DE HAVILLAND AIRCRAFT OF CANADA LIMITED

PROPRIETARY INFORMATION

PPS 9.35

PRODUCTION PROCESS STANDARD

TERMINATING AND SPLICING ALUMINUM WIRES

Issue 18
- This standard supersedes PPS 9.35, Issue 17.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS 9.35 related questions to christie.chung@dehavilland.com.
- This PPS is effective as of the distribution date.

Prepared By: (Christie Chung) May 7, 2020

PPS Group

Approved By: (Stephen Mabee) May 11, 2020

M&P Engineering

Issue 18 – Summary of Changes (over the previous issue)

The following summaries are not detailed and are intended only to assist in alerting PPS users to changes which may affect them. Refer to the applicable sections of this PPS for detailed procedure and requirements.

- Replaced throughout PPS where “Bombardier” is specified with “De Havilland Aircraft of Canada Limited” or “DHC”.
- Replaced procedure and requirements for qualification of crimp tools by referring to PPS 9.55 (Qualification of Crimp Tools) for such requirements.
- Specified all testing specified herein shall be performed by DHC Materials laboratory or a BAERD GEN-018 Rev. E approved laboratory.
- Specified requirements for Arvan Inc. HS20-5435-xx terminal lugs which are interchangeable with MS25435-xx terminal lugs.
- Specified that there shall be no burrs on lug edges when performing the visual check on crimped MS and Arvan terminals.

Table of Contents

Sections **Page**

Tables

Table of Contents

1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for terminating and splicing No. 8 through No. 2/0 aluminum wire using standard MS or Arvan terminal lugs and Tyco (AMP) Copalum terminal lugs and splices.

1.2 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS shall 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.

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

2 Hazardous Materials

2.1 Before receipt at De Havilland Aircraft of Canada Limited (DHC), all materials shall be approved and assigned Material Safety Data Sheet (MSDS) numbers by the DHC 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 DHC Environment, Health and Safety Department.

3 References

3.1 BAERD GEN-018, Rev. E – Engineering Requirements for Laboratories.

3.2 PPS 9.24 - Wire and Cable Stripping

3.3 PPS 9.55 – Qualification of Crimp Tools

3.4 PPS 10.16 - Installation of Heat Shrinkable Tubing, Tape and Identification Sleeves

3.5 PPS 13.26 - General Subcontractor Provisions

3.6 PPS 13.39 - Bombardier Toronto Engineering Process Manual

4 Materials, Equipment and Facilities

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 Aluminum wire cable as specified on the engineering drawing or wiring list.

4.1.3 Military standard (MS) aluminum terminal lugs as specified on the engineering drawing or wiring list. Refer to Figure 1 for a general description of MS type terminal lugs.

4.1.3.1 MS25435-(*) terminal lugs are interchangeable with Arvan Inc. HS20-5435-(*) terminal lugs. Only the same dash numbers are interchangeable (i.e., MS25435-***1*** is interchangeable with HS20-5435-***1***, etc.).

4.1.4 Tyco (AMP) Copalum terminal lugs and splices as specified on the engineering drawing or wiring list. Refer to Figure 2 for a general description of Copalum terminal lugs and splices.

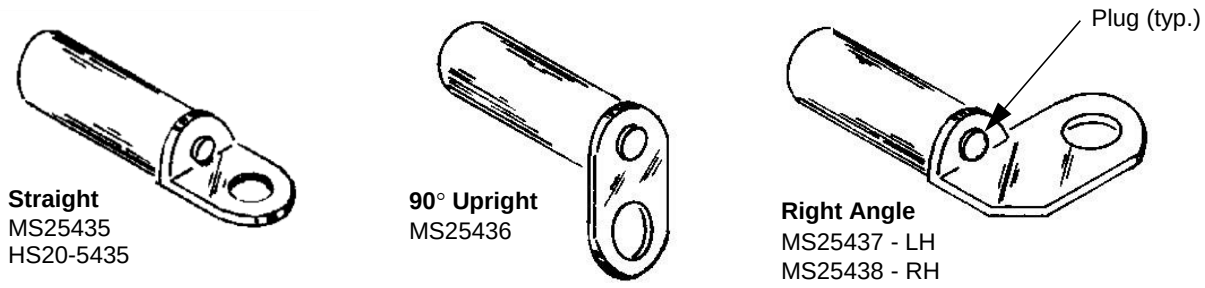


Figure 1. General Description of MS and HS Terminal Lugs

Figure 2. General Description of Tyco (AMP) Terminals Lugs and Butt Splices

4.2 Equipment

4.2.1 Cutting tool for heavy gauge wires. See below for examples of acceptable tools:

- Daniels PH 2004 wire cutting system (complete with PHWC wire cutter and PHRPU3 remote power unit)
- Klein 63060
- Ideal 35-052

4.2.2 SD2991 cable end rounding block.

4.2.3 Hand operated wire stripping tool (e.g., Ideal Industries #45-164).

4.2.4 Crimping tools for MS and Arvan HS20-5435 terminal lugs as listed in Table 1.

4.2.5 Crimping tools for Tyco (AMP) Copalum terminal lugs and splices as listed in Table 2.

4.2.6 Stainless steel wire brush, (e.g., Gordon Brush No. 15).

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 terminating and splicing aluminum wires according to this PPS.

