DE HAVILLAND AIRCRAFT OF CANADA LIMITED

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PPS 20.07 - ELECTRICAL CONDUCTIVITY TESTING OF ALUMINUM ALLOYS

Issue 11
- This standard supersedes PPS 20.07, Issue 10.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to christie.chung@dehavilland.com.
- This PPS is effective as of the distribution date.

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

Issue 11 - 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.

- Specified this is a jointly owned PPS by both De Havilland Aircraft of Canada Limited and Bombardier Inc.
- Added DHC NDT Responsible Level 3 to PPS signatory approval.
- Emphasized use of any other type of conductivity direct reading test instrument requires PSD approval (i.e., direct reading only).
- Deleted the statement “Test instruments must be certified according to the manufacturers instructions, by either the manufacturer or a suitable metrology organization, at least once every 6 months. In addition, conductivity test systems (including the certified test instrument, probe and a set of verified instrument conductivity standards) must be certified **as a system** at least once every 6 months according to section 5.2”.
- Defined room temperature during the certification process to be 68 ±5°F (20 ±3°C). Previous issue was 68 ±2°F (20 ±1°C).
- Restructured sections (i.e., Moved previous issue (Issue 10) section 5.2 (Certification of Conductivity Test System) content to section 4.1.4. (i.e., deleted specifying instructions on certification of test system before use on production parts). General statements are in current PPS.
- Specified laboratory conductivity standards must be re-certified at least once every 24 months in place of 12 months.
- Added two new sections (i.e., section 4.1.2 and section 4.1.3).
- Replaced “certification conductivity standards” with “laboratory conductivity standards” throughout.
- Specified laboratory conductivity standards must be certified by comparing eddy current measurement with primary conductivity standards.
- Specified instrument conductivity standards are similar to the laboratory conductivity standards with the exception that these standards must accompany a particular test instrument at all times.
- Deleted last step from paragraph 4.1.4.3, stating “Certify the test system utilizing the verified instrument conductivity standards according to section 5.2 before use on production parts” as section details have been deleted.
- When calibrating the test instrument, specified to allow a minimum of 5 minutes warm-up time after turning the power on in place of 20 minutes.
- Specified the maximum surface roughness of parts to be tested must be no more than 150 Ra in place of 165 RHR.
- Specified the minimum concave curvature on which an accurate reading can be taken is 20" in diameter (in place of 10” in radius). The minimum convex curvature on which an accurate reading can be taken is greater than 6" in diameter (in place of 6” radius). See paragraph 5.3.7.

Issue 11 - Summary of Changes (over the previous issue) con't

- Specified to ensure readings are not distorted from edge effect, the specimen area to which the eddy current instrument probe is applied must be at least as large as the outside diameter of the test probe or per manufacturer's specifications. This statement replaces, "To preclude edge effect, do not take readings with the edge of the probe closer than 1/4" to any edge or rib of the surface under test". See paragraph 5.3.8.
- Added the following:
  - If the clad raw material is thicker than 0.016", that requires conductivity testing was machined or chem milled from one side (i.e., aircraft skin) and must be inspected from the other side (clad side), it is required to remove the cladding from an inspection area which will not affect the usefulness of the part or material and take conductivity readings on the bare section of material.

    If the clad raw material is thicker than 0.016", that requires conductivity testing was machined or chem milled from one side (i.e., aircraft skin) and must be inspected from the same side (bare side), it is required to remove the cladding from the opposite side on the inspection area which will not affect the usefulness of the part or material and take conductivity readings on the bare machined side.

    The conductivity readings must meet the requirements specified in Table I.
- Specified if the conductivity measurement is required on the assembled aircraft skin, refer to Liaison Engineering for cladding removal instructions.
- Specified to refer to PPS 31.17 for the safety precautions for handling and using solvents.

TABLE OF CONTENTS

Sections **Page**

Tables

1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for eddy current electrical conductivity inspection of aluminum alloys to verify response to heat treatment.

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.

1.2 Conductivity inspection according to this standard is used in conjunction with hardness testing according to PPS 20.08 to verify that aluminum alloys have responded to heat treatment and have reached the specified tempers.

1.3 This PPS is co-owned by De Havilland Aircraft of Canada Limited (DHC) and Bombardier Inc. (BA) due to its applicability for both the DHC DASH 8 and BA Lear 45 programs.

2 HAZARDOUS MATERIALS

2.1 Before receipt at DHC or BA, all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the DHC/BA 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 DHC/BA Environment, Health and Safety Department.

