BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 3.05

PRODUCTION PROCESS STANDARD

Proof Loading Cable and Chain Assemblies

Issue 16
- This standard supersedes PPS 3.05, Issue 15.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS 3.05 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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Tables

Figures

1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for proof loading cable and chain assemblies fitted with end terminals.

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 PPS 2.06 - Riveting Connecting Links on Chains.

3.2 PPS 3.02 - Swaging Straight Shank Terminals.

3.3 PPS 3.04 - Swaging of Ball Terminals.

3.4 PPS 3.08 - Fabrication of Steel Cable Assemblies Using Nicopress Sleeves.

3.5 PPS 3.10 - Induction Brazing of Terminals to Steel Cables.

3.6 PPS 13.26 - General Subcontractor Provisions.

3.7 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

4 Materials, Equipment and Facilities

4.1 Materials

4.1.1 Refer to the applicable cable or chain assembly PPS for a listing of materials required for assembly of the cable or chain.

4.2 Equipment

4.2.1 SD 2342 cable test bench and accessories (see Figure 1). In place of the SD 2342 cable test bench (and accessories), it is acceptable to substitute alternative test equipment provided that the following conditions are met:

- Test equipment must be capable of proof loading the cable or chain assembly to the appropriate value specified in this PPS without causing damage to the assembly.
- Test equipment must be set-up and operated according to the manufacturer's instructions.
- Test equipment must include suitable adapters to match the terminals installed on cable or chain assemblies.
- If the test equipment utilizes a pulley system, the minimum pulley diameter must meet the following requirements:

CABLE DIAMETER	1/16"	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	9/32"	5/16"	3/8"
MINIMUM PULLEY DIAMETER	4.5"				6.25"		8.0"		10.5"	

4.2.2 Wiping cloths (e.g., DSC 378-2).

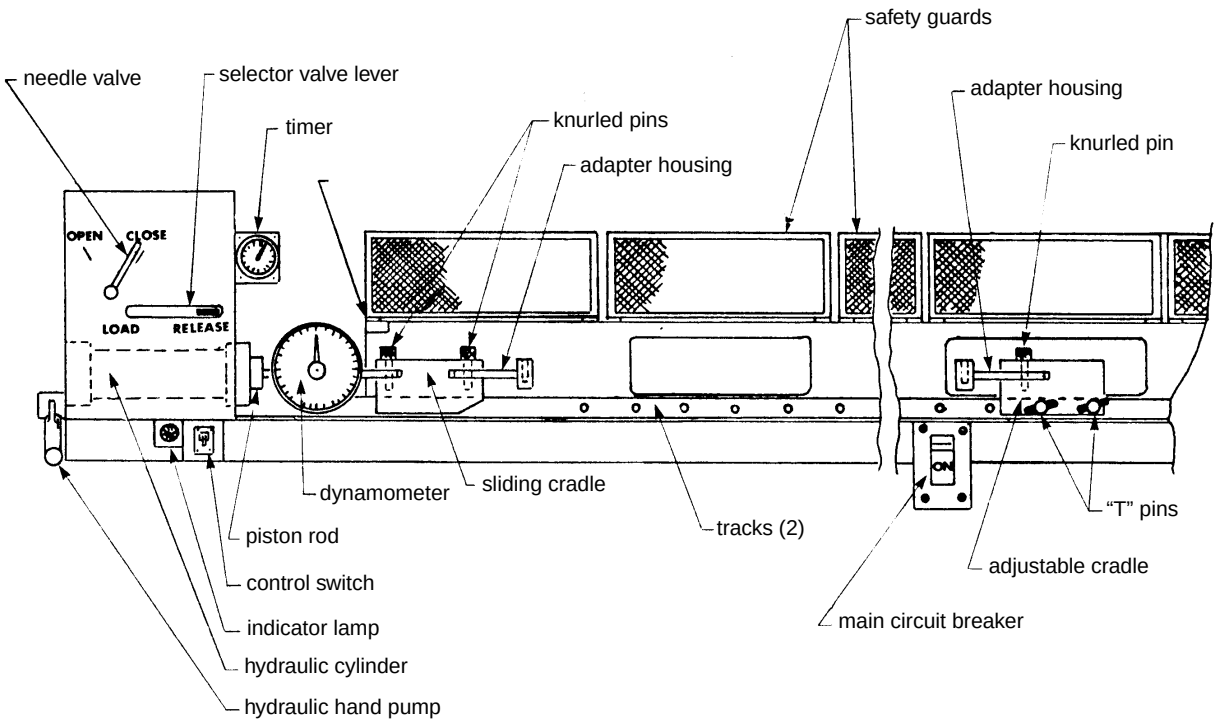


Figure 1 - SD 2342 Cable Test Bench

4.3 Facilities

4.3.1 This PPS has been categorized as a “Controlled Special Process” according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform proof loading of cable and chain assemblies fitted with end terminals according to this PPS.

4.3.2 Bombardier subcontractors must direct requests for approval to Bombardier Aerospace Supplier Quality Management. Bombardier Aerospace facilities must direct requests for approval to the appropriate internal Quality Manager.

