	#24	ZT1867–10 (TS.412.32.11)	—	ZT2968–10 (TS.412.32.12)
RIVETS – Solid						
MS 20426 & MS 20427 or AN 426 & 427	3/16	–6	#11	ZT1855–3/16	—	ZT2953–3/16 (TS.412.31.12)
RIVET – Blind (Note 1)						
Cherry and Lockspindle	3/16	–6	#20	—	ZT1751–3/16 (TS.412.33.11)	ZT2912–3/16 (TS.412.33.12)

Notes:
1. Pilot hole is undersize and must be drilled to size after dimpling.
2. All dimensions in inches.
3. Refer to the applicable Tool Standards for the part number break down of the Die assembly (Ram and Die Body).

Table 3 - Dwell Time (Seconds) for Hot Dimpling Metal Sheet

MATERIAL	TOTAL SHEET THICKNESS (Inches)									
	up to .016	.017 to .025	.026 to .032	.033 to .040	.041 to 050	.051 to .063	.064 to .070	.071 to .080	.081 to .090	.091 to .100
Aluminum (Single Sheet)	1/4	1/2	1	2	3	4	6	6	6	6
Aluminum (Multiple Sheets)	4	5	5	6	6	7	7	8	9	13
Titanium (Single Sheet)	4 (Note)	5 (Note)	5	6	6	7	7	8	9	13

Note: For temperature settings of 575°F to 625°F (as per 5.4.3.5.1 and 5.5.2.3.1), increase dwell times by 1 second.

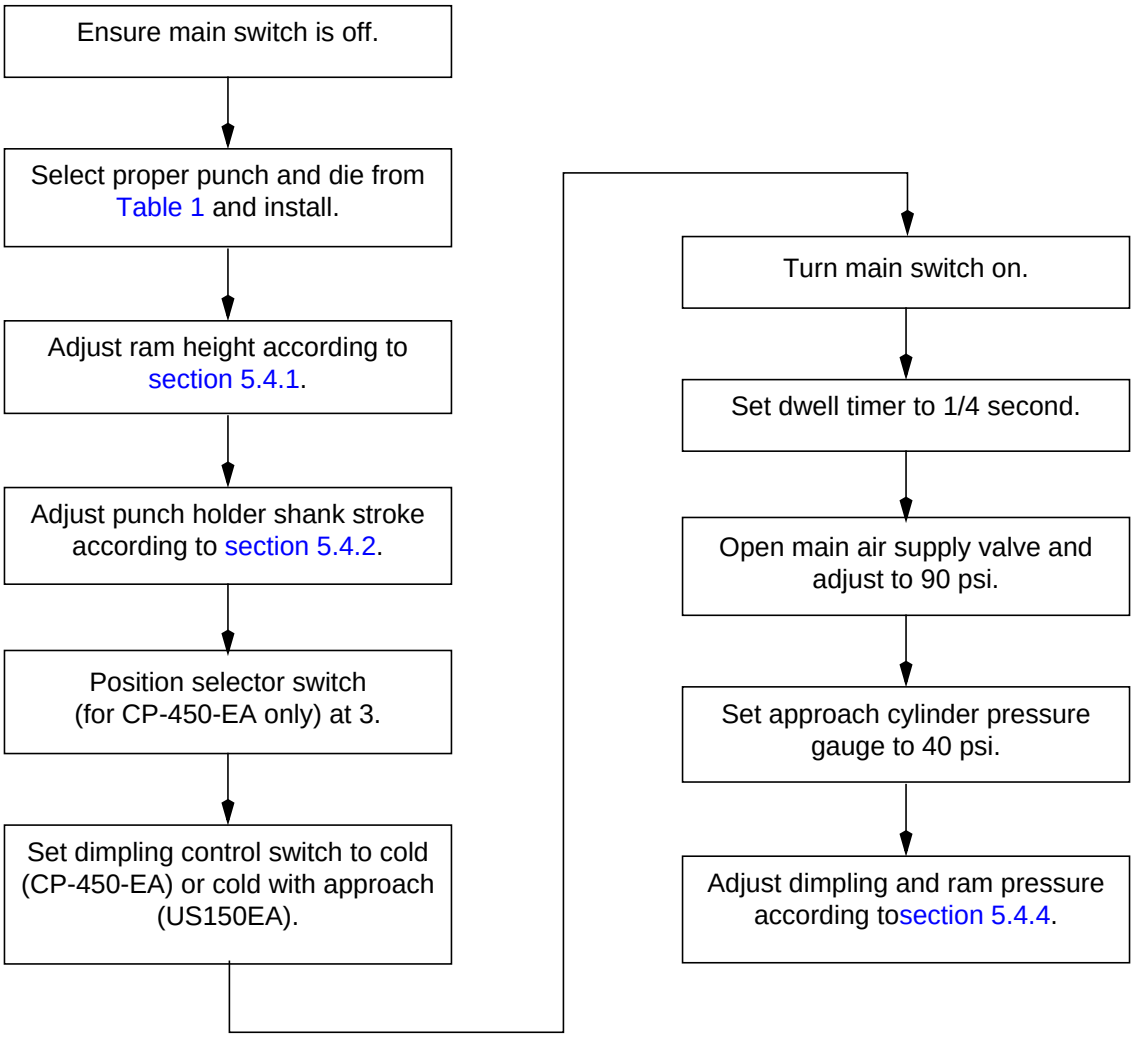
Table 4 - Initial Ram and Dimpling Pressure Settings for the CP-450-EA and US150EA Dimpler (Note 1)

MATERIAL GAUGE (Inches)	FASTENER SIZE (Inches) (Notes 2 & 3)					
	3/32 RIVET	1/8 RIVET	#8 SCREW 5/32 RIVET	#10 SCREW 3/16 RIVET	1/4 SCREW 3/16 RIVET	5/16 SCREW
.020	3/40	3/50	4/60	10/70	20/70	– –
.025	3/50	4/60	4/80	10/75	20/85	– –
.032	3/55	4/65	10/80	20/110	20/100	– –
.040	4/65	4/75	10/90	20/120	20/120	30/100
.051	4/75	4/85	10/110	20/160	20/160	25/165
.064	4/90	4/90	10/110	20/160	20/160	25/165
.072		4/110	10/140	20/230	20/220	20/290
.081			15/180	20/140	20/240	20/300
.091				20/260	20/260	25/300
.102				– –	20/280	– –

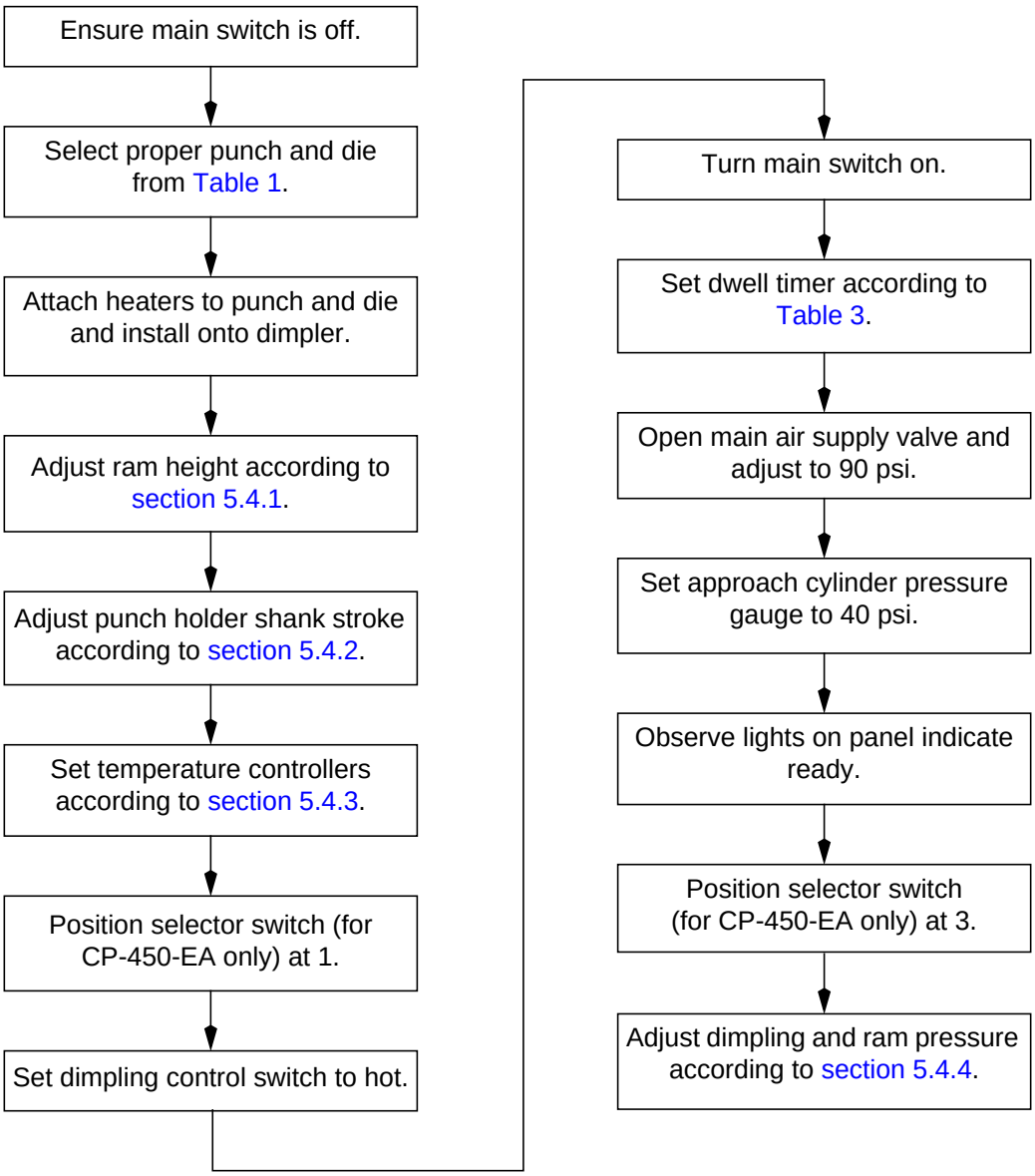
Notes:

1. 4/75 — Ram pressure setting (psi); Dimpling pressure control setting
2. For Hi–Shear rivets reduce settings by approximately 25%.
3. For Titanium alloys increase settings by a factor of 2.

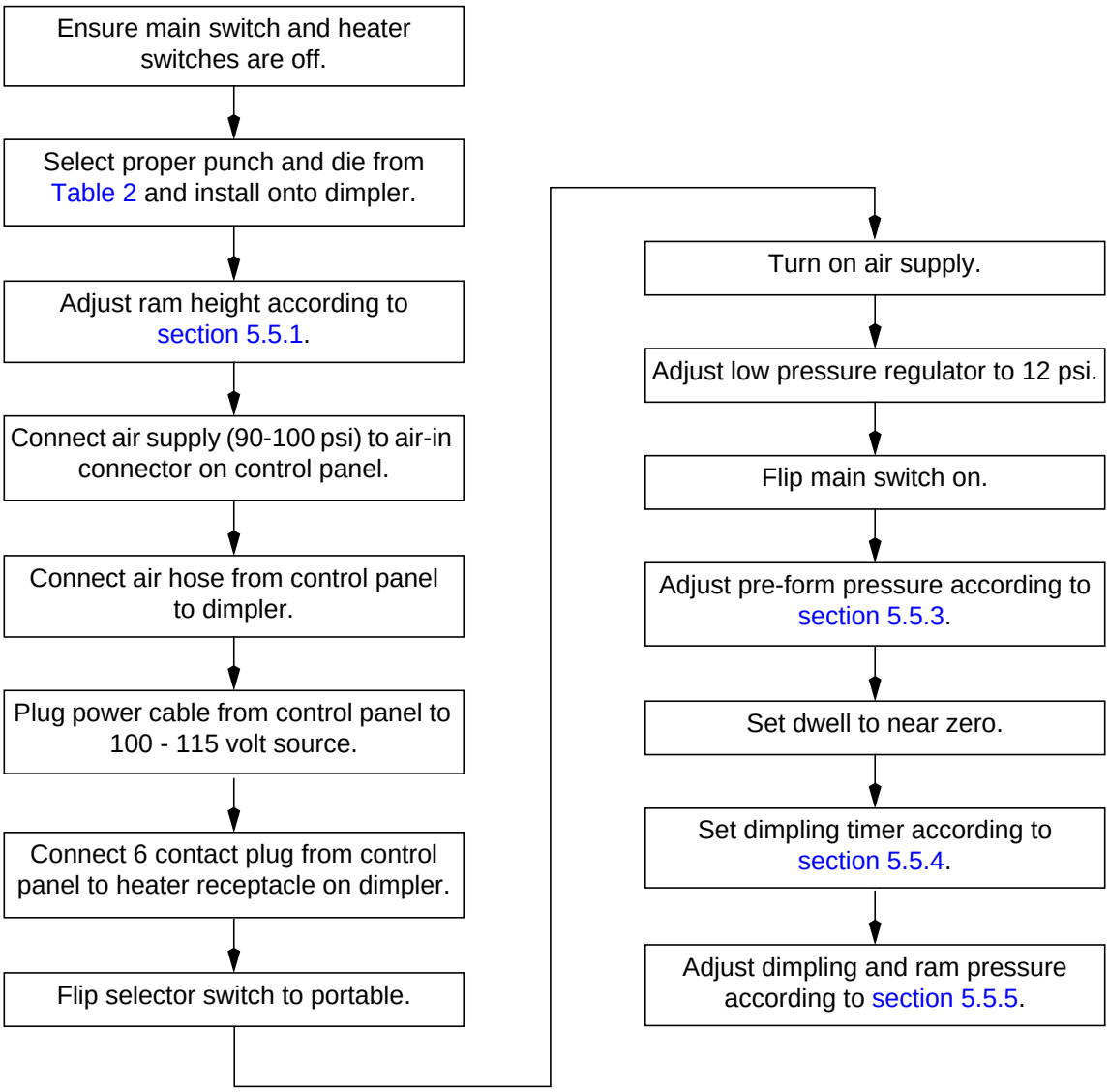
Flow Chart 1 - CP-450-EA and US150EA Set Up For Cold Dimpling



Flow Chart 2 - CP-450-EA and US150EA Set Up for Hot Dimpling



Flow Chart 3 - ZT 2012D and ZT 2409 Set Up for Cold Dimpling



Flow Chart 4 - ZT 2012D and ZT 2409B Set Up for Hot Dimpling