

AIR CANADA



ELECTROMAGNETIC INTERFERENCE (EMI) GROUND TEST PROCEDURE

for the Testing of Transmitting Portable Electronic Devices (TPEDs) onboard aircraft Boeing 787-800

EMI-8-030058

Revision 00

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Restricted to Company	☒
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Confidential	☐

Prepared by:	Tanjima Mulk	Air Canada	Date:	2014-02-03
Approved by:		Air Canada	Date:	
Approved by:		TCCA	Date:	

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1. RECORD OF REVISIONS

Revision	Date	Prepared by	Description
00	2014-01-29	T. Mulk	Initial release of document

2. INTRODUCTION

The purpose of this test is to demonstrate that the use of cellular phones on board aircraft during the taxi-in phase of the flight will not cause any electromagnetic interference with existing aircraft systems. A test will be performed on each aircraft type on which Air Canada is planning to allow passenger to use cell phones during taxi-in.

The test described in this document may be performed on B787-800 aircraft.

3. REFERENCE DOCUMENTS

CAR 602.08	Portable Electronic Devices
CAR 705.40/725.40	Passenger and Cabin Safety Procedures / Use of Portable Electronic Devices
TCCA AC 500-002	Electromagnetic Compatibility Testing of Electrical and Electronic Equipment
TCCA AC 700-005	Use of Transmitting Portable Electronic Devices
AC91.21-1B	FAA Advisory Circular - Use of Portable Electronic Devices Aboard Aircraft
RTCA DO-160E	Environmental Conditions and Testing Procedures for Airborne Equipment.
RTCA DO-294C	Guidance on allowing Transmitting Portable Electronic Devices (TPEDs) on aircraft.
B787 AMM	Boeing 787 Aircraft Maintenance Manual
0-25-20/02-007455-15	Glossary of Abbreviations, EMI Ground Test Procedures
ISO/EIC 17025:1999	Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz

4. DESCRIPTION

Currently, the regulatory requirements for the operation of commercial aircraft, prohibits the usage of cellular phones when engines are running. A global exemption was issued to allow air operators to permit the use of TPEDs during the taxi-in phase until the necessary regulatory changes are made. In order for Air Canada to allow use of cell phones usage during taxi-in, tests need to be conducted to verify no interference is induced directly into aircraft systems and wiring.

5. REQUIREMENTS FOR CERTIFICATION

The requirements for testing the cellular phones are described in TCCA Advisory Circular 700-005, Issue 01.

The air operator has to determine the safety of TPEDs operation by performing an Electro Magnetic Interference (EMI) test. The EMI test verifies operation of all the aircraft equipment that is powered and normally used during the taxi-in phase. Acceptable means for assessment of the effect on aircraft system include usage of cellular phones representing different technologies and manufacturers.

A number of cell phones equal to 90% of the aircraft LOPA (Layout Of Passenger Arrangement) seating capacity is used and cell phones are placed on passenger seats and equally distributed throughout the cabin. Aircraft systems are monitored while cell phones are being turned on, to assess any effect on each system.

6. EQUIPMENT TO BE TESTED

Equipment Name: Cellular Phones and Smartphones
Manufacturer: The equipment list includes, but is not limited to:
Motorola, BlackBerry, Apple, Sony-Ericsson, Samsung, LG,
Nokia, Siemens, HTC, etc.
Model: Various
MFR P/N: Various
Air Canada Assembly P/N: Not Applicable.

7. TEST METHODOLOGY

The testing to be performed takes into account the following factors:

- The usage of cellular phones is to be permitted only during taxi-in phase of flight;
- The taxi-in phase of flight is defined as the moment at which the aircraft has exited the main runway until cabin door(s) is(are) opened. The flight attendants will make an announcement from when it is permissible to use the cellular phones.
- During taxi in, only the following systems are in operation:
 - (a) Cabin Interphone
 - (b) Flight crew audio system
 - (c) VHF communication system (Includes ATC communications)¹
 - (d) Engine Indication and Crew Alerting System (EICAS)
 - (e) Full Authority and Digital Engine Control (FADEC)
 - (f) Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR)
 - (g) Electronic Flight Bag (EFB)
- The cellular phones can be used by all passengers only (not crew), in any seat of the passenger layout.
- The potential interference emissions coming from the cellular phones frequencies are identified below.

Emission Source from current and planned	Modulation	Frequency (MHz)
I-DEN	PM, CW	815.5
GSM 900	PM	837.0
CDMA, CDMA 2000, WCDMA	CW	837.0
GSM 1800	PM	1880.0
CDMA, CDMA 2000, WCDMA	CW	1880.0
IEEE 802.11b/g	PM, CW	2441.0
IEEE 802.11a	PM, CW	5500.0

¹ The B787 ATC system does not transmit on the ground, therefore only the Pilot-Controller VHF communications are tested. (Ref AMM, 34-42-00-19B-340A-A, Para 1.A.(1))

- The target systems communication frequencies are identified below.

