BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 9.32

PRODUCTION PROCESS STANDARD

Assembly and Installation of Aircraft Thermocouple Leads

Issue 7
- This standard supersedes PPS 9.32, Issue 6.
- Vertical lines in the left hand margin indicate changes over the previous issue.
- Direct PPS related questions to PPS.Group@aero.bombardier.com or (416) 375-4365.
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1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for assembling and installing aircraft thermocouple leads.

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. Similarly, the procedure and requirements specified in this PPS are not applicable when use of a BAPS, MPS, LES or P. Spec. is specified.

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 9.01 - Crimping Electrical Terminal Lugs to Copper Wire.

3.2 PPS 9.04 - Assembly and Installation of Aircraft Electrical and Electronic Wires and Cables.

3.3 PPS 9.22 - Assembly of Connectors

3.4 PPS 9.36 - Manual Crimping of Size 12-22 Electrical Contacts.

3.5 PPS 10.16 - Installation of Heat Shrinkable Tubing, Tape and Sleeves.

3.6 PPS 13.26 - General Subcontractor Provisions.

3.7 PPS 15.01 - Part Marking.

3.8 PPS 15.02 - Identification Coding of Electrical and Electronic Wires and Cables.

4 Materials and Equipment

4.1 Materials

4.1.1 Thermocouple leads and terminals as specified on the engineering drawing.

4.1.2 White Heat Shrinkable Tubing, bulk length, M23053/5 (Flexible Crosslinked Polyolefin).

4.1.3 Solder for silver soldering, H&H Braze #560 or Engelhard Silvaloy A-56T.

4.1.4 Flux for silver soldering, H&H Type B-1, 1200 Universal Flux or Engelhard Ultra Flux.

4.2 Equipment

4.2.1 Pyropen Soldering Kit (e.g., Weller WSTA-3).

5 Procedure

5.1 General

5.1.1 Thermocouple wires are paired in braided jackets and are colour coded as shown in Table 1, according to the material combination.

Table 1 - Thermocouple Wire Identification

MATERIAL COMBINATION	WIRE INSULATION COLOUR	POLARITY	OUTER JACKET		
			BASE COLOUR	WIRE TYPE	TRACER COLOUR
CHROMEL	WHITE	POSITIVE (+)	WHITE	II A	1 GREEN
				III A	2 GREEN
ALUMEL	GREEN	NEGATIVE (-)		IV A	3 GREEN
IRON	BLACK	POSITIVE (+)	LIGHT BLUE	II A	NONE
				II B	1 RED
CONSTANTIN	YELLOW	NEGATIVE (-)		III A	2 BLACK
				III B	2 RED
COPPER	RED	POSITIVE (+)	BLACK	A	1 WHITE
CONSTANTIN	YELLOW	NEGATIVE (-)		B	2 WHITE

5.1.2 Thermocouple leads consist of pairs of insulated wires of specific material combinations to provide accurate transmission of thermocouple EMF (electromotive force) to temperature indicating instruments.

5.2 Preparation of Thermocouple Leads

5.2.1 Cut the thermocouple leads to length as specified on the engineering drawing or wiring list.

5.2.2 Unless otherwise noted on the engineering drawing, strip the outer jacket from the thermocouple leads as specified in PPS 9.34 to expose approximately 4" of the braided insulation.

5.2.3 Except as noted in paragraph 5.2.4 or paragraph 5.2.5, serve all thermocouple leads to be terminated with crimp contacts as follows and as shown in Figure 1-A.

Step 1. Using a plier type stripping tool or a sharp knife, strip the braided insulation from the thermocouple leads to expose the inner insulation. Take care when stripping the braided insulation to avoid nicking or damaging the inner wire insulation.

Step 2. Slide a 1" length of white heat shrinkable sleeving (see Materials section, paragraph 4.1.2) onto the thermocouple jacket. Position the sleeve such that it overlaps approximately equally over the outer jacket and exposed inner insulation and shrink it in place using a hot air gun according to PPS 10.16.

Step 3. Strip the thermocouple leads to receive crimp contacts according to PPS 9.36.

5.2.4 If the outside diameter of the inner insulation is too large to fit into the connector cavity, prepare the thermocouple leads to be terminated with crimp contacts as follows and as shown in Figure 1-B.

Step 1. Using a plier type stripping tool or a sharp knife, strip the braided insulation from the thermocouple leads to expose the inner insulation.

Step 2. Using a plier type stripping tool or a sharp knife, strip the inner insulation from the thermocouple leads to expose approximately 2” of the bare wire. Take care when stripping the inner insulation to avoid nicking or damaging the bare wire.

Step 3. Fit a 2 1/4" length of white heat shrinkable insulating sleeve over the bare wire on each lead so that it slightly overlaps the inner insulation.

Step 4. Use a hot air gun to shrink the sleeving in place according to PPS 10.16.

Step 5. Slide a 1" length of white heat shrinkable sleeving (see Materials section, paragraph 4.1.2) onto the thermocouple jacket. Position the sleeve such that it overlaps approximately equally over the outer jacket and exposed inner insulation.

Step 6. Use a hot air gun to shrink the sleeving in place according to PPS 10.16.

Step 7. Prepare the wire to receive crimp contacts by trimming back the white heat shrinkable sleeving to expose the bare wire as specified in PPS 9.36.

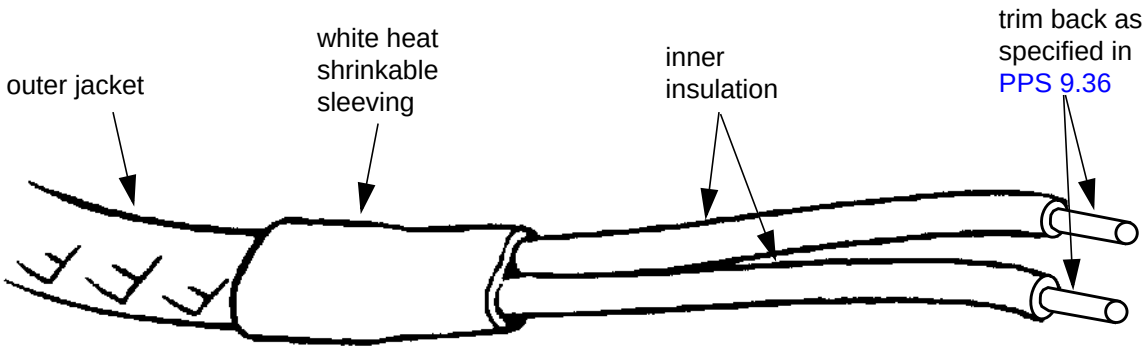

Figure 1-A

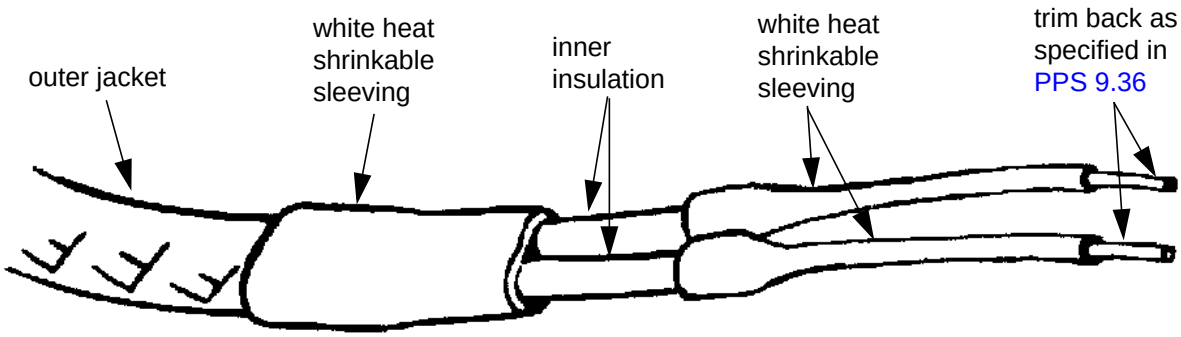

Figure 1-B

Figure 1 - Preparation of Thermocouple Leads for Crimp Contacts

5.2.5 Prepare all thermocouple leads which are to be terminated with solder terminals or with crimped contacts having a wire barrel size of 16 or larger as follows and as shown in Figure 2.

Step 1. Fit a length of white heat shrinkable sleeving (see Materials section, paragraph 4.1.2) over the braided insulation on each lead. Leave a space of approximately 1" between the heat shrinkable sleeving and the outer jacket.

Step 2. Use a hot air gun to shrink the sleeving in place according to PPS 10.16.

Step 3. Slide a 1" length of white heat shrinkable sleeving onto the outer jacket. Position the sleeve so that it overlaps approximately equally onto the outer jacket and served wires and so that the colour of the braided insulation is still visible.

Step 4. Use a hot air gun to shrink the sleeving in place according to PPS 10.16.

Step 5. Taking care to avoid nicking or damaging the bare wire, use a sharp knife to strip the white heat shrinkable sleeving, braided insulation and inner insulation from the end of each thermocouple wire and expose 1/4" - 5/16" of the bare wire.

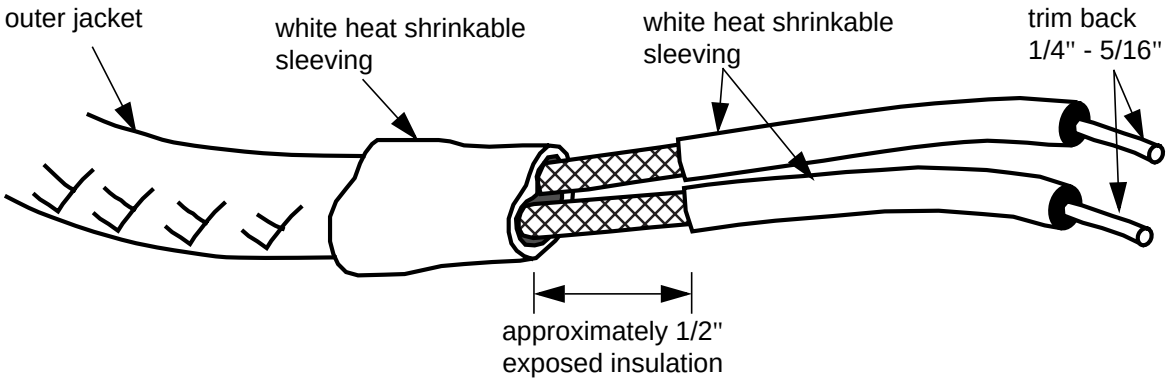

Figure 2 - Preparation of Thermocouple Leads for Solder Terminals or for Crimp Contacts having a Wire Barrel Size of 16 or Larger

5.3 Termination of Thermocouple Leads

5.3.1 Crimp Type Contacts

5.3.1.1 Crimp crimp type contacts onto thermocouple lead wires according to PPS 9.36.

5.3.1.2 Ensure that thermocouple lead contacts are of the same material as the lead wires.

5.3.1.3 Carry out the assembly of thermocouple contacts into connectors according to PPS 9.22.

5.3.2 Crimp Type Terminals

5.3.2.1 Crimp crimp type thermocouple lead terminals onto lead wires according to PPS 9.01.

5.3.3 Solder Type Terminals

5.3.3.1 Assemble solder type terminals to thermocouple lead wires as follows:

Step 1. Ensure that solder type terminals are of the same material as the lead wires.

Step 2. Position the solder type terminal so that the insulation grip lugs are flush with the end of the thermocouple lead insulating sleeve and the wire end is 0" - 1/16" past the wire grip lugs (see Figure 3)

Step 3. Using a suitable pair of pliers, fold the insulation grip lugs onto the insulating sleeve to securely grip the insulation and fold the wire grip lugs onto the wire to securely grip the wire.

Step 4. Solvent clean the area of the joint using the solvent specified in PPS 31.17 and a stiff bristle brush.

Step 5. Apply flux to the lead wire/wire grip joint.

Step 6. Using a suitable copper or aluminum heat sink, grip the terminal in an upright position by the insulation grip lugs.

Step 7. Use a propane torch (see Equipment section, paragraph 4.2.1) to solder the lead wire/wire grip joint. Take extreme care not to overheat the insulation or insulation sleeving. Only use sufficient solder to fill the lead wire/wire grip joint. Leave the outline of the wires visible. Ensure that solder does not extend into or fill the gap between the wire grip and the insulation grip (see Figure 4).

Step 8. Allow joint to cool before any further handling. Do not attempt to force cool by blowing or fanning the joint.

Step 9. After cooling, thoroughly solvent clean the joint as specified by PPS 31.17 to remove all traces of residual flux.

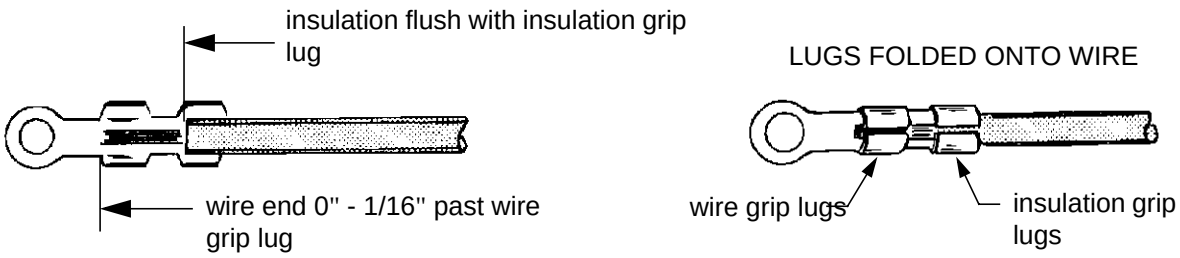

Figure 3 - Lead Wire Placement in Solder Type Terminals

CORRECT - solder just fills wire grip

INCORRECT - excess solder between lugs

Figure 4 - Soldering of Solder Type Terminals

5.4 Installation of Thermocouple Leads

5.4.1 Except as noted, install and route thermocouple leads according to PPS 9.04. Either evenly distribute excess slack in the thermocouple lead between supports or coil the lead at a support as shown in Figure 5. Do not bend thermocouple leads through a radius of less than 2".

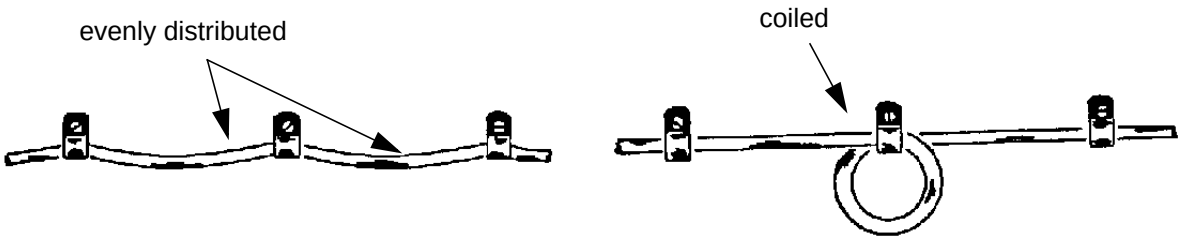

Figure 5 - Slack in Thermocouple Leads

5.4.2 Connect the thermocouple lead wires to the correct thermocouple studs. Take extreme care to ensure that the correct polarity is maintained at all connections in the thermocouple loop at all stages of the installation of thermocouple leads. Refer to Table 1 for a listing of the polarity of thermocouple wires.

5.4.3 Connect the thermocouple lead wires to the temperature indicators as follows:

- If the engineering drawing or wiring list specifies use of thermocouple loops including AN5534-2 trimming resistors, connect a suitable decade bridge across the thermocouple wires at the indicator end of the lead before connecting the thermocouple lead wires to the temperature indicators. Use an AN5534-2 resistor to adjust the resistance of the loop to provide a resistance of either 8.0 ± 0.05 ohms or 25.0 ± 0.10 ohms, as applicable to the temperature indicators.
- On all temperature indicators having stud connections, the positive (+) post is larger than the negative (-) post.
- On cannon type connectors, the positive lead is pin “A” and the negative lead is pin “B”.

5.5 Identification

5.5.1 Identification code thermocouple wires and leads according to PPS 15.02.

5.5.2 Part mark thermocouple assemblies according to PPS 15.01.

6 Requirements

6.1 Visually check completely installed thermocouple loops at the indicators and thermocouple lugs to ensure that the correct wire polarity has been maintained.

6.2 Visually examine crimp type terminations for compliance with the requirements of PPS 9.01 or PPS 9.36, as applicable.

6.3 Evidence of nicking or damage to the wire insulation at the point of removal of the braided jacket of the thermocouple wire assembly is not acceptable.

6.4 Insulating sleeves shall not show evidence of overheating caused by the shrinking process. Slight discolouration of the insulating sleeve in the area of the insulation grip on solder type terminations is acceptable.

6.5 Acceptable solder joints shall have a shiny surface, show a wetting action on all surfaces of the solder joint, a slightly concave fillet and a feather edge. Evidence of any of the defects specified in Table 2 is not acceptable.

Table 2 - Solder Defects

DEFECT	DESCRIPTION	USUAL CAUSE	REMEDIAL ACTION
cold solder	The solder usually appears dull and crystalline, but may be shiny and smooth. It appears stacked or piled-up.	1. Condition resulting from underheated or disturbed joint (during cooling). 2. Improper solder flow and wetting action.	1. Increase heat or dwell time. 2. Do not handle during cooling cycle.
disturbed solder	The solder has a dull, porous and crystalline appearing surface. It may also, under magnification, reveal cracks or fractures.	1. Handling shock during cooling period. 2. Movement between lead and terminal during solder operation (spring back).	1. Allow solder to solidify before handling. 2. Assure mechanical connection is tight before soldering. 3. Avoid exerting excessive pressure with soldering iron tip during solder operation.
fractured solder joint	A solder joint in which the solder has cracked or broken between the joint elements.	1. Mechanical stresses during cooling cycle. 2. Thermal stresses during cooling cycle.	1. Allow solder to solidify before handling. 2. Allow solder to solidify without forced cooling such as blowing or fanning.
excessive solder	Contour of lead is completely obscured. Solder overflow beyond confines of area being soldered.	1. Improper flow and wetting action. 2. Insufficient heat allowing solder to solidify too rapidly.	1. Improve method of applying heat, flux, or solder.
insufficient solder	The terminal or wire lead shows exposed base metal and the absence of a solder fillet between the terminal and conductor.	1. Improper flowing and wetting action. 2. Improper application of flux, solder and heat. 3. Insufficient solder applied to joint.	1. Improve method of applying heat, flux or solder. 2. Apply more solder.
insufficient solder fillet	Lack of a concave junction of solder at the interface of the terminal and lead.	1. Excessive heat application or dwell time. 2. Insufficient solder.	1. Improve soldering technique.
dewetting	Dewetting is distinguished from the remainder of the solder areas by appearing dull and depleted in contrast to the shiny, more thickly coated surrounding areas.	Condition produced when molten solder contacts the metal surface and recedes, leaving only a thin film of solder on it.	1. Reduce dwell time during heat application. 2. Assure parts and tools are clean before solder operation. 3. Increase amount of flux.
non-wetting	Non-wetting is distinguished from the surrounding areas of solder coated material by exhibiting its original, bare, uncoated base metal.	1. Improper flux, solder, or heat application. 2. Condition produced when molten solder contacts the metal surface but has none of the solder adhere to it.	1. Assure elements to be soldered are clean. 2. Improve method of applying flux, heat, and solder.
over heated solder	The solder has a chalky, dull or crystalline appearance and shows evidence of coarse grain porosity or pitting.	1. Excessive heat application or dwell time.	1. Reduce heat or dwell time.

Table 2 - Solder Defects

DEFECT	DESCRIPTION	USUAL CAUSE	REMEDIAL ACTION
pits	Small holes occurring as imperfections in the surface of the solder which do not penetrate entirely through the solder to the base metal.	1. Contaminates and dross on the soldering iron tip. 2. Flux and oxide contaminates on solder surface. 3. Too rapid cooling.	1. Assure tip is tinned properly. 2. Assure surfaces to be soldered are clean and all surface oxides are removed. 3. Do not force cool solder.
pin holes	Small holes occurring as imperfections which penetrate entirely through the solder to the base metal.	1. Contaminates and oxides on the surface to be soldered. 2. Failure of flux to clean surface. 3. Dirty or untinned solder tip.	1. Assure surfaces to be soldered are clean of all contaminates. 2. Increase amount of flux applied. 3. Keep tip clean and well tinned.
rosin or flux joint	A rosin joint has almost the same appearance as that of a cold solder joint. However, it shows evidence of rosin entrapped within the joint.	1. Condition results from an underheated solder joint. Flux not heated sufficiently to produce cleaning action. 2. Due to poor flow and wetting action, raw flux (underheated) is trapped within the joint and will seep out.	1. Assure joint elements are heated sufficiently to melt and flow the solder freely, (flux will activate just before solder flow).
solder projections	Solder projections (e.g. icicles, spikes, bridges, etc.) are undesirable protrusions from a solidified solder joint or coating.	1. Insufficient dwell time, solder elements not hot enough to flow solder properly. 2. Excessive solder application.	1. Assure surfaces to be soldered are hot enough 2. Apply less solder.

7 Safety Precautions

7.1 Hot air guns used for shrink fitting insulating sleeves develop temperatures of up to 500°F at the screen nozzle. Exercise caution during handling to avoid burns.

7.2 Take care to ensure personnel are not accidentally burned by hot soldering equipment or solder. Properly store soldering equipment when not in use not in use. When using the Weller cordless Pyropen, ensure that the work area is free of all combustible materials.

7.3 Always refill the Weller cordless Pyropen in a well ventilated area, under a fume hood if possible.

8 Personnel Requirements

8.1 Personnel responsible for assembling and installing aircraft thermocouple leads must have a good working knowledge of the procedure and requirements as specified herein and shall have exhibited their familiarity to their supervisor.