4.3.2 Subcontractors shall direct requests for approval to DHC Quality.

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 shall 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 shall be detailed in the facility report. Based upon the facility report, DHC Engineering may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification shall be prepared to demonstrate their capability. Once approved, no changes to subcontractor facilities may be made without prior written approval from DHC Quality.

4.3.3.1 For approval of subcontractor facilities to perform terminating and splicing aluminum wires according to this PPS, completion of a test program and submission of suitable test samples representative of production parts is required. Test samples shall meet the requirements specified in section 6.

4.3.3.2 All testing and evaluation specified herein shall only be performed by DHC Materials Laboratory or by laboratories accredited according to BAERD GEN-018 Rev E.

5 Procedure

5.1 General

5.1.1 Handle aluminum wire cables carefully during all stages of assembly to prevent breakage of the wire strands. Avoid excessive bending of the cable as this cold works the wire strands, making them more fragile and subject to breakage.

5.1.2 Copalum terminal lugs and splices are fitted with a perforated insert in the wire barrel which effectively shears the aluminum oxide coating on the wire strands during the crimping process to make a good electrical contact.

5.1.3 Both MS and Arvan terminal lugs are partly filled with a petroleum based abrasive compound which helps break down the oxide coating on the aluminum wire strands during crimping to make a good electrical contact. Do not remove the plastic plug or any of the abrasive compound from MS or Arvan terminals before crimping.

5.1.4 Crimping tools/dies shall be qualified according to PPS 9.55 before use on Production parts. For additional details regarding tool operation, refer to the manufacturers' instructions.

5.2 Cutting Aluminum Wire Cables

5.2.1 Cut aluminum wires to the length specified on the engineering drawings using a heavy gauge wire cutting tool as specified in para. 4.2.1.

5.2.2 After cutting, ensure that the cable end is square to the cable axis and that the end is round in profile (see Figure 3). Make eccentric ends round by squeezing them in an SD 2991 rounding block.

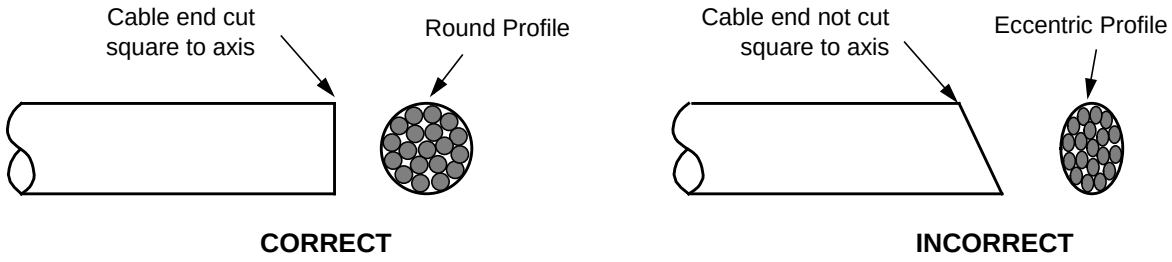


Figure 3. Appearance of Cut Cables

5.3 Stripping Wire Insulation

5.3.1 Taking extreme care to avoid nicking or cutting any wire strands, strip the wire insulation from the bare conductor as specified in PPS 9.24. Refer to Table 1 or Table 2 for the length of insulation to be removed for installation of MS and Arvan terminal lugs or Copalum terminal lugs and splices, respectively.

5.3.2 For termination in Copalum terminals, strip back the outer 2 layers of braided insulation to the length specified in Table 2 as follows:

Step 1. Use a stripping tool (ref. para. 4.2.3) or knife to carefully make a circumferential cut around the wire at the specified strip length. Take care to only cut through the braided insulation without cutting the inner plastic insulation.

Step 2. Slide the braided insulation off the end of the wire.

Step 3. Trim any frayed or ragged edges from the wire insulation.

5.3.3 Crimp the lug or splice to the aluminum wire within 24 hours of stripping the wire insulation. If more than 24 hours elapses between stripping and crimping, clean the exposed wire strands with aluminum wool immediately before crimping.

5.4 Crimping Terminal Lugs

5.4.1 Visually check all crimp die sets before use and clean as necessary to remove dirt, oil, residue, or build-up on the die closure faces and die certification recess. Ensure that the pressure source is shut off or disconnected from the power crimping tool before cleaning. A small stainless steel wire brush (ref. para. 4.2.6) may be used to remove die

pick-up from die faces. A sharp pointed knife or scrubber is recommended for removing die pick-up from the die certification recess.

5.4.2 Crimp MS and Arvan terminal lugs as follows:

Step 1. Ensure that the pressure source is shut off or disconnected from the power crimping tool before installing or removing dies.

Step 2. Install the correct die set, as specified in Table 1, in the crimping tool.

Step 3. Slide the heat shrinkable sleeve, as specified in Table 3, onto the cable.

Step 4. Insert the stripped wire end into the terminal lug until the wire bottoms against the end of the barrel.

Step 5. Wipe off any excess compound which has squeezed out of the terminal barrel.

Step 6. Place the wire/terminal assembly into the movable (lower) die and centre the terminal barrel in the die nest (see Figure 4).

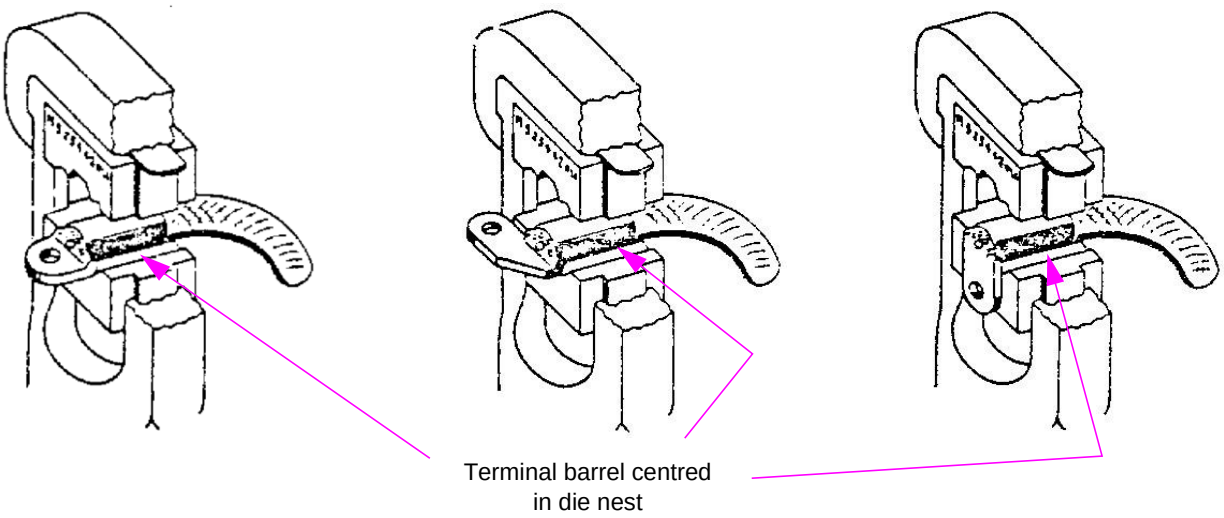


Figure 4. Positioning Arvan, MS25435 - MS25438 Terminals in Crimping Tool

Step 7. Turn on or connect the pressure source.

Step 8. Depress the actuating button on the control handle to close the dies and crimp the assembly. Do not release the button until the dies open automatically upon completion of the crimp cycle.

Step 9. Turn off or disconnect the pressure source and remove the crimped assembly.

Table 1. Stripping and Crimping Data for Arvan and MS Terminal Lugs

Terminal Lug		Wire Size	Strip Length ± 1/32" (Note 1)	Crimping Tools (Note 2)	
Type	Dash Number			Die Set	Crimp Head
MS25435 MS25436 MS25437 MS25438 HS20-5435	-1, -2, -3 & -4	8	11/16"	MS 25442-8A	MS 25441-1 (12 Ton Head)
	-5, -6, -7 & -8	6	13/16"	MS 25442-6A	
	-9, -10, -11 & -12	4	27/32"	MS 25442-4A	
	-13, -14, -15 & -16	2	1 1/32"	MS 25442-2A	
	-17, -18, -19 & -20	1	1 1/32"	MS 25442-1A	
	-21, -22, -23 & -24	1/0	1 3/32"	MS 25442-01A	
	-25, -26 & -27	2/0	1 7/32"	MS 25442-02A	

Note 1. No nicked or broken wire strands allowed.

Note 2. If the engineering drawing or wiring list does not specify a particular class for a MS terminal lug, install either a Class 1 or a Class 2 lug. Crimp Class 1 lugs using the tooling specified in this table; crimp Class 2 lugs using the lug manufacturer's instructions and crimp tool/dies.

5.4.3 Crimp Tyco (AMP) Copalum terminal lugs and butt splices as follows:

Step 1. Ensure that the hydraulic power unit is turned **off**.

Step 2. Remove the latch pin from the crimp head and open the yoke.

Step 3. If necessary, install the correct die set, as specified in Table 2, in the crimping tool. The shanks on the moving and stationary dies are offset and there are alignment dots on the front surfaces of the dies; ensure that the shanks of the dies are offset to the same surface and the dots are aligned to face the operator. Do not mix components from different die sets.

Step 4. Use a dry, lint-free cloth to wipe any accumulation of grease or dirt from the crimping head, especially near the dies.

Step 5. As needed, use a dry, lint-free cloth to apply a small amount of silicon grease to the stationary die. Wipe off any excess grease from the die.

Step 6. Slide the heat shrinkable sleeve specified in Table 3 onto the cable.

Step 7. Insert the stripped wire end into the terminal barrel or butt splice until the wire bottoms against the end of the barrel or splice. In order to prevent wire strands from fouling, ensure that the wire end is round and the strands are tight against

the natural lay of the cable before inserting. If necessary, use a fine cut file in order to facilitate insertion into the terminal barrel. Do not turn or twist the wire or terminal/splice during insertion.

Step 8. For crimping terminal lugs, locate the terminal lug in the stationary die so that the back of the tongue is against the stationary die and end of the tongue butts up against the stopper (see Figure 5). The stopper has a spring which allows it to move back when the terminal expands during crimping. Ensure that the stopper is not tightened and is able to move.

Step 9. Close the yoke and insert the latch pin.

Step 10. Turn **on** the hydraulic power unit.

Step 11. If using the 58422-1 crimping head, use the foot pedal to slowly advance the moving die until the terminal or splice is secure between both dies.

Step 12. Ensure that the wire is fully pushed into the terminal barrel or splice and the terminal or splice is correctly located.

Step 13. Depress the foot pedal or actuator button to close the dies and crimp the assembly.

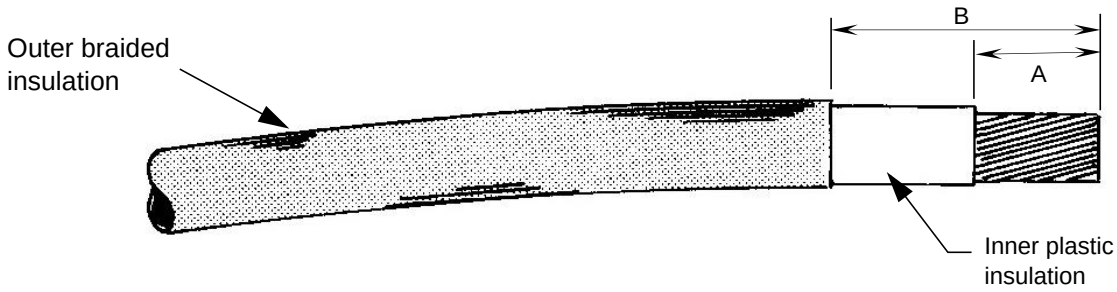
Step 14. On completion of the crimp cycle, release the foot pedal or actuator button.

Step 15. Turn **off** the hydraulic power unit, open the yoke, and remove the crimped assembly. If the crimped terminal or splice sticks to the upper die, rock the terminal or splice up and down to release it.

Step 16. To crimp the other half of a splice, follow the same procedure used to crimp the first half of the splice.

Table 2. Stripping and Crimping Data for Copalum Terminal Lugs and Splices

Wire Size	Copalum Part No.		Strip Length ± 1/32" (Note 1 & Note 2)		Crimping Tools (Note 3)	
	Terminal Lug	Butt Splice	Dimension "A"	Dimension "B"	Tyco (AMP) Die Set	Crimp Head
8	277147-X	277156-1	7/16"	7/8"	Tyco (AMP) 68006	Tyco (AMP) 69066 (Note 4) --- or --- Tyco (AMP) 58422-1 (Note 5) --- or --- Tyco (AMP) 1752877-1 (Note 4)
6	277148-X	277157-1	1/2"	7/8"	Tyco (AMP) 68007	
4	277149-X or 1958119-1	277158-1	11/16"	1"	Tyco (AMP) 68008	
2	277150-X	277159-1	3/4"	1 1/4"	Tyco (AMP) 68009	
1/0	277151-X	277160-1	1"	1 9/32"	Tyco (AMP) 68010 or 68010-2	
2/0	277152-X or 1958038-1	277161-1	1"	1 3/8"	Tyco (AMP) 68011-1 or 314964-1 (Note 4 & Note 5)	



Note 1. For wires having **braided** outer insulation, strip back the braid to Dim "B" as shown above.

Note 2. No nicked or broken wire strands are allowed.

Note 3. Operate the crimp heads specified in this Table using a Tyco (AMP) hydraulic power unit (e.g., 1804700-1) or hand operated hydraulic pump (e.g., 314979-1).

Note 4. The Tyco (AMP) 69066 and 1752877-1 crimp heads cannot be used with the Tyco (AMP) 68011-1 die set. Use the Tyco (AMP) 58422-1 crimp head with the 68011-1 die set.

Note 5. The Tyco (AMP) 58422-1 crimp head cannot be used with the Tyco (AMP) 314964-1 die set. Use the Tyco (AMP) 69066 or 1752877-1 crimp heads with the 314964-1 die set.

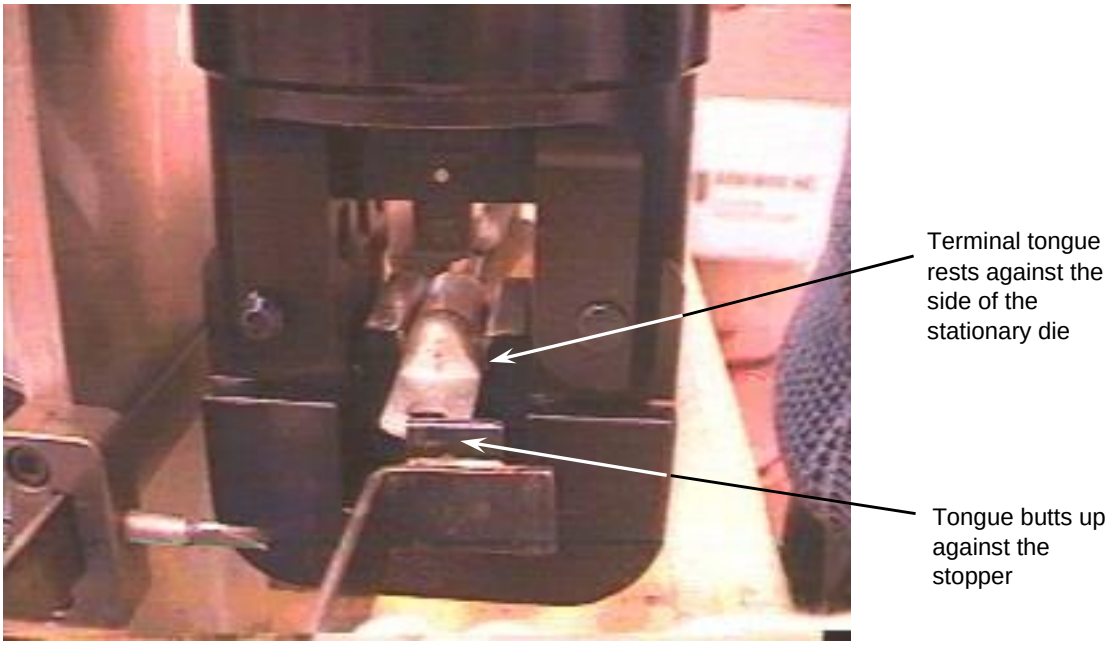


Figure 5. Positioning of Copalum Terminal Lug in Crimping Tool

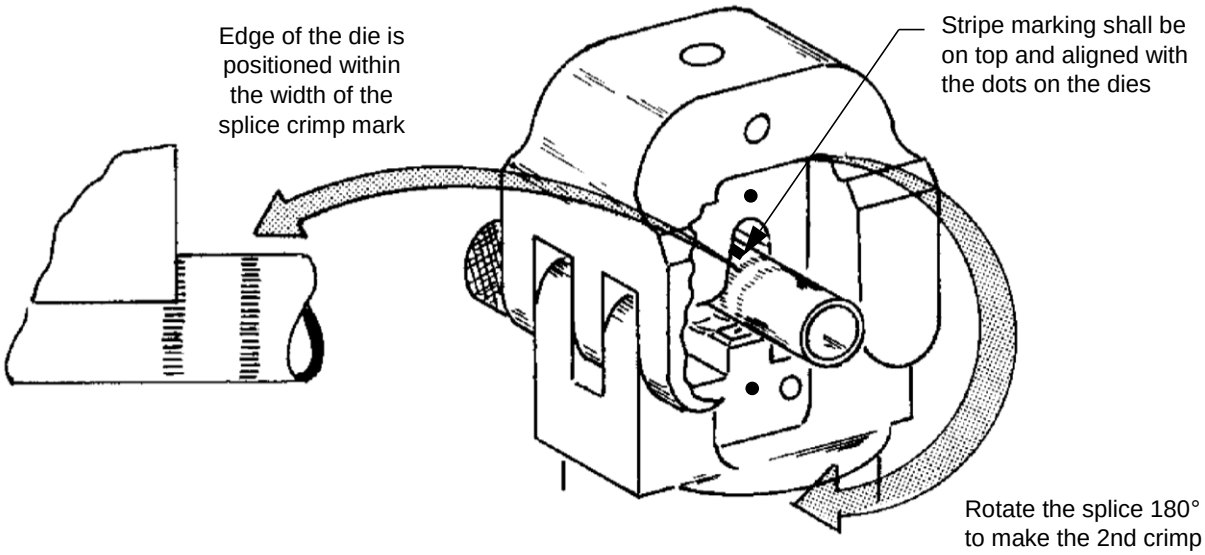


Figure 6. Positioning of Butt Splice in Crimping Tool

5.5 Insulating Crimped Terminals

5.5.1 After crimping and visual check according to section 6, insulate all terminals and butt splices using the white heat shrinkable sleeve specified in Table 3.

5.5.2 Locate insulating sleeves on terminal lugs so as to cover the terminal barrel without interfering with the tongue of the lug (see Figure 7).

5.5.3 Centrally locate insulating sleeves on butt splices so the sleeve overlaps approximately equally onto the wire insulation at each end.

5.5.4 Install heat shrinkable sleeves according to PPS 10.16.

Table 3. Heat Shrinkable Insulating Sleeves

Wire Size	SAE AMS-DTL-23053/5 Heat Shrinkable Sleeve	Original I.D. (Note 1)	Sleeve Length
8	M23053/5-107-9	0.375	For terminal lugs, sleeves shall be approximately twice the length of the terminal barrel. - - - For butt splices, use sleeves approximately twice the overall length of the splice.
6	M23053/5-108-9	0.500	
4			
2	M23053/5-109-9	0.750	
1			
1/0			
2/0	M23053/5-110-9	1.000	

Note 1. The final (shrunk) I.D. of the above sleeves will be approximately 1/2 of the original diameter

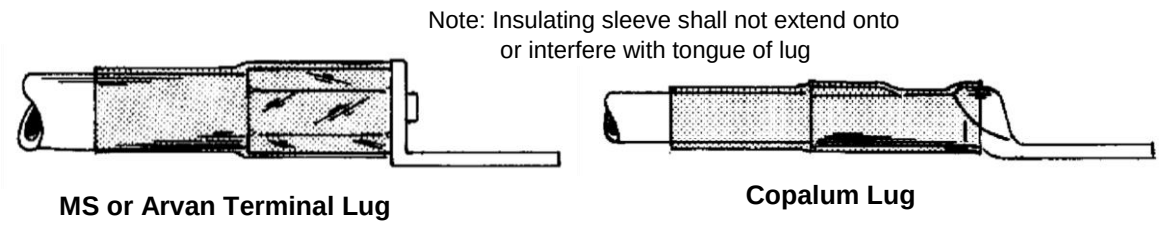


Figure 7. Application of Insulating Sleeves on Terminal Lugs

6 Requirements

6.1 General

6.1.1 Cables with nicked or cut wire strands are unacceptable.

6.1.2 The wire insulation shall be clean cut with no frayed or ragged edges.

6.1.3 A portion of the insulation shall extend under the terminal or splice.

6.2 Visual and Dimensional Requirements for Crimped Terminal Lugs

6.2.1 Crimped MS and Arvan terminals shall meet the following requirements (see Figure 8):

- The crimp shall be uniform and clearly defined over length of barrel.
- There shall be no burrs on lug edges.
- The terminal barrel shall not be cracked.
- The correct wire size shall be imprinted on the barrel.

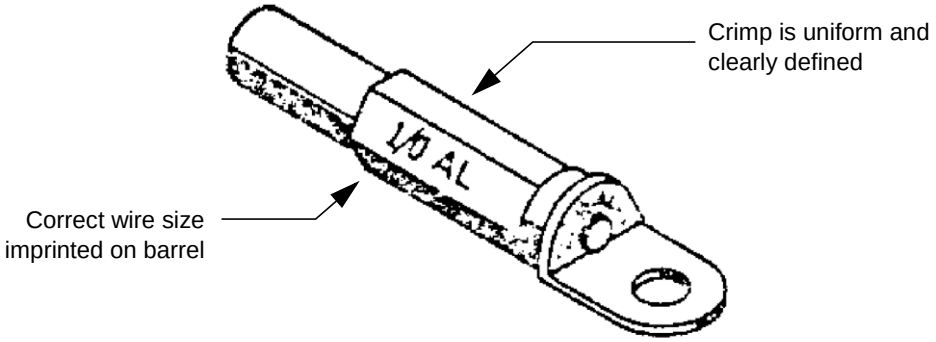


Figure 8. Arvan and MS25435 - MS25438 Terminal Lugs

6.2.2 Crimped Tyco (AMP) Copalum terminal lugs shall meet the following requirements (see Figure 9):

- The crimp certification mark shall be located in the centre of the crimp relief area and shall be clearly defined, so that the dimple on top of the mark is reproduced.
- The terminal barrel shall not be cracked.
- The correct wire size shall be stamped on the tongue of the terminal.
- The distance between the heel of the terminal and the beginning of the crimp marking (as shown in Figure 10) shall not be greater than 1/8"
- The crimped terminal shall be within the degree of straightness specified in Figure 11.
- The wire barrel flash that results from the crimping process shall not exceed the limit shown in Figure 12.

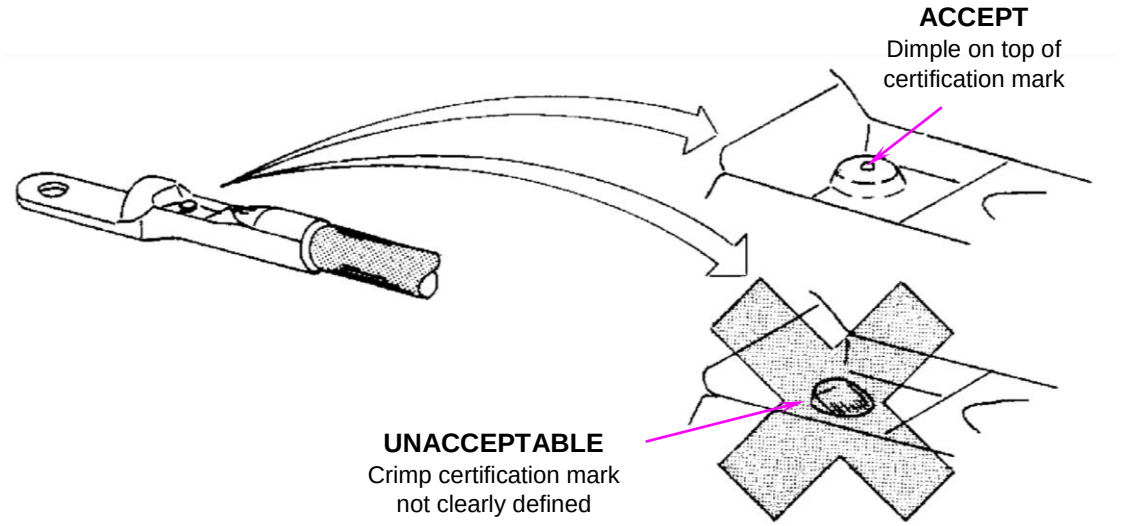


Figure 9. Copalum Terminal Lugs - Crimp Certification Mark

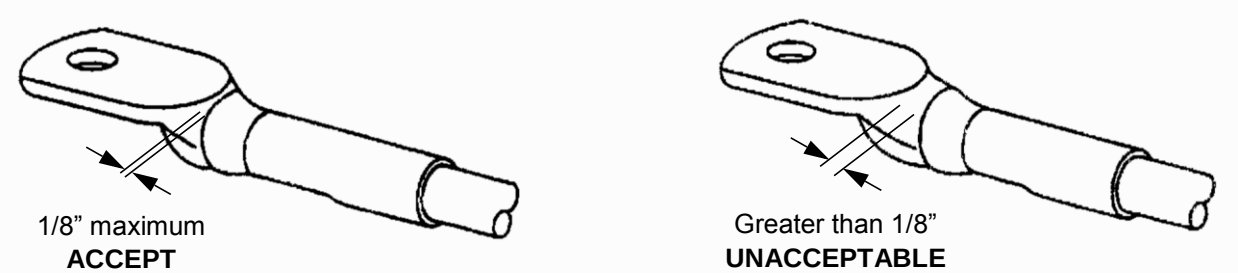


Figure 10. Copalum Terminal Lugs - Crimp Location

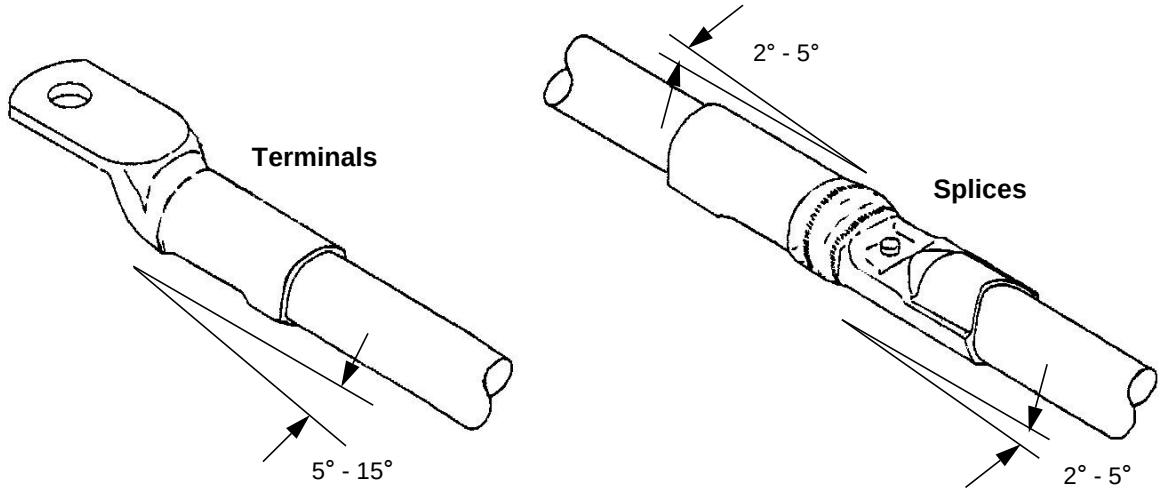


Figure 11. Copalum Terminal Lugs and Splices - Degree of Straightness

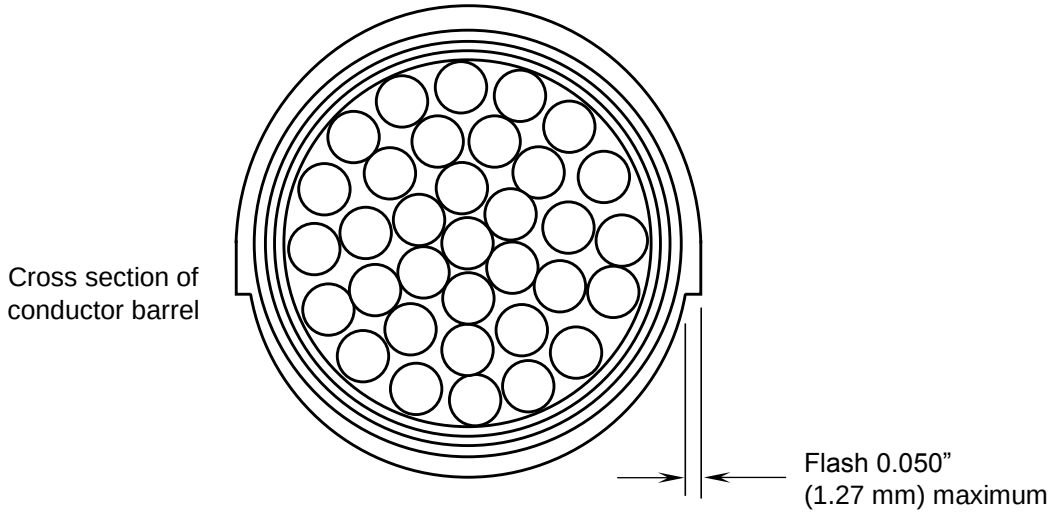


Figure 12. Copalum Terminal Lugs and Splices - Wire Barrel Flash

6.2.3 Crimped Copalum butt splices shall meet the following requirements (see Figure 13):

- The crimp certification mark shall be located in the centre of the crimp relief area and shall be clearly defined, so that the dimple on top of the mark is reproduced.
- The mark-off from the stationary die face shall be located within the width of the splice crimp mark.
- The first and second crimps shall be offset by 180°.
- The splice barrel shall not be cracked.
- The correct wire size shall be stamped on the barrel of the splice.
- The crimped splice shall be within the degree of straightness specified in Figure 11.
- The wire barrel flash that results from the crimping process shall not exceed the limit shown in Figure 12.

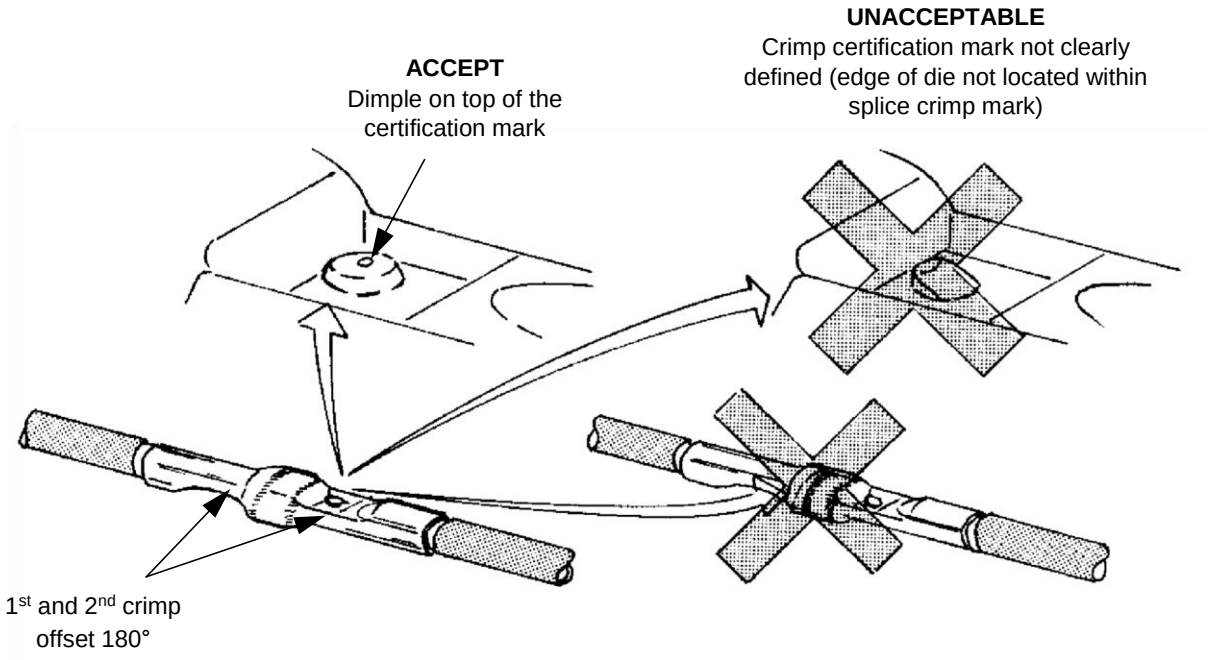


Figure 13. Copalum Butt Splice

6.3 Insulating Sleeves

6.3.1 After visual check according to section 6.2, as applicable, all terminals and butt splices shall be insulated with a heat shrinkable sleeve according to section 5.5. Insulating sleeves on terminal lugs shall completely cover the terminal barrel without interfering with the lug. Insulating sleeves on butt splices shall completely cover the splice and overlap approximately equally onto the wire at each end.

7 Safety Precautions

7.1 The safety precautions specified herein are specific to DHC 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 standard plant safety precautions when performing the procedure specified herein.

7.3 Crimping equipment shall only be operated by employees that are trained (ref. section 8) and authorized.

7.4 For all crimping tools, if a malfunction occurs do not operate the equipment and contact management immediately.

7.5 For all crimp tools, if the die set or crimp head cannot be securely locked in place do not operate the equipment and contact management immediately.

7.6 For hydraulic crimp tools, ensure that the hydraulic power unit is off at all times when tools are not in use and also when inserting or removing die sets or crimp head.

7.7 Do not operate crimp tools without the appropriate guards in place.

7.8 When crimping terminals to wires, take care to keep hands clear of dies before actuating crimping tools.

7.9 Ensure that the power source is shut off or disconnected from power crimp tools before removing or replacing dies.

8 Personnel Requirements

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

9 Maintenance of Equipment

9.1 Set up and operate power crimp tools according to the manufacturer’s instructions.