Emission Frequencies	Target Systems
118-137 MHz	VHF COMM

The test equipment used in this test will be will be set to simulate cellular phones frequency emissions. Aircraft systems will be monitored during these operations.

8. CONCLUSION

A successful accomplishment of the entire test procedure enclosed in Appendix A on the Boeing B787-800 aircraft shall consist of the individual test procedures accompanied only by a PASS field, and the Appendix C form correctly filled in with valid signatures. With the support of all the substantiating data, results and observations made during the successful accomplishment of the test procedure set, it can then be concluded that cellular phones may be safely operated during the taxi-in phase of the flight on the B787-800 aircraft.

APPENDIX A

1. Test Set Up & Test Equipment Operating Procedures

Required Test Equipment

Device	Manufacturer	Model	Serial Number	Calibration date
Antenna, 1.8 GHz to 2.0 GHz	ETC	ETC	ETC1, ETC2	
Antenna, 5.5 GHz	ETC	ETC	ETC3, ETC4	
Amplifier, 500 MHz to 1 GHz	ETC	ETC	-	
Amplifier, 1 GHz to 2 GHz	Hughes	1177H09F000	162	
Amplifier, 4 GHz to 8 GHz	Varian	VZC6961K1DH	5371	
Signal Generator, RF, 10 MHz to 20 GHz	Hewlett Packard	83623A	3009A00209	
Antenna, 815 to 837 MHz	ETC	ETC	ETC5, ETC6	
E-Field Monitor, 10 kHz to 40 GHz	Amplifier Research	FM2000	18578	
E-Field Probe, 80 MHz to 40 GHz	Amplifier Research	FP2080	12527	
Amplifier, 2 GHz to 4 GHz	Varian	VZS-6951KDH	5457	
Power Head, 10 kHz to 8 GHz	Amplifier Research	PH2000	28741	
Power Meter, 10 kHz to 40 GHz	Amplifier Research	PM2002	26700	
Directional Coupler, 400 MHz to 1.2 GHz	Werlatone	7220	14376	
Power Head, 40 GHz	Amplifier Research	PH2010	307262	
Directional Coupler, 1 GHz to 18 GHz	Microwave Engineering	IJ-160-40-N	116	
Isolator, 4 GHz to 8 GHz	Channel Microwave	AC652	102	
Power Supply, 0-40 VDC, 0-1A Dual	Lambda	LPD422FM	-	
Coax Isolator, 2GHz to 4 GHz	Channel Microwave	AS667	103	

Test Set Up and Test Equipment Operation

The steps described below constitute the procedure to be accomplished when prompted to operate the test equipment in the test procedures of Appendix A, with the various aircraft systems operating.

- (a) The test shall be carried out on an aircraft that is fully serviceable and with all required avionics systems operating. Testing shall be performed with APU and engines operations. Doors shall be closed and testing will be done with test equipment positioned in the passenger cabin, per Appendix B of this document. The aircraft shall be positioned at a distance greater than 250 feet from any building.
- (b) Record state of target aircraft system before the test equipment is turned on.

- (c) Configure the test equipment in the rolling Faraday cage and connect the power supply extensions to the 115 VAC 400Hz receptacles located throughout the aircraft (as required at the test location) Connect the equipment and apply power and wait 20 minutes for the equipment to warm up
- (d) Set the test equipment to the test frequencies, as defined in Appendix A of this document. When transmitting on the target frequencies, monitor the electric field strength using an electric field probe positioned within 1m, +/- 30 cm of the transmitting antenna. Set the antenna for vertical/horizontal polarization and position the antenna at approx. 30 cm above the seat bottom cushion or from top of the business class seat partition, for each of the test location defined in Appendix B.
- (e) Start transmission on the required frequency, allowing to ramp up from the initial power level to the desired power level and monitor the aircraft systems as defined in Appendix A.
- (f) When the system under test is operating, there shall not be any deviation of any instrument beyond the tolerances given in the specified Maintenance Manual tasks, or as directed in this document.

Note: Operate each piece of communication equipment, navigation equipment and flight control systems independently. Operate at the most commonly used frequency bands.

2. Multiple Equipment Factor (MEF) and Test Frequencies

The Multiple Equipment Factor is determined by using 90% cellular phones coverage against the seating capacity of the B787-800 aircraft:

251 pax * 0.90 = 226 Cellular Phones
The typical seat pitch of a B787 is 31 inches

The MEF shall be +14 dB (ref, RTCA DO-294C, Appendix 6, Table 6.G-1)

The following frequencies are to be tested at each of the locations given in Appendix B.