4.3.3 Facility approval shall be based on a facility report, a facility survey and completion of a qualification test program, if required. The facility report must detail the materials and equipment to be used, the process sequence to be followed and the laboratory facilities used to show compliance with the requirements of this PPS. Any deviation from the procedure or requirements of this PPS must be detailed in the facility report. Based upon the facility report, Bombardier Toronto (de Havilland) Materials Technology may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification must be prepared to demonstrate their capability. Once approved, no changes to subcontractor facilities may be made without prior written approval from Bombardier Aerospace Supplier Quality Management.

4.3.3.1 Unless otherwise specified by Bombardier Aerospace Supplier Quality Management, approval of subcontractor facilities to perform proof loading of cable and chain assemblies fitted with end terminals according to this PPS does not require completion of a test program or submission of test samples.

5 Procedure

5.1 Set-Up of Cable Test Bench for Proof Load Testing

5.1.1 Set-up the SD 2342 cable test bench for proof load testing as follows:

Step 1. Check to ensure that the needle valve is in the CLOSED position.

Step 2. Close the safety guards along the entire length of the test bench.

Step 3. Close the main circuit breaker.

Step 4. Set the control switch to the ON position to start the hydraulic pump motor. The indicator lamp will light.

Step 5. Move the selector lever to the REVERSE position to extend the piston rod and sliding cradle.

Step 6. When the piston rod is fully extended, set the control switch to the OFF position. The piston rod will remain extended, ready for setting-up the cable assembly.

Step 7. Open the safety guards.

5.2 Set-Up of Cable or Chain Assembly in Test Bench

5.2.1 For cable or chain assemblies which are shorter than the test bench, set-up the cable or chain assembly in the Test Bench as follows:

Step 1. Connect one end of the cable or chain assembly to the sliding cradle, using the appropriate accessories and methods as specified below:

- When securing cable or chain assemblies to the test bench cradles, use adapters matching the terminals and, if necessary, adapter housings, as shown in Figure 2, Figure 3, Figure 4 and Figure 5.
- Use “L” pins for fastening forked ends or similar terminals to adapters. Ensure a sliding fit of the “L” pin in the holes of the terminals and adapters (see Figure 2).
- When connecting threaded terminals to adapters, ensure that at least 15 threads of the terminal engage with the adapter (see Figure 3).
- Secure terminals incorporating spherical or anti-friction bearings to the test bench adapters by means of suitable “L” pins through the centre of the bearing (see Figure 4).
- Use knurled pins for connecting either the adapters or the adapter housings to the cradles.
- Ensure that the mating faces of the adapters for ball end or roller shaped terminals make contact with approximately 1/2 of the area of the spherical or cylindrical faces of the terminals.
- Secure loop terminals (with or without thimbles) to the test bench cradles using suitable pins and, if necessary, packing plugs as specified in Table 1 (see Figure 5).
- Secure standard AN terminals to the cradles by means of the adapters listed in Table 2.

Step 2. Lay the cable or chain assembly in a straight line along the surface of the test bench. Take care to prevent kinking or twisting.

Step 3. Move the adjustable cradle up to the free end terminal of the assembly and connect the terminal to the cradle using the appropriate accessories and methods as specified in Step 1. Ensure that the cable or chain are free of kinks and twists.

Step 4. Move the adjustable cradle to its furthest possible position and lock it to the track using 2 “T” pins.

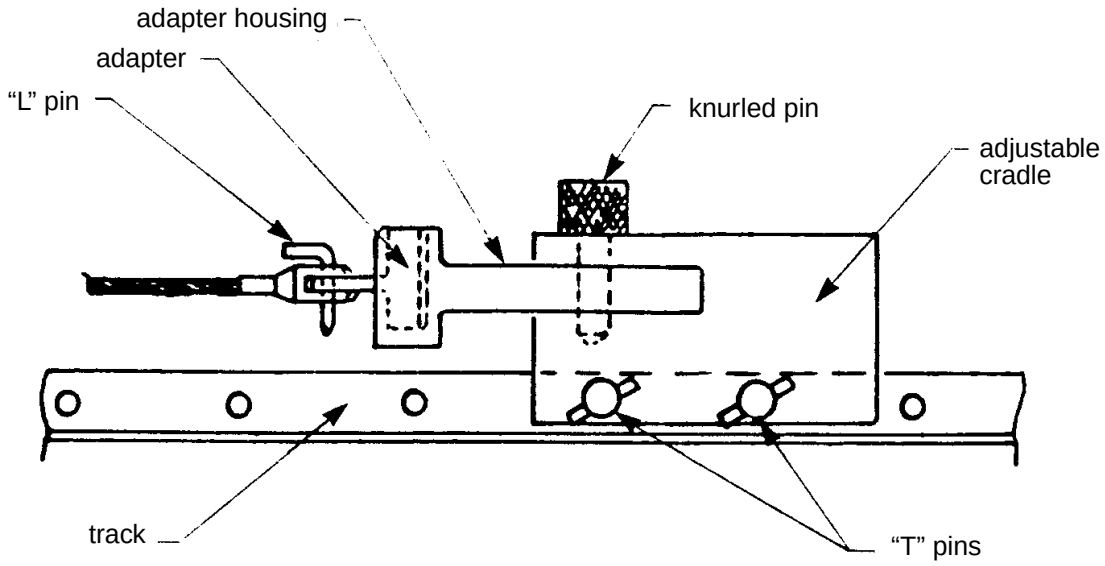


Figure 2 - Forked End Terminal

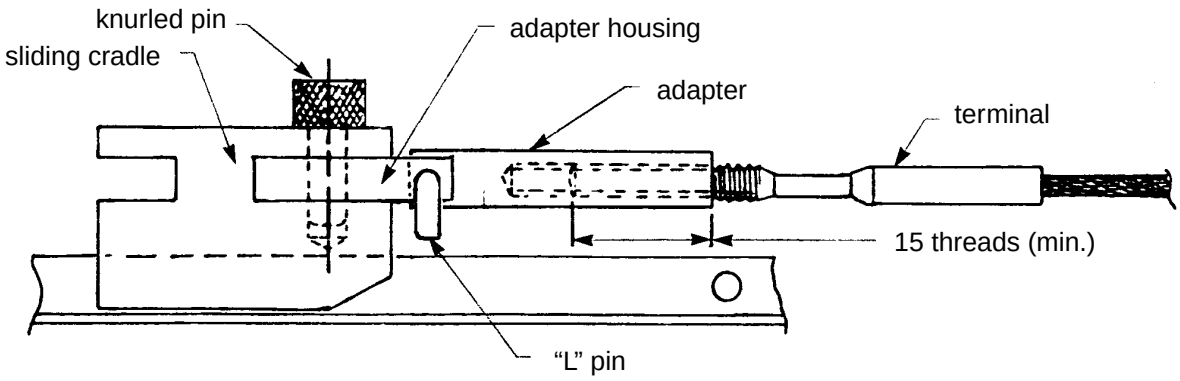


Figure 3 - Threaded Terminal

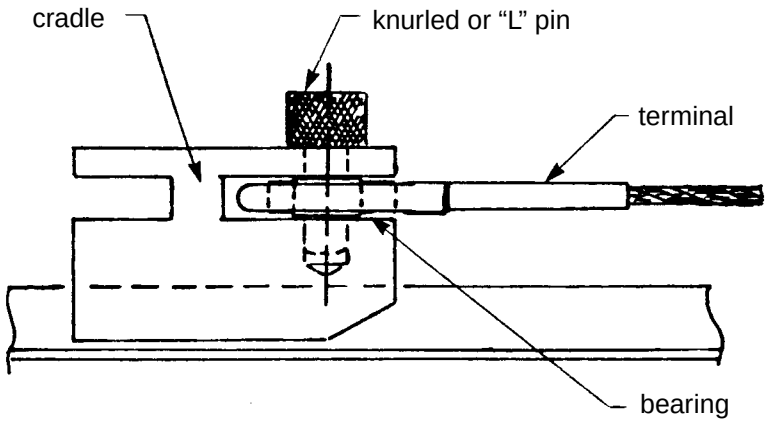


Figure 4 - Spherical or Anti-Friction Bearing Terminal

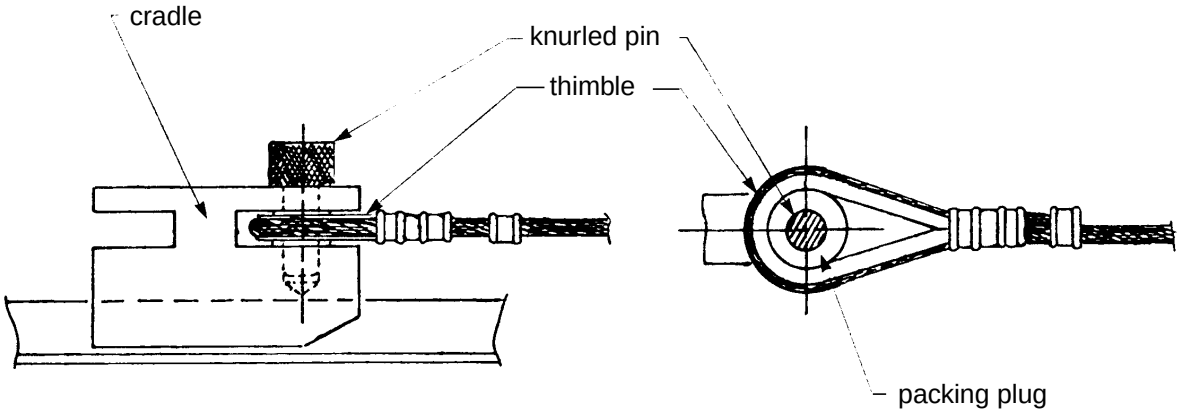


Figure 5 - Loop Terminal

Table 1 - Pin Sizes for Securing Loop Terminals

CABLE DIAMETER	PIN OR PLUG DIAMETER (± 1/16")
1/16"	5/16" (0.3125")
3/32"	
1/8"	
5/32"	3/8" (0.375")
3/16"	1/2" (0.5")
7/32"	9/16" (0.5625")

CABLE DIAMETER	PIN OR PLUG DIAMETER (± 1/16")
1/4"	11/16" (0.6875)
9/32"	3/4" (0.75")
5/16"	7/8" (0.875")
3/8"	1"
7/16"	1 1/8" (1.125")
1/2"	1 1/4" (1.25")

Table 2 - Adapters for Holding Swaged AN Terminals

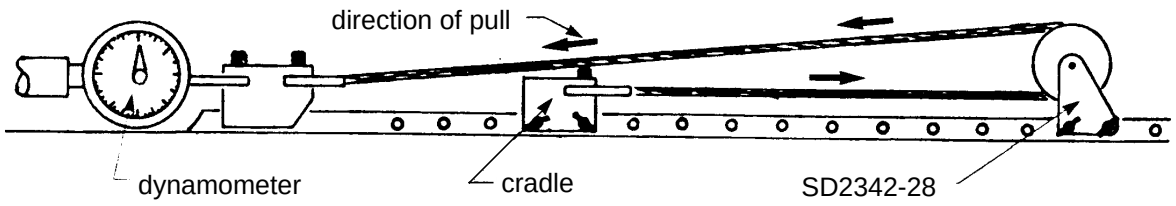
TERMINAL NUMBER		ADAPTER NUMBER	TERMINAL NUMBER		ADAPTER NUMBER
AN	MS		AN	MS	
663-2	20663-2	664-2	666-2LH	21259-2LH	669-2LH #6-40
664-2	20664-2		666-3LH	21259-3LH	669-3LH #10-32
663-3	20663-3	664-3	666-4LH	21259-4LH	669-4LH 1/4-28 or 669-5LH 1/4-28
664-3	20664-3		666-5LH	21259-5LH	
663-4	20663-4	664-4	666-6LH	21259-6LH	669-6LH 5/16-24
664-4	20664-4		666-2RH	21259-2RH	669-2RH #6-40
663-5	20663-5	664-5	669L2RH	21260L2RH	
664-5	20664-5		669S2RH	21260S2RH	
663-6	20663-6	664-6	666-3RH	21259-3RH	669-3RH #10-32
664-6	---		669L3RH	21260L3RH	
667-2	20667-2	667-2	669S3RH	21260S3RH	
667-3	20667-3	667-3	666-4RH	21259-4RH	669-4RH 1/4-28 or 669-5RH 1/4-28
667-4	20667-4	667-4	669L4RH	21260L4RH	
667-5	20667-5	667-5	669S4RH	21260S4RH	
667-6	20667-6	667-6	666-5RH	21259-5RH	
668-2	20668-2	668-2	669L5RH	21260L5RH	
668-3	20668-3	668-3	669S5RH	21260L5RH	
668-4	20668-4	668-4	666-6RH	21259-6RH	669-6RH 5/16-24
668-5	20668-5	668-5	669L6RH	21260L6RH	
668-6	20668-6	668-6	669S6RH	21260S6RH	

Note 1. No. 667 and 668 adapters require an adapter housing for attachment.
Note 2. No. 666 adapters require an adapter to allow for float.

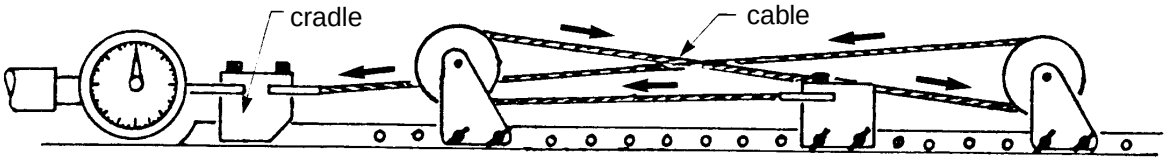
5.2.2 For cable assemblies which are longer than the test bench, set-up the cable or chain assembly in the test bench using pulleys and pulley attachments as follows:

Step 1. Ensure that the diameter of the pulley grooves is equal to the diameter of the cable being tested. For plastic covered cable, include the thickness of the plastic jacket when determining the cable diameter. The diameter of the pulley groove is stamped on each test bench pulley.

Step 2. Set-up the pulleys to use either one track of the test bench, as per Figure 6, or both tracks, as per Figure 7, whichever is convenient to production. Incorporate either one or two pulleys into the set-up, as necessary, for the cable length being tested.

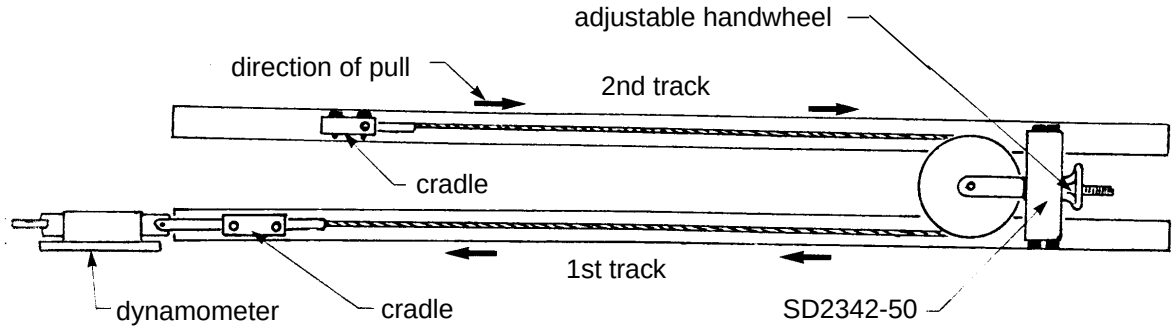


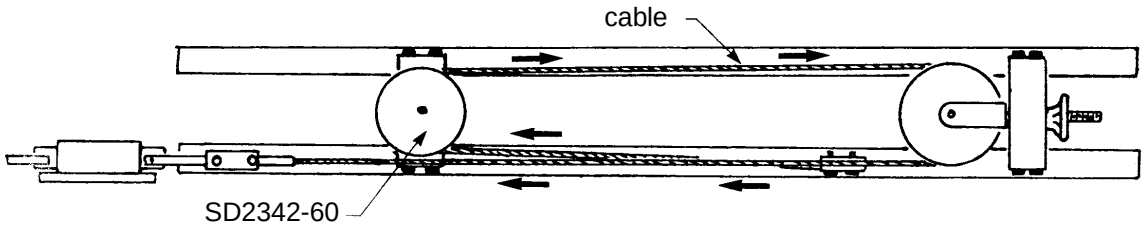
Single Pulley



Double Pulley

Figure 6 - Single Track Set-Up of Pulley and Attachments





Double Pulley

Figure 7 - Double Track Set-Up of Pulleys and Attachments

Step 3. Set-up the cable assembly in the test bench, according to Figure 6 or Figure 7, using the appropriate adapters according to Step 1 of paragraph 5.2.2. Take care to prevent kinking or twisting the cable or chain assembly.

Step 4. Adjust the cradle and pulley attachments, to reduce the slack in the cable or chain to a minimum. If using an SD2342-50 pulley attachment, any remaining slack in the cable may be taken up by means of the handwheel adjustment.

Step 5. Lock the cradle and pulley to the track by means of the pins provided.

5.3 Set-Up of Special Assemblies and Plain Cable

5.3.1 Set-up cable assemblies comprised of a main cable with attached branch cables (as shown in Figure 8) for proof loading by anchoring the free end of the main cable to the sliding cradle and anchoring the free end of one of the branch cables to the adjustable cradle, according to section 5.2.

5.3.2 When setting-up cables without an end terminal for proof loading, use special adapters.

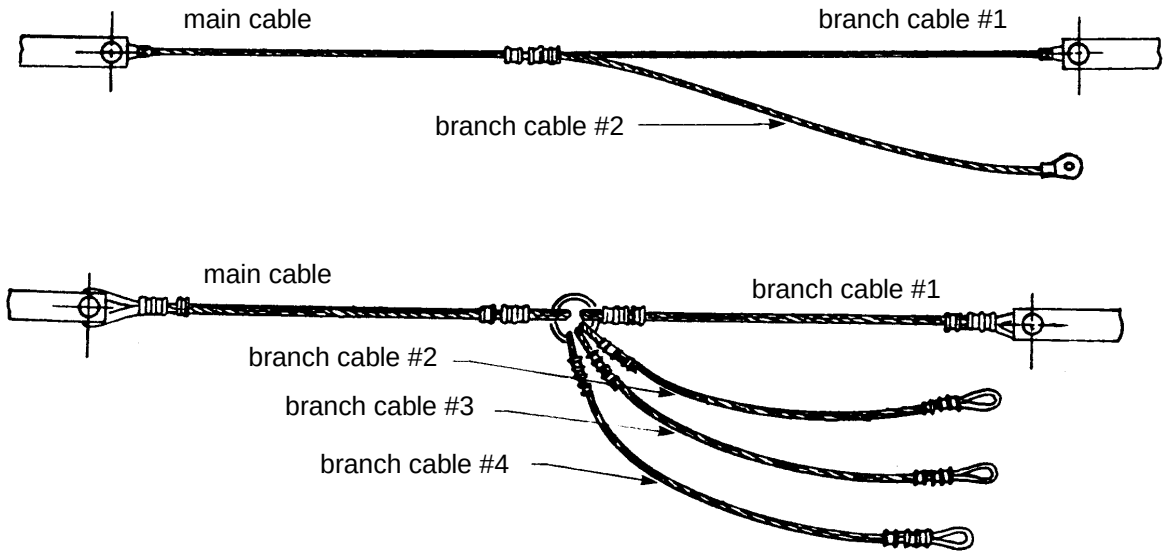


Figure 8 - Cable Assemblies with Main Cable and Branch Cables Attached

5.4 Test Procedures

5.4.1 Perform **proof load** testing as follows:

Step 1. Ensure the cable or chain assembly has been properly installed in the test bench as specified herein and close the safety guard over the entire length of the bench.

Step 2. Move the control switch to the ON position.

Step 3. Move the selector lever to the LOAD position.

Step 4. Open the needle valve slowly and evenly to attain the applicable proof load as specified by the engineering drawing in approximately 3 seconds. If the engineering drawing does not specify a proof load, refer to Table 3. When proof loading assemblies having dissimilar terminals, or combined assemblies comprising different sizes or types of cables, apply the load for the terminal or cable with the lowest proof load requirements. For cable assemblies fitted with reworked standard terminals, proprietary terminals, or chains and loop terminals without thimbles, if the required proof load value is not specified on the engineering drawing contact Liaison Engineering.

Step 5. Hold the load for 5 seconds. To maintain a steady proof load over the required period, it is necessary to bring the needle valve back to the nearly closed position. The amount the valve is to be opened may be determined by watching the needle of the dynamometer.

Step 6. Fully close the needle valve.

Step 7. Move the selector lever to the RELEASE position to fully extend the piston rod.

Step 8. Open the safety guard and disconnect and remove the cable assembly.

Step 9. To close down the test bench, move the control switch to the OFF position and open the circuit breaker.

5.4.2 If the engineering drawing or PPS specifies determination of the **breaking load** of a test assembly, submit the test assembly to a Bombardier Aerospace approved laboratory for destructive tensile testing. Unless otherwise specified by the engineering drawing the minimum breaking load must meet the requirements of Table 4.

Table 3 - Proof Load

CABLE TYPE AND SPECIFICATION (Note 5)	**NOMINAL DIAMETER OF CABLE**	**PROOF LOAD**		
		SWAGED TERMINALS - Straight Shank & Ball Shank **NICOPRESS ASSEMBLIES** - With Thimbles	**NICOPRESS ASSEMBLIES** - Without Thimbles - Branched Assemblies	**BRAZED TERMINALS** - Plain Ball Type
BAMS 511-001 Composition A	3/16"	2520 lbs	1260 lbs	n/a
MIL-C-6940 Carbon Steel Cable and MIL-C-5693 Corrosion Resistant Steel Cable	1/16"	300 lbs	150 lbs	240 lbs
	3/32"	720 lbs	360 lbs	575 lbs
	1/8"	1260 lbs	630 lbs	n/a
	5/32"	1980 lbs	990 lbs	
	3/16"	2820 lbs	1410 lbs	
	7/32"	3780 lbs	1890 lbs	
	1/4"	4920 lbs	2460 lbs	
	5/16"	7500 lbs	3750 lbs	

Table 3 - Proof Load

CABLE TYPE AND SPECIFICATION (Note 5)	**NOMINAL DIAMETER OF CABLE**	**PROOF LOAD**		
		SWAGED TERMINALS - Straight Shank & Ball Shank **NICOPRESS ASSEMBLIES** - With Thimbles	**NICOPRESS ASSEMBLIES** - Without Thimbles - Branched Assemblies	**BRAZED TERMINALS** - Plain Ball Type
MIL-W-1511 or MIL-W-83420 Types I & II Composition A Carbon Steel Wire Rope	1/16"	290 lbs	145 lbs	230 lbs
	3/32" - 7x7 Construction	550 lbs	275 lbs	440 lbs
	3/32" - 7x19 Construction	630 lbs	315 lbs	505 lbs
	1/8"	1200 lbs	600 lbs	n/a
	5/32"	1680 lbs	840 lbs	
	3/16"	2520 lbs	1260 lbs	
	7/32"	3360 lbs	1680 lbs	
	1/4"	4200 lbs	2100 lbs	
	9/32"	4800 lbs	---	
	5/16"	5880 lbs	2940 lbs	
	3/8"	8640 lbs	---	
MIL-C-5424 or MIL-W-83420 Types I & II Composition B Corrosion Resistant Steel Cable	1/16"	290 lbs	145 lbs	230 lbs
	3/32" - 7x7 Construction	550 lbs	275 lbs	440 lbs
	3/32" - 7x19 Construction	550 lbs	315 lbs	505 lbs
	1/8"	1055 lbs	530 lbs	n/a
	5/32"	1440 lbs	720 lbs	
	3/16"	2220 lbs	1110 lbs	
	7/32"	3000 lbs	1500 lbs	
	1/4"	3840 lbs	1920 lbs	
	9/32"	4680 lbs	---	
	5/16"	5400 lbs	2700 lbs	
	3/8"	7200 lbs	---	
MIL-C-18375 Corrosion Resistant Steel Cable (Non-Magnetic)	1/16"	215 lbs	110 lbs	170 lbs
	3/32"	420 lbs	210 lbs	335 lbs
	1/8"	780 lbs	390 lbs	n/a
	5/32"	1200 lbs	600 lbs	
	3/16"	1740 lbs	870 lbs	
	7/32"	2280 lbs	1140 lbs	
	1/4"	2940 lbs	1470 lbs	
	9/32"	3660 lbs	---	
	5/16"	4560 lbs	2280	

Table 4 - Minimum Breaking Load

CABLE TYPE AND SPECIFICATION (Note 5)	**NOMINAL DIAMETER OF CABLE**	**MINIMUM BREAKING LOAD**		
		SWAGED TERMINALS - Straight Shank & Ball Shank **NICOPRESS ASSEMBLIES** - With Thimbles	**NICOPRESS ASSEMBLIES** - Without Thimbles - Branched Assemblies	**BRAZED TERMINALS** - Plain Ball Type
BAMS 511-001 Composition A	3/16"	4200 lbs	2100 lbs	3360 lbs
MIL-C-6940 Carbon Steel Cable and MIL-C-5693 Corrosion Resistant Steel Cable	1/16"	500 lbs	250 lbs	400 lbs
	3/32"	1200 lbs	600 lbs	960 lbs
	1/8"	2100 lbs	1050 lbs	n/a
	5/32"	3300 lbs	1650 lbs	
	3/16"	4700 lbs	2350 lbs	
	7/32"	6300 lbs	3150 lbs	
	1/4"	8200 lbs	4100 lbs	
	5/16"	12500 lbs	6250 lbs	
MIL-W-1511 or MIL-W-83420 Types I & II Composition A Carbon Steel Wire Rope	1/16"	480 lbs	240 lbs	385 lbs
	3/32" - 7x7 Construction	920 lbs	460 lbs	735 lbs
	3/32" - 7x19 Construction	1000 lbs	500 lbs	800 lbs
	1/8"	2000 lbs	1000 lbs	n/a
	5/32"	2800 lbs	1400 lbs	
	3/16"	4200 lbs	2100 lbs	
	7/32"	5600 lbs	2800 lbs	
	1/4"	7000 lbs	3500 lbs	
	9/32"	8000 lbs	---	
	5/16"	9800 lbs	4900 lbs	
	3/8"	14400 lbs	---	
MIL-C-5424 or MIL-W-83420 Types I & II Composition B Corrosion Resistant Steel Cable	1/16"	480 lbs	240 lbs	385 lbs
	3/32" - 7x7 Construction	920 lbs	460 lbs	735 lbs
	3/32" - 7x19 Construction	920 lbs	500 lbs	800 lbs
	1/8"	1760 lbs	880 lbs	n/a
	5/32"	2400 lbs	1200 lbs	
	3/16"	3700 lbs	1850 lbs	
	7/32"	5000 lbs	2500 lbs	
	1/4"	6400 lbs	3200 lbs	
	9/32"	7800 lbs	---	
	5/16"	9000 lbs	4500 lbs	
	3/8"	12000 lbs	---	

Table 4 - Minimum Breaking Load

CABLE TYPE AND SPECIFICATION (Note 5)	NOMINAL DIAMETER OF CABLE	MINIMUM BREAKING LOAD		
		SWAGED TERMINALS - Straight Shank & Ball Shank **NICOPRESS ASSEMBLIES** - With Thimbles	**NICOPRESS ASSEMBLIES** - Without Thimbles - Branched Assemblies	**BRAZED TERMINALS** - Plain Ball Type
MIL-C-18375 Corrosion Resistant Steel Cable (Non-Magnetic)	1/16"	360 lbs	180 lbs	290 lbs
	3/32"	700 lbs	350 lbs	560 lbs
	1/8"	1300 lbs	650 lbs	n/a
	5/32"	2000 lbs	1000 lbs	
	3/16"	2900 lbs	1450 lbs	
	7/32"	3800 lbs	1900 lbs	
	1/4"	4900 lbs	2450 lbs	
	9/32"	6100 lbs	---	
	5/16"	7600 lbs	3800	

5.5 Identification of Proof Load Tested Assemblies

5.5.1 On one terminal of each successfully proof load tested assembly, metal stamp a 1/16" diameter circled “T” in the area shown in Figure 9. When applying the stamp, use only one striking operation, applied lightly, to ensure that no damage to the terminal results. Do not stamp ball end terminals.

5.6 Protective Treatment

5.6.1 Remove excess grease from the outside diameter of cables (e.g., using a clean dry cloth). Do **not** use solvent when removing excess grease.

6 Requirements

6.1 During the proof load test, there must be no slipping of the cable in the sleeve of the terminal.

6.2 After proof loading, the length of the assembly must conform to the dimensions specified on the relevant engineering drawing within the tolerances specified in Table 5.

6.3 There must be no visual evidence of broken wires or strands in cables or cracking of terminals or links.

6.4 On chain assemblies, the links or connectors must move freely about the pins without binding.

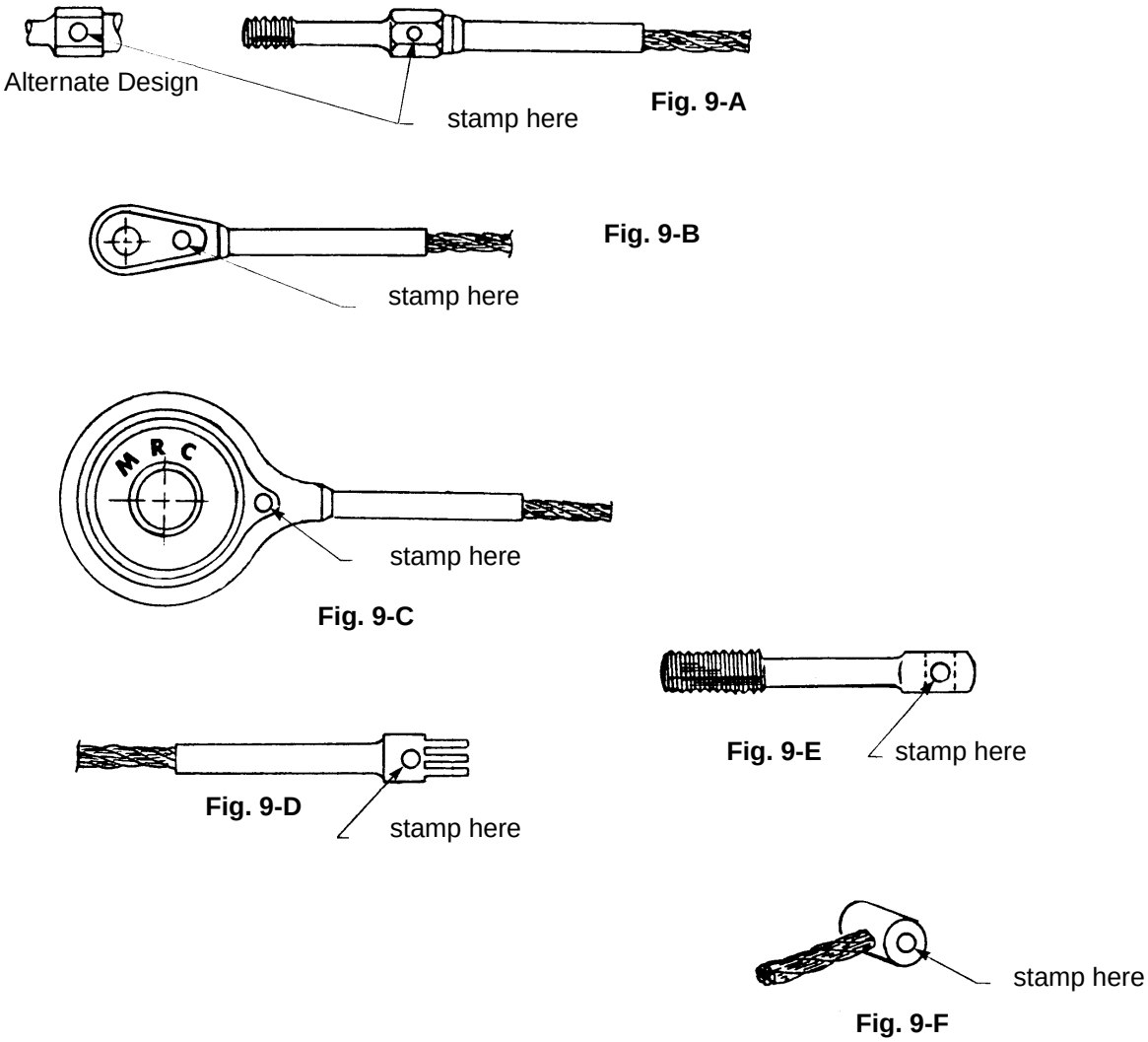


Figure 9 - Inspection Marking of Typical Terminals

Table 5 - Tolerances on Lengths of Assemblies Following Proof Loading

ASSEMBLY LENGTH	TOLERANCE	
	SWAGED OR BRAZED ASSEMBLIES	NICOPRESS ASSEMBLIES
Up to 240"	± 0.125"	± 0.25"
241" to 480"	± 0.20"	± 0.375"
481" to 720"	± 0.25"	± 0.435"
721" to 1080"	± 0.38"	± 0.50"

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 Do not turn on the cable test bench unless the safety guard is closed over its entire length.

7.4 Only authorized personnel may operate the cable test bench.

8 Personnel Requirements

8.1 This PPS has been categorized as a “Controlled Special Process” by PPS 13.39. Refer to PPS 13.39 for personnel requirements.

9 Maintenance of Equipment - Bombardier Toronto (de Havilland)

9.1 Replace worn or damaged parts of attachment fittings immediately.

9.2 Repair any leaks in the fluid lines, pressure cylinder, generator or hand pumps. Replace any lost hydraulic fluid.

9.3 Do not force terminals into adapters. If a terminal does not fit easily, either the terminal does not have the correct dimensions or the adapter is damaged.

9.4 Adjustments to valves or other hydraulic components may only be performed by authorized personnel.

9.5 Use hand pumps only in the case of a power failure.

9.6 Ensure that dynamometers are calibrated.

9.7 Do not perform any unauthorized rework of parts and accessories of the cable test.