3 REFERENCES

3.1 PPS 13.26 - General Subcontractor Provisions.

3.2 PPS 13.39 - DASH 8 & Lear 45 Critical and Special Processes PPS Index.

3.3 PPS 20.08 - Hardness Testing of Metals.

3.4 PPS 30.01 - Heat Treatment of Aluminum and Aluminum Alloys.

4 EQUIPMENT AND FACILITIES

4.1 Equipment

4.1.1 Test Instrument

4.1.1.1 Eddy current conductivity test instruments must be capable of determining the electrical conductivity of aluminum alloys as a percentage of the International Annealed Copper Standard (IACS) over the entire aluminum conductivity range. For the purposes of this PPS, it is acceptable to use either of the following alternative types of equipment.

- Portable direct reading eddy current test instrument with a probe and a set of conductivity standards operating at a frequency of 60 kHz. When using a test instrument operating at a frequency of 60 kHz, the conductivity values specified in Table I and Table II are applicable, unless otherwise specified by the engineering drawing.
- Verimet M4900B or M4900C (or equivalent) variable frequency conductivity test instrument. When using a Verimet M4900B or M4900C (or equivalent) variable frequency conductivity test instrument, the conductivity values specified in Table III are applicable, unless otherwise specified by the engineering drawing.

4.1.1.1.1 Use of any other type of conductivity direct reading test instrument is only acceptable if authorized by a PPS Process Standard Deviation (PSD).

4.1.1.1.2 Conductivity test instrument sensitivity must be capable of clearly distinguishing changes of 0.5% IACS (i.e., 0.3 MS/m) or better over the desired conductivity range.

4.1.1.1.3 Conductivity test instruments must be capable of determining the conductivity of aluminum alloy as a percentage of the IACS with accuracy of ±1% IACS (i.e., 0.6 MS/m) or better. This requirement must apply to bare material and through non-conductive coatings up to 0.003 inch (0.08 mm) thick.

4.1.1.1.4 Conductivity test instrument stability must be capable of repetitive (within ±0.5% IACS (i.e., 0.3 MS/m)) conductivity measurements for a minimum of 15 minutes, without any adjustments.

4.1.2 Test Instrument Certification

4.1.2.1 A temperature difference of no more than ±2°F (±1°C) between the test instrument, test probe, reference standards, and ambient room temperature must be maintained during the certification process.

4.1.2.2 Room temperature during the certification process must be 68 ±5°F (20 ±3°C).

4.1.2.3 The test instrument and test probe must be certified together as a unit.

4.1.2.4 Primary, secondary, or laboratory reference standards must be used in instrument certification.

4.1.2.5 Certification of the test instrument must document test instrument acceptability to the requirements of section 4.1.1.

4.1.2.6 Test instruments must be labelled to indicate certification status.

4.1.2.7 Test instruments must be certified by either the manufacturer or a suitable metrology organization, at least once every 12 months.

4.1.3 Test Probes

4.1.3.1 Conductivity probes must be clearly identified with P/N and S/N.

4.1.3.2 Test instrument and test probe must be certified together as a unit.

4.1.3.3 Certification must document probe acceptability to the requirements of section 4.1.1 and the following:

- Moderate handling pressure on the probe must not cause a change in the test instrument response exceeding 0.5% IACS.

4.1.4 Laboratory and Instrument Conductivity Standards

4.1.4.1 Sets of laboratory conductivity standards and instrument conductivity standards consist of sets of homogeneous blocks of non-ferrous metal of known conductivity in %IACS. Each conductivity standard must be a minimum of 1.2" x 1.2" x 0.2" thick or 1.2" diameter x 0.2" thick; in addition, depending on the size of the test instrument probe, all conductivity standards must be large enough to negate any possibility of edge effect. The surface upon which conductivity measurements are taken must have a 63 Ra finish or better.

4.1.4.2 Laboratory conductivity standards must be certified by comparing eddy current measurement with primary conductivity standards according to an internationally or nationally recognized standard (e.g., United States National Institute of Standards and Technology - NIST). Accuracy of the certification conductivity standards must be ±0.35% IACS or ±1% of the percentage IACS value being tested, whichever is less, at 68 ±5°F (20 ±3°C). Laboratory conductivity standards must be re-certified according to an internationally or nationally recognized standard (e.g., United States National Institute of Standards and Technology - NIST) at least once every 24 months. All laboratory conductivity standards must be suitably identified with their nominal conductivity value as well as their require re-certification date.

4.1.4.3 Instrument conductivity standards are similar to the laboratory conductivity standards with the exception that these standards must accompany a particular test instrument at all times. Also, these standards are calibrated by comparison with laboratory conductivity standards. Using this comparison method, the value of the instrument conductivity standards must be certified within ±0.85% IACS accuracy. Before use, and at least once every 12 months thereafter, verify the conductivity values of the instrument conductivity standards using laboratory conductivity standards as follows:

Step 1. Ensure that the ambient temperature in the test area is 68 ±2°F (20 ±1°C) and that the test instrument, probe, laboratory conductivity standards, instrument conductivity standards and the ambient temperature are at the same temperature within ±2°F (±1°C).

Step 2. Turn on the test instrument and allow it to warm-up for a minimum of 5 minutes before testing.

Step 3. Calibrate the test instrument using laboratory conductivity standards according to the equipment manufacturers instructions. The calibrated test instrument must read each laboratory conductivity standard within ±0.35% IACS of its nominal conductivity value.

Step 4. Use the calibrated test instrument to test each of the instrument conductivity standards **without** adjustment of the test instrument.

Step 5. Identify each of the tested instrument conductivity standards with the nominal conductivity values determined and required re-verification date.

4.1.4.4 The values of the conductivity standards in each set of laboratory conductivity standards and instrument conductivity standards must meet the following requirements. Instrument conductivity standards **do not** have to have the same nominal conductivity values as the nominal conductivity values of the laboratory conductivity standards used for certification of the test system.

- For a test instrument that will only be used in the lower ranges, the sets of conductivity standards (laboratory and instrument) must comprise a minimum of 3 conductivity standards including one conductivity standard at a nominal 16 ±5% IACS, one conductivity standard at a nominal 29 ±5% IACS and one conductivity standard at a nominal 42 ±5% IACS.
- For a test instrument that will only be used in the upper ranges, the sets of conductivity standards (laboratory and instrument) must comprise a minimum of 3 conductivity standards including one standard at a nominal 29 ±5% IACS, one conductivity standard at a nominal 42 ±5% IACS and one conductivity standard at a nominal 60 ±5% IACS.
- For test instruments that will be used in both the lower and higher ranges, the sets of conductivity standards (laboratory and instrument) must comprise a minimum of 4 conductivity standards including one conductivity standard at a nominal 16 ±5% IACS, one conductivity standard at a nominal 29 ±5% IACS, one at a nominal 42 ±5% IACS and one conductivity standard at a nominal 60 ±5% IACS.

4.2 Facilities

4.2.1 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 eddy current electrical conductivity inspection of aluminum alloys to verify response to heat treatment according to this PPS.

4.2.2 Subcontractors must direct requests for approval to DHC or BA Quality.

4.2.3 Facility approval must 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, DHC or BA Engineering 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 DHC or BA Quality.

5 PROCEDURE

5.1 General

5.1.1 Under normal conditions, the test system components will be the same temperature within ±2°F if they have sat in the same inspection area for a minimum of 1 hour. This can be verified by taking several readings at time intervals until the values have stabilized.

5.2 Calibration of Test Instruments (also known as Standardization)

5.2.1 Before each production use, calibrate the test instrument as follows:

Step 1. Allow a minimum of 5 minutes warm-up time after turning the power on.

Step 2. Ensure that the test instrument, probe and instrument conductivity standards are at the same temperature within ±2°F.

Step 3. Calibrate the test instrument using a minimum of 3 instrument conductivity standards according to the equipment manufacturers instructions. The calibrated test instrument must read each of the instrument conductivity standards (3 minimum) within ±0.5% IACS of their respective nominal conductivity values.

Step 4. Perform lift-off verification as follows:

a) Place the probe on a bare instrument conductivity standard which has the closest nominal conductivity value to the part being inspected and note the reading.

b) Place a 0.003" thick non-conductive flat shim between the probe and the instrument conductivity standard and note the reading.

The difference between the 2 readings should be no more than ±0.5% IACS. If the reading is greater than ±0.5% IACS, determine the cause of failure and correct before re-calibration as specified herein.

Step 5. Every 10 minutes during continuous use and at the end of testing, verify the calibration of the test instrument using the instrument conductivity standards. If the measured conductivity value of each instrument conductivity standard is not within ±0.5% IACS of the value obtained during calibration in Step 3, re-calibrate the test instrument and re-measure all areas that have been measured since the last calibration verification.