Frequency (MHz)	Polarization	MEF	Modulation	Base Power output	Base Power output + MEF
815.5	Vert./Horiz.	+14 dB	PM	33 dBm	47 dBm
			CW	33 dBm	47 dBm
837.0	Vert./Horiz.	+14 dB	PM	33 dBm	47 dBm
			CW	33 dBm	47 dBm
1880.0	Vert./Horiz.	+14 dB	PM	30 dBm	44 dBm
			CW	33 dBm	47 dBm
2441.0	Vert./Horiz.	+14 dB	PM	27 dBm	41 dBm
			CW	27 dBm	41 dBm
5500.0	Vert./Horiz.	+14 dB	PM	30 dBm	44 dBm
			CW	30 dBm	44 dBm

3. EMI Tests

Verify operation of the following aircraft systems:

- A. AUXILIARY POWER UNIT (APU)
- B. FLIGHT INTERPHONE/CABIN INTERPHONE SYSTEM
- C. PASSENGER ADDRESS (PA) SYSTEM
- D. COCKPIT VOICE RECORDER (CVR) & FLIGHT DATA RECORDER (FDR) SYSTEM
- E. ELECTRONIC FLIGHT BAG (EFB) SYSTEM TESTS
- F. VHF COMMUNICATION SYSTEM
- G. ENGINES, EICAS

A. AUXILIARY POWER UNIT (APU) AND POWER GENERATION SYSTEM TESTS

1. Follow the steps below to start the APU (reference AMM task 49-11-00-00A-110A-A)
 - 1.1. Make sure that the APU selector switch [3] on the P5 overhead panel is OFF.
 - (a) If the APU selector switch [3] is in the ON position, set it to the OFF position.
 - 1.2. Set the BATTERY switch [2] light on the P5 overhead panel to the ON position.
 - 1.3. Make sure that the L APU GEN switch [1] and R APU GEN switch [5] on the P5 overhead panel are ON.
 - 1.4. Get access to the lower display on the aisle stand in the flight compartment
 - (a) Make sure that the lower display shows the airplane data.
 - (b) Wait approximately 15 seconds before you start the APU.
 - (c) Make sure that you do not operate other flight compartment switches on the P5 overhead panel until the left CCR cabinet completes its start sequence.
 - 1.5. Let the APU reach the permanent regime.
2. Operate the cell phones and verify there is no adverse effect on RPM (100% = 36050 RPM and range of display is 3% to 125%) or status page on EICAS display (ref. AMM task 49-70-00-05A-110B-A), Verify no EICAS message comes up. Verify there is no effect on DC and AC electrical system pages on EICAS.

EMI Test results:

Pos.	Observations	
1	Pass ☐	Fail ☐
2	Pass ☐	Fail ☐
3	Pass ☐	Fail ☐
4	Pass ☐	Fail ☐

B. FLIGHT INTERPHONE/CABIN INTERPHONE SYSTEM TESTS

Note: This test may be accomplished in conjunction with PA test (next).

1. Setup for the System Test of the flight Interphone System per instructions below (reference AMM 23-51-00-00A-300B-A steps 1.A, 1.B and 1.D).
 - 1.1. Make sure the SERV INTPH (OFF/ON) switch on the overhead P5 panel is in the OFF position.
 - 1.2. Make sure the OBS AUDIO switch on the aisle stand P8 panel is in the NORM position.
 - 1.3. Make sure the oxygen masks at each flight crew station are in their stowage boxes.
 - 1.4. Set the audio control panel (ACP) at each flight crew station to these conditions:
 - (a) Push all the on-off/volume control switches (make sure the LEDs are off).

- (b) Push the FLT microphone selector switch (make sure the MIC light comes on).
 - (c) Push the FLT and SPKR on-off/volume controls (make sure the LEDs come on).
 - (d) Turn the FLT and SPKR on-off/volume controls to approximately the middle position.
 - (e) Turn the V-B-R switch to the B position.
2. Using the cockpit headsets, monitor flight pilot-to-pilot and attendant-to-pilot audio (in both directions) while operating the cell phones;
 3. Check for any interference and verify no adverse effect on the interphone system. For example, an adverse effect could be described as repetitive "... dit-dit-dit ... dit-dit-dit ...", pops, hums, clicks, crackles, low frequency rumble, hiss, warbling, low/high frequency beats, volume variations, noise heard in the handset or cabin speakers.

EMI Test results:

Pos.	Observations	
1	Pass ☐	Fail ☐
2	Pass ☐	Fail ☐
3	Pass ☐	Fail ☐
4	Pