BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 3.10

PRODUCTION PROCESS STANDARD

Brazing of Terminals to Steel Cables

Issue 11
- This standard supersedes PPS 3.10, Issue 10.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to PPS.Group@aero.bombardier.com or (416) 375-4365.
- This PPS is effective as of the distribution date.

Prepared By:	(Michael Wright)	January 23, 2014
	Production Process Standards (PPS)	
Approved By:	(L.K. John)	January 23, 2014
	Materials Technology	
	(Adam Gordon)	January 24, 2014
	Quality	

Table of Contents

Sections **Page**

Tables

Figures

1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for brazing terminals to carbon steel cables (MIL-W-1511 or MIL-W-83420 Type 1, composition A) and corrosion resistant steel wire cables (MIL-C-5424 or MIL-W-83420 Type I composition B).

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 3.04 - Swaging of Ball Terminals.

3.2 PPS 3.05 - Proof Loading of Cable and Chain Assemblies.

3.3 PPS 13.26 - General Subcontractor Provisions.

3.4 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.5 PPS 15.01 - Part Marking.

3.6 PPS 16.01 - Application of Hard and Soft Film Corrosion Preventive Compound.

3.7 PPS 31.17 - Solvent Usage.

4 Materials, Equipment and Facilities

4.1 Materials

4.1.1 Terminals and cable as specified on the engineering drawing.

4.1.2 Silver brazing alloy - QQ-B-654 Grade VII or Silver Alloy No. 45.

4.1.3 High temperature brazing flux - AMS 3411 (1100°F - 1800°F (593°C - 982°C)) or Handy Harmen Type B1 (1100°F - 1700°F (593°C - 927°C)).

4.1.4 Protective oil treatment - Esso Instrument Oil, Texaco 1692 Low Temperature Oil (MIL-L-7870).

4.2 Equipment

4.2.1 Ultrasonic cleaning machine.

4.2.2 Radio frequency induction heating unit.

4.2.3 Brazing crucible.

4.2.4 Terminal heating block.

4.2.5 Container and heater for maintaining water at boiling temperature.

4.2.6 Lint free cotton cloth (e.g., DSC 378-2).

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 brazing of terminals to steel cables 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, for approval of subcontractor facilities to perform brazing of terminals to steel cables according to this PPS completion of a test program and submission of suitable test samples representative of production parts is required. Test samples must meet the requirements specified in section 6.

5 Procedure

5.1 Preparation of Terminals and Cable for Brazing

5.1.1 Prepare terminals and carbon steel or corrosion resistant steel wire cables for brazing as follows:

Step 1. Measure off the required length of cable. Determine the length of cable required by taking into consideration the permanent increase in length (permanent stretch) caused by proof-loading. If necessary, determine the degree of permanent stretch by experimentation before producing production parts.

Step 2. Cut the cable cleanly and squarely using an abrasive wheel or, in the case of smaller size cables, hand operated cutters.

Step 3. Degrease the brazing area of the terminal by solvent cleaning according to PPS 31.17. Do not handle surfaces to be brazed after they have been cleaned.

Step 4. Place **only** the portion of the cable where the terminal is to be fitted in a container (e.g., beaker) containing the solvent specified in PPS 31.17 (take **special** care to ensure that no other area of the cable is degreased).

Step 5. Place the container in the reservoir of an ultrasonic cleaner so that the level of the solvent in the container is just below the level of the water in the reservoir and then ultrasonic clean for a minimum of 10 minutes.

Step 6. Empty and replace the solvent in the container before ultrasonically cleaning for another 10 minutes.

Step 7. Wipe the cleaned portion of the cable with a lint free cotton cloth to remove excess solvent.

Step 8. Orient the cable so that cable lubricant will not seep into the cleaned area from the un-cleaned portion of the cable (i.e., for cable ends to be brazed to end terminals, point the cable end upwards; where a terminal is to be brazed along a cable assembly, orient the cable so that it lies horizontally). Take care to prevent any contamination of the cleaned area before brazing.

Step 9. Allow the solvent to flash off for at least 5 minutes.

Step 10. For terminals which are to be located at the ends of cable assemblies, insert the cable through the bore of the terminal and spread the cable wire ends uniformly around the countersink (see Figure 1). Do not handle cleaned surfaces to be brazed.

For terminals which are to be located along the cable assembly, drill a hole approximately 1/16" in diameter through the centre of one end to intersect the bore of the terminal at right angles (see Figure 1). After drilling, insert the cable through the bore and locate the terminal at the correct position on the cable. Do not handle cleaned surfaces to be brazed.

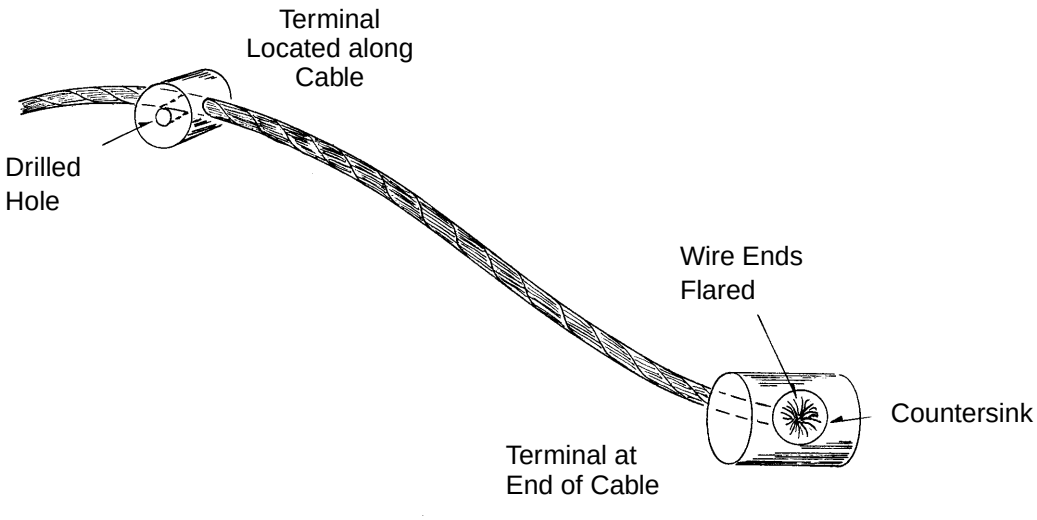

Figure 1 - Assembly of Terminals on Cable

Step 11. For terminals located at the end of a cable assembly, slide the terminal back on the cable and apply flux to the flared cable wire ends and approximately 1/8" of the cable. After applying flux, replace the terminal to the end of the cable and ensure that the flared wire ends are re-seated into the countersink and that the cable is square to the terminal.

For terminals which are to be located along a cable assembly, apply flux to the hole drilled in the end of the terminal.

5.2 Brazing

5.2.1 For terminals at cable ends, braze as follows:

Step 1. Install a brazing coil of suitable size to enclose the brazing crucible (see Figure 2).

Step 2. Position the brazing crucible on an adjustable table so that it is centred within the brazing coil and adjust the table height so that the brazing coil is located near the bottom of the crucible.

Step 1. Place a sufficient quantity of brazing alloy (see paragraph 4.1.2) into the crucible to fill it to operating level when the alloy is melted.

Step 2. Energize the brazing coil and adjust the power so as to completely melt the braze alloy in the crucible.

Step 3. Once the brazing alloy has completely melted, reduce the power setting to a level sufficient to maintain the alloy as liquid without excessive boiling or bubbling.

Step 4. Holding the cable and terminal square to the surface of the liquid brazing alloy, immerse approximately 1/16" of the terminal into the liquid as shown Figure 3-A. Note the depression of the liquid around the terminal.

Step 5. Hold the cable and terminal until the liquid previously depressed around the terminal reverses and tends to flow up the sides of the terminal and a small amount of braze (not more than 3/32") is observed on the cable above the terminal (see Figure 3-B). As soon as braze is observed on the cable, remove the terminal from the liquid alloy.

Step 6. Allow the terminal to cool to room temperature undisturbed. Do not force cool.

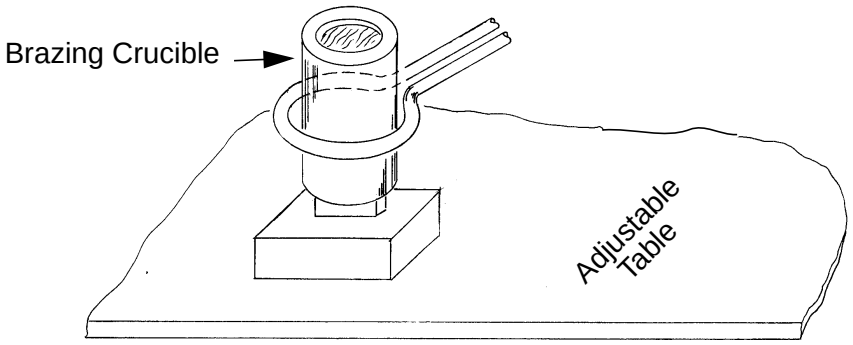

Figure 2 - Set-Up of Brazing Crucible

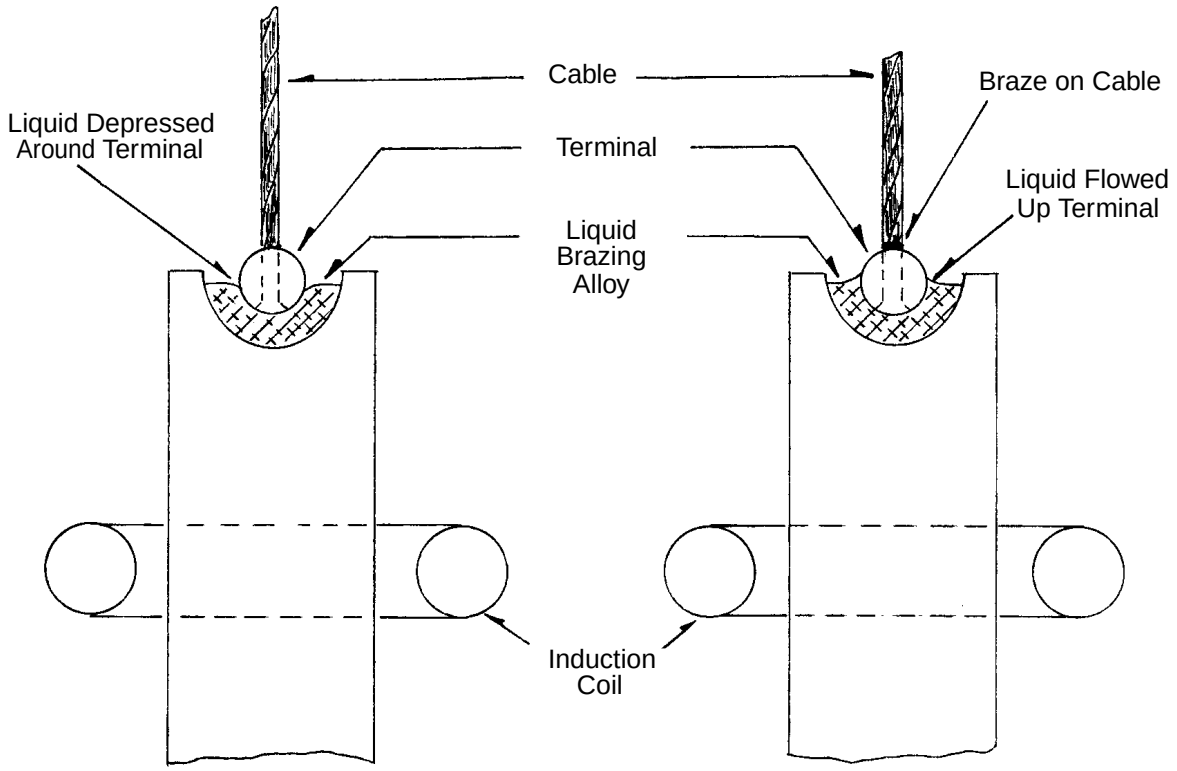

Fig. 3-A

Fig. 3-B

Figure 3 - Dip Brazing of Terminals on Cable Ends

5.2.2 For terminals located along cable assemblies, braze as follows:

Step 1. Install a brazing coil of suitable size to enclose the heating block on the induction brazing unit (see Figure 4).

Step 2. Position the heating block on an adjustable table so that it is centred within the brazing coil and adjust the table height so that the brazing coil is located near the bottom of the block.

Step 3. With the terminal located correctly on the cable assembly, insert the terminal into the recess in the top of the heating block with the drilled end of the terminal facing up.

Step 4. Energize the brazing coil and adjust the power as required to heat the terminal block sufficiently to effect brazing of the terminal.

Step 5. Apply brazing alloy (see paragraph 4.1.2) to the drilled hole in the end of the terminal until braze is observed on the cable (not more than 3/32"). It is not necessary that the drilled hole remain filled with braze alloy. As soon as braze is observed on the cable, remove the terminal and cable from the heating block.

Step 6. Allow the brazed terminal to cool to room temperature undisturbed. Do not force cool.

Step 7. De-energize the brazing coil.

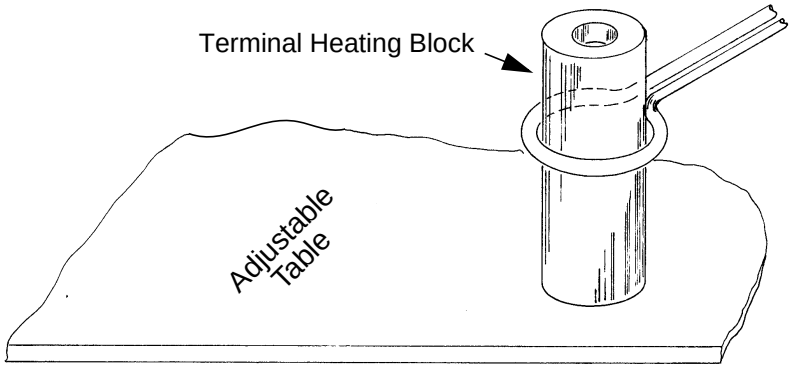

Figure 4 - Set-Up of Induction Brazing Unit

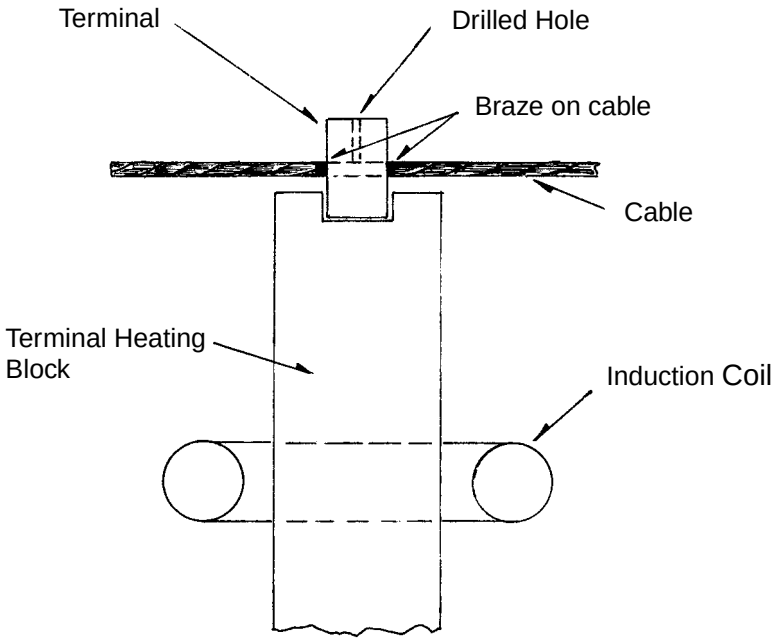

Figure 5 - Brazing of Terminals Along Cable

5.3 Post-Brazing Procedure

5.3.1 After brazing, process cable assemblies as follows:

Step 1. Immerse the brazed portion of the cable assembly only (approximately 3" beyond the terminal) in clean boiling water and thoroughly scrub with a stiff bristle brush. Allow the brazed portion of the cable assembly to boil for at least 15 minutes.

Step 2. Remove any remaining flux by carefully scrubbing with a stainless steel wire brush.

Step 3. Remove all excess braze alloy from the surface of the terminal.

Step 4. For corrosion resistant steel cable, work protective oil treatment (see paragraph 4.1.4) well into the cable interstices in the cleaned portion of the cable overlapping the un-cleaned portion of the cable by approximately 3". Remove excess fluid from the cable and the terminal by wiping with a clean cloth.

Protect non-jacketed carbon steel cables by applying F13, Grade 2, soft film, corrosion preventative compound over the entire length of the cable according to PPS 16.01.

Step 5. Identify the completed cable assembly according to PPS 15.01.

6 Requirements

6.1 For every batch of production cables, prepare 2 test samples along with the batch for testing as follow:

Step 1. For each test sample, braze a terminal onto one end of an 18" long steel cable. The cable and the terminals used in the preparation of test samples shall be representative of current production.

Step 2. If representative of current production, braze another terminal approximately midway on each test sample.

Step 3. For each test sample, swage a suitable ball terminal onto the other end of the cable assembly according to PPS 3.04.

Step 4. Proof load both test samples according to PPS 3.05 to the proof load value applicable to the production part that the samples represent. There shall be no slippage or breakage of the cable on proof loading.

Step 5. Tensile test one cable assembly to destruction to determine the breaking load. Tensile test cable assemblies with brazed terminals located midway on the sample in the same manner as cable assemblies which do not have brazed terminals located midway on the sample. Refer to PPS 3.05 for the minimum required breaking load.

Step 6. Section the brazed end terminal of the remaining test sample longitudinally through the centre. If terminals were brazed midway on the assemblies, section these terminals along with the end terminal.

Step 7. Polish one face of each cross section for microscopic examination. Microscopic examination shall show a minimum of 97.5% braze material flow on **each** side of the sample in the area of the fitting/cable interface (see Figure 6). Voids in the centre area of the cable are acceptable provided they do not extend into the terminal/cable interface.

Step 8. If any of the test requirements are not met, refer the represented production parts to Bombardier Toronto (de Havilland) MRB or Bombardier Toronto (de Havilland) delegated MRB for disposition. In the case of failure, determine and correct the cause before any further brazing of production cable assemblies.

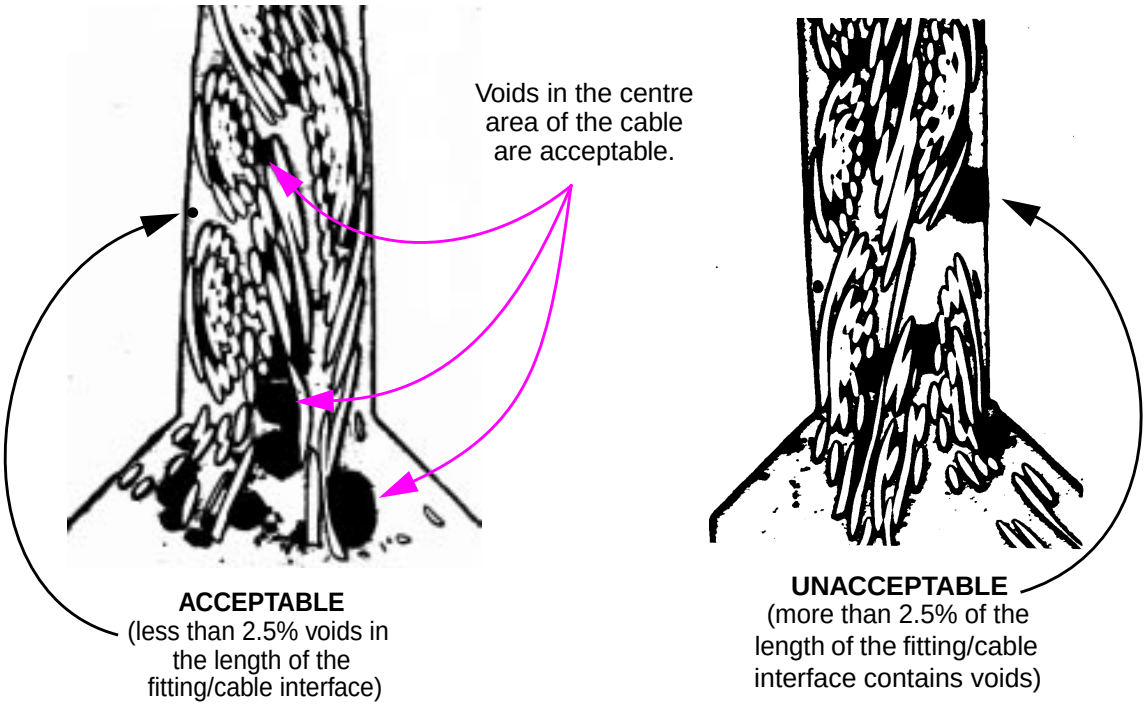

Figure 6 - Sectioned Metallographic Test Samples

6.2 Proof load all completed cable assemblies according to PPS 3.05. Refer to the engineering drawing for the required proof load. If the engineering drawing does not specify a proof load, refer to PPS 3.05. Proof load cable assemblies with terminals located between end terminals in the same manner as cable assemblies which do not have terminals located between end terminals.

6.3 Cable assemblies for which any of the following requirements are not met are not acceptable:

- Cables and terminals shall meet drawing specifications.
- For brazed end terminals, the wire strands of the cable shall finish flush with the diameter of the terminal and be spread towards the outer edge of the countersink.
- The space between the wires in the countersink of end terminals shall be completely filled with braze and be free of blowholes, oxides or other impurities or defects.
- For terminals located along the cable, a continuous fillet of solder shall show at each side of the terminal.
- Brazed joints shall show no evidence of partially fused beads of braze alloy.
- Braze alloy must be visible beyond the terminal but shall not have flowed more than 3/32" down the cable beyond the terminal.
- The surface of the terminal shall be free of excess braze alloy.
- The cable shall be free of kinks and the spiral pattern of the wire shall be uniform over the entire length with no looseness or looping of individual wires or strands.
- The length of the cable assembly shall be checked after it has been proof load tested according to paragraph 6.2 and shall conform to the drawing dimension and the tolerances specified in PPS 3.05.

7 Safety Precautions

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

7.2 Refer to PPS 31.17 for safety precaution relating to solvents.

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 Transportation/Storage

9.1 When transporting or storing partially or fully complete cable assemblies, roll each cable assembly into a coil. Refer to Table 1 for the minimum acceptable coil diameter

9.2 For transportation purposes, enclose cable assemblies in suitable containers, such as boxes or bags, so that they remain coiled and protected from abrasion and contamination.

9.3 If the protective coating has been damaged or removed during handling or installation, touch up immediately with the original protective compound.

Table 1 - Coil Diameters for Cables

CABLE DIAMETER	MINIMUM ACCEPTABLE COIL DIAMETER
3/32" or less	8"
1/8"	10"
5/32" through 5/16"	12"