5.3 Conductivity Testing

5.3.1 Conductivity testing is most accurate at a temperature within the reference temperature range (usually 64°F - 72°F (18°C - 22°C)); however, testing may be performed in-situ at ambient temperature. If the ambient temperature is outside the reference temperature range and unacceptable readings are obtained, re-testing under controlled conditions at a temperature within the reference range is recommended.

5.3.2 The temperature of the test instrument, probe, instrument conductivity standards and parts being tested must be within ±2°F of each other and the ambient temperature.

5.3.3 Parts and equipment must be free from oil, grease, dirt and other visible contaminants before and during inspection.

5.3.4 Before use, calibrate the test instrument according to section 5.2.

5.3.5 For parts to be tested which have a non-conductive coating thickness greater than 0.003", perform the following lift-off compensation if the test instruments does not have a lift-off compensation included.

Step 1. Select an instrument conductivity standard with a nominal conductivity within ±5% IACS of the part to be tested and measure the conductivity of the instrument conductivity standard using a calibrated test instrument.

Step 2. Obtain a shim of non-conductive material with a thickness which matches the thickness of the non-conductive coating on the part to be tested. If the thickness of the non-conductive coating is not known, determine the coating thickness without damaging the non-conductive coating. Refer to Liaison Engineering for assistance, if necessary.

Step 3. Place the shim of non-conductive material between the test instrument probe and the instrument conductivity standard from Step 1 and measure the resultant conductivity.

Step 4. Use the difference in readings from the value determined in Step 1 and the value determined in Step 3 as a correction factor when measuring part conductivity.

5.3.6 The maximum surface roughness of parts to be tested must be no more than 150 Ra.

5.3.7 Surfaces must be flat so that all of the probe shoe touches the test area. Avoid rocking or sliding the probe on flat surfaces as false readings can result. The minimum concave curvature on which an accurate reading can be taken is 20" in diameter. The minimum convex curvature on which an accurate reading can be taken is greater than 6" in diameter. Material or parts having a radius less than the minimums specified above may be tested according to MIL-STD-1537 if the manufacturer curvature correction factor is available for the conductivity test instrument.

5.3.8 To ensure readings are not distorted from edge effect, the specimen area to which the eddy current instrument probe is applied must be at least as large as the outside diameter of the test probe or per manufacturer's specifications.

5.3.9 Take sufficient readings at various points on each part to ensure uniform conductivity. On parts of non-uniform thickness, take readings at points of thickness extremes. Conductivity must not vary more than 2% IACS over any 2 points on the part.

5.3.10 Except in the following cases, take readings on the surface of the parts.

- For clad raw material thicker than 0.160", remove the cladding from an area which will not affect the usefulness of the part or material and take conductivity readings on the bare section of material. The conductivity readings must meet the requirements specified in Table I.
- If the clad raw material is thicker than 0.160", that requires conductivity testing was machined or chem milled from one side (i.e., aircraft skin) and must be inspected from the other side (clad side), it is required to remove the cladding from an inspection area which will not affect the usefulness of the part or material and take conductivity readings on the bare section of material.

  If the clad raw material thicker is than 0.160", that requires conductivity testing was machined or chem milled from one side (i.e., aircraft skin) and must be inspected from the same side (bare side), it is required to remove the cladding from the opposite side on the inspection area which will not affect the usefulness of the part or material and take conductivity readings on the bare machined side.

  The conductivity readings must meet the requirements specified in Table I.
- For all clad and bare parts heat treated to the T76XX temper and having a thickness of 0.100" or over, remove 10% of the thickness of the material by machining or chemical milling before taking conductivity readings.
- If cladding or metal removal is required, restrict such removal to tooling lugs or areas to be trimmed off. If this is not possible, use a separate test specimen of suitable size with the production batch. The test specimen must be of the same gauge, temper and material specification as the production parts. If the conductivity measurement is required on the assembled aircraft skin, refer to Liaison Engineering for cladding removal instructions.

5.3.11 Unless otherwise specified by the engineering drawing, for the conductivity of specific alloys and tempers of various thickness refer to Table I, Table II or Table III, as applicable. When using a test instrument operating at a frequency of 60 kHz, refer to Table I for bare material and to Table II for clad material. When using a Verimet M4900B or M4900C (or equivalent) variable frequency conductivity test instrument; refer to Table III for the conductivity values for wrought aluminum alloys, excluding rivets. If a conductivity value is not specified (by the engineering drawing or in Table I, Table II or Table III, as applicable), if an accurate reading cannot be obtained due to the part configuration or if the requirements of paragraph 5.3.10 cannot be met, the hardness value alone, obtained according to PPS 20.08, may be used to verify response to heat treatment.

6 REQUIREMENTS

6.1 Electrical conductivity must not vary more than 2% IACS between any 2 measured points on the part or material.

6.2 Parts and material must meet the conductivity requirements specified by the engineering drawing or in Table I, Table II or Table III, as applicable, when measured with the equipment specified in paragraph 4.1.1.1.

6.3 Conductivity alone must not be cause to accept or reject parts or material. Refer to PPS 30.01 for other accept/reject criteria and disposition of parts failing to meet electrical conductivity requirements.

TABLE I - CONDUCTIVITY VALUES FOR BARE WROUGHT ALUMINUM ALLOYS (60 KHZ TEST INSTRUMENT)

ALLOY & TEMPER	CONDUCTIVITY (%IACS) FOR SINGLE SHEET THICKNESS OF						
	0.016"-0.019"	0.020"-0.024"	0.025"-0.031"	0.032"-0.039"	0.040"-0.049"	0.050"-0.059"	0.060" AND OVER
1100-O	---						57.0 - 62.0
2004-T42/T62	---						35.5 - 42.0
2014-O	---						43.5 - 51.5
2014-T3	---						31.5 - 35.0
2014-T4	---						31.5 - 35.0
2014-T6	---						35.0 - 41.5
2024-O	35.4 - 44.0	45.3 - 51.5	49.3 - 54.1	47.7 - 51.5	45.5 - 49.0	45.5 - 49.0	45.5 - 49.0
2024/2524-T3	15.2 - 21.6	20.8 - 28.0	27.7 - 33.3	31.2 - 35.6	30.7 - 34.1	29.5 - 32.7	28.5 - 32.0
2024/2524 T4/T42	15.2 - 21.5	20.3 - 29.0	27.7 - 33.3	31.2 - 35.6	30.7 - 34.1	29.5 - 32.7	28.5 - 32.0
2024/2524-T6X	25.2 - 30.0	32.5 - 37.6	38.3 - 42.5	38.9 - 42.3	37.4 - 40.7	36.3 - 40.0	34.0 - 44.0
2024-T8XXX	27.0 - 32.1	34.6 - 40.6	40.1 - 45.0	40.1 - 44.2	38.9 - 42.3	38.0 - 42.0	35.0 - 42.0
2219-O	44.0 - 49.0						
2219-T3	26.0 - 31.0						

TABLE I - CONDUCTIVITY VALUES FOR BARE WROUGHT ALUMINUM ALLOYS (60 KHZ TEST INSTRUMENT)

ALLOY & TEMPER	CONDUCTIVITY (%IACS) FOR SINGLE SHEET THICKNESS OF						
	0.016"-0.019"	0.020"-0.024"	0.025"-0.031"	0.032"-0.039"	0.040"-0.049"	0.050"-0.059"	0.060" AND OVER
2219-T4	28.0 - 32.0						
2219-T6X	21.6 - 24.0	28.0 - 31.5	33.3 - 37.2	35.6 - 38.2	34.1 - 36.5	32.7 - 35.3	32.0 - 36.0
2219-T8XXX	20.0 - 24.0	25.5 - 31.5	31.3 - 37.2	34.8 - 38.2	33.0 - 36.5	31.5 - 35.3	31.0 - 35.0
3003-O	---						44.5 - 50.5
5052-H32	34.0 - 37.0						
6013-T4	---						37.0 - 39.0
6013-T6	---						40.0 - 43.0
6061-O	37.8 - 47.4	47.2 - 54.2	50.9 - 56.5	49.0 - 53.4	47.0 - 56.0	47.0 - 56.0	47.0 - 56.0
6061-T4	25.5 - 34.1	34.6 - 41.8	40.1 - 45.7	40.1 - 45.0	38.9 - 45.5	38.0 - 45.5	36.0 - 45.3
6061-T6	32.1 - 39.7	40.6 - 48.2	45.0 - 51.0	44.2 - 48.6	42.3 - 51.0	42.0 - 51.0	40.0 - 51.0
7050-T74XX (Note 2)	---						40.0 - 44.0
7050-T76XX	---						39.0 - 44.0
7075-O	34.1 - 42.7	43.8 - 50.0	47.7 - 52.5	46.1 - 51.0	44.2 - 47.7	44.0 - 47.5	44.0 - 47.5
7075-T6	14.2 - 25.4	21.6 - 33.6	28.6 - 37.6	32.3 - 39.3	31.4 - 36.8	30.0 - 35.0	30.0 - 35.0
7075-T73XX (Note 2)	27.0 - 32.9	34.6 - 41.5	38.0 - 45.7	38.0 - 44.8	38.0 - 42.9	38.0 - 42.5	40.0 - 43.0
7075-T76XX	25.8 - 32.1	33.5 - 40.6	39.3 - 45.0	39.4 - 44.2	38.1 - 42.3	37.2 - 42.0	38.0 - 42.0 (Note 1)
7150-T7751/ T77511	---						36.0 - 41.0
7475-T73	---						40.0 - 44.5
7475-T76	---		38.0 - 42.0				

Note 1. On parts having a thickness of 0.100" and over, remove 10% of thickness according to paragraph 5.3.10 before conductivity testing.

Note 2. For 7075-T73 and 7050-T74 with a thickness of 0.060" or greater, conductivities of 38% - 39.9% IACS are acceptable provided that the hardness of the part is greater than the minimum specified in PPS 20.08 and less than the following maximum:

Material Thickness	Maximum Hardness (R_B)
0.060" to 0.500"	88
0.501" to 2.000"	86
over 2.000"	84

TABLE II - CONDUCTIVITY VALUES FOR CLAD WROUGHT ALUMINUM ALLOYS (60 KHZ TEST INSTRUMENT)

ALLOY & TEMPER	THICKNESS (INCHES)	ELECTRICAL CONDUCTIVITY (%IACS)
2014-T6	All	35.5 - 44.0
2024-O	0.016 - 0.019	35.4 - 44.0
	0.020 - 0.024	45.3 - 51.5
	0.025 - 0.031	49.3 - 54.1
	0.032 - 0.039	47.7 - 51.1
	0.040 - 0.049	45.5 - 49.0
	0.050 - 0.062	45.5 - 49.0
	0.063 - 0.079	45.5 - 49.0
	0.080 - 0.089	45.0 - 49.2
	0.090 - 0.099	45.6 - 49.3
	0.100 - 0.109	45.8 - 49.5
	0.110 - 0.124	45.9 - 49.6
	0.125 - 0.139	46.0 - 49.9
	0.140 - 0.159	46.1 - 50.0
	0.160 (Note 1)	46.3 - 50.2
2024/2524 T3/T4/T42	0.016 - 0.019	15.2 - 21.6
	0.020 - 0.024	20.8 - 28.0
	0.025 - 0.031	27.7 - 33.3
	0.032 - 0.039	31.2 - 35.6
	0.040 - 0.049	30.7 - 33.8
	0.050 - 0.062	29.5 - 33.6
	0.063 - 0.079	29.2 - 33.8
	0.080 - 0.089	29.2 - 34.1
	0.090 - 0.099	29.2 - 34.3
	0.100 - 0.109	29.5 - 34.7
	0.110 - 0.124	29.7 - 35.0
	0.125 - 0.139	30.1 - 35.6
	0.140 - 0.159	30.4 - 36.2
	0.160 (Note 1)	31.1 - 37.0
2024/2524 T6/T62	All	35.0 - 45.0
2024-T8	All	35.0 - 45.0

TABLE II - CONDUCTIVITY VALUES FOR CLAD WROUGHT ALUMINUM ALLOYS (60 KHZ TEST INSTRUMENT)

ALLOY & TEMPER	THICKNESS (INCHES)	ELECTRICAL CONDUCTIVITY (%IACS)
2024-T81	0.016 - 0.019	27.5 - 32.5
	0.020 - 0.024	34.5 - 42.0
	0.025 - 0.031	40.0 - 45.5
	0.032 - 0.039	41.3 - 44.5
	0.040 - 0.049	40.0 - 44.0
	0.050 - 0.062	38.5 - 43.0
	0.063 - 0.079	38.5 - 43.0
	0.080 - 0.089	39.0 - 43.0
	0.090 - 0.099	39.0 - 43.0
	0.100 - 0.109	39.5 - 43.5
	0.110 - 0.124	39.5 - 43.5
	0.125 - 0.139	40.0 - 44.0
	0.140 - 0.159	40.5 - 44.0
	0.160 (Note 1)	41.5 - 44.5
2024-T86	All	36.5 - 41.5
2219-O	All	44.3 - 49.0
2219-T3	All	26.0 - 31.0
2219-T4	All	28.0 - 32.0
2219-T6	All	32.0 - 37.0
2219-T8	All	31.0 - 37.0
7075-O	0.016 - 0.019	34.1 - 42.7
	0.020 - 0.024	43.8 - 50.0
	0.025 - 0.031	47.7 - 52.5
	0.032 - 0.039	46.1 - 50.0
	0.040 - 0.049	44.2 - 47.7
7075-O	0.050 - 0.062	44.0 - 47.5
	0.063 - 0.079	44.2 - 47.8
	0.080 - 0.089	44.3 - 47.9
	0.090 - 0.099	44.4 - 48.0
	0.100 - 0.109	44.5 - 48.1
	0.110 - 0.124	44.6 - 48.2
	0.125 - 0.139	44.7 - 48.4
	0.140 - 0.159	44.8 - 48.6
	0.160 (Note 1)	45.0 - 48.9

TABLE II - CONDUCTIVITY VALUES FOR CLAD WROUGHT ALUMINUM ALLOYS (60 KHZ TEST INSTRUMENT)

ALLOY & TEMPER	THICKNESS (INCHES)	ELECTRICAL CONDUCTIVITY (%IACS)
7075-T6	All	30.5 - 36.0
7075-T73XX (Note 2)	0.016 - 0.019	28.0 - 33.0
	0.020 - 0.024	37.0 - 42.5
	0.025 - 0.031	40.0 - 45.5
	0.032 - 0.039	43.5 - 45.0
	0.040 - 0.049	41.0 - 43.5
	0.050 - 0.062	39.0 - 43.0
	0.063 - 0.079	38.5 - 43.5
	0.080 - 0.089	38.5 - 43.5
	0.090 - 0.099	39.0 - 43.5
	0.100 - 0.109	39.5 - 43.5
	0.110 - 0.124	39.5 - 43.5
	0.125 - 0.139	39.5 - 44.0
	0.140 - 0.159	40.0 - 44.0
	0.160 (Note 1)	41.0 - 44.0
7075-T76	0.063 and over	38.0 - 42.0
7150-T7751	0.063 and over	37.0 - 41.0
7475-T73	0.050 and over	40.0 - 44.0
7475-T76	0.063 and over	39.0 min.

Note 1. For clad material thicker than 0.160", remove the cladding from an area which will not affect the usefulness of the part or material and take conductivity readings on the bare section of material.

Note 2. For 7075-T73 with a thickness of 0.060" or greater, conductivities of 38% - 39.9% IACS are acceptable provided that the hardness of the part is greater than the minimum specified in PPS 20.08 and less than the following maximum:

Material Thickness	Maximum Hardness (R_B)
0.060" to 0.500"	88
0.501" to 2.000"	86
over 2.000"	84

TABLE III - CONDUCTIVITY VALUES USING VERIMET CONDUCTIVITY TEST INSTRUMENT

ALLOY & TEMPER	FORM (Note 1)	THICKNESS	ELECTRICAL CONDUCTIVITY (%IACS)
2014-T3/T4	Bare	0.060" and over	31.5 - 35.0
2014-T6	Bare	0.060" and over	35.0 - 41.5
2024-T3/T4	All	0.016" - 0.019"	22.5 - 27.5
		0.020" - 0.024"	26.5 - 31.5
		0.025" - 0.031"	29.5 - 35.5
		0.032" - 0.039"	32.0 - 37.0
	Bare	0.040" - 0.049"	29.5 - 34.0
		0.050" - 0.062"	29.0 - 32.0
		0.063" and over	28.5 - 31.5
	Clad	0.040" - 0.049"	30.0 - 34.5
		0.050" - 0.062"	29.5 - 34.0
		0.063" - 0.079"	29.5 - 34.5
		0.080" - 0.089"	30.0 - 34.5
		0.090" - 0.099"	30.0 - 35.0
		0.100" - 0.109"	30.0 - 35.0
		0.110" - 0.124"	31.0 - 35.0
		0.125" - 0.139"	31.5 - 36.0
		0.140" - 0.159"	31.0 - 36.5
2024-T6	Bare	0.060" and over	35.5 - 39.5
	Clad	0.060" - 0.159	35.0 - 45.0
2024-T8	Bare	0.060" and over	37.5 - 41.5
	Clad	0.060" - 0.159"	38.5 - 43.0
2024-T86	All	All	37.5 - 41.5
2219-T3	All	All	26.0 - 31.0
2219-T4	All	All	28.0 - 32.0
2219-T6	Bare	All	32.0 - 35.0
	Clad	Up to 0.159"	32.0 - 37.0
2219-T8	Bare	All	31.0 - 35.0
	Clad	Up to 0.159"	31.0 - 37.0
6013-T4	All	0.063" and over	36.5 - 40.0
6013-T6	All	0.063" and over	40.5 - 45.0

TABLE III - CONDUCTIVITY VALUES USING VERIMET CONDUCTIVITY TEST INSTRUMENT

ALLOY & TEMPER	FORM (Note 1)	THICKNESS	ELECTRICAL CONDUCTIVITY (%IACS)
6061-T4	All	0.016" - 0.019"	30.0 - 37.0
		0.020" - 0.024"	35.0 - 43.5
		0.025" - 0.031"	39.0 - 48.0
		0.032" - 0.039"	40.5 - 49.0
		0.040" - 0.049"	38.0 - 46.5
		0.050" - 0.062"	36.0 - 45.5
		0.063" and over	35.5 - 44.8
6061-T6	All	0.016" - 0.019"	33.5 - 38.5
		0.020" - 0.024"	38.5 - 49.5
		0.025" - 0.031"	42.5 - 53.5
		0.032" - 0.039"	44.0 - 55.0
		0.040" - 0.049"	41.5 - 52.0
		0.050" - 0.062"	40.0 - 50.0
		0.063" and over	40.0 - 50.0
7050-T736/T74	Bare Plate & Forgings	All	40.0 - 45.0 (Note 2)
7050-T76	Bare Plate & Forgings	All	39.0 - 44.0
7055-T77	Bare Plate, Extrusions & Forgings	All	35.5 - 38.0
7075-T6	All	0.016" - 0.019"	22.0 - 30.0
		0.020" - 0.024"	27.0 - 36.0
		0.025" - 0.031"	32.0 - 39.0
		0.032" - 0.039"	33.5 - 41.0
		0.040" - 0.049"	31.5 - 38.0
		0.050" - 0.062"	30.5 - 36.0
	Bare	0.063" and over	29.5 - 34.0
7075-T6	Clad	0.063" - 0.079"	31.0 - 36.5
		0.080" - 0.089"	31.5 - 36.0
		0.090" - 0.099"	31.5 - 37.0
		0.100" - 0.109"	32.0 - 37.0
		0.110" - 0.124"	32.4 - 37.5
		0.125" - 0.139"	33.0 - 37.5
		0.140" - 0.159"	32.5 - 38.0
7075-T73	All	0.063" and over	40.0 - 42.0 (Note 2)
7075-T76	All	0.063" and over	38.0 - 42.0
7150-T77	All	0.063" and over	35.5 - 39.0

TABLE III - CONDUCTIVITY VALUES USING VERIMET CONDUCTIVITY TEST INSTRUMENT

ALLOY & TEMPER	FORM (Note 1)	THICKNESS	ELECTRICAL CONDUCTIVITY (%IACS)
7475-T73	Bare Sheet	0.063" and over	40.0 - 42.6
	All	0.050" and over	40.0 - 44.0
7475-T76	Bare Sheet	0.063" and over	36.5 - 41.5
	Clad Sheet	0.063" - 0.159"	39.0 minimum
	All	0.250" and over	36.5 - 41.5

Note 1. For heat treated aluminum alloys having temper designations with two, three or four digits not shown in this table, use the conductivity value for the basic temper with the same first digit.

Note 2. For 7075-T73 and 7050-T74 with a thickness of 0.060" or greater, conductivities of 38% - 39.9% IACS are acceptable provided that the hardness of the part is greater than the minimum specified in PPS 20.08 and less than the following maximum:

Material Thickness	Maximum Hardness (R_B)
0.060" to 0.500"	88
0.501" to 2.000"	86
over 2.000"	84

7 DHC/BA SAFETY PRECAUTIONS

7.1 The safety precautions specified herein are specific to DHC/BA to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is strongly 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 Refer to PPS 31.17 for the safety precautions for handling and using solvents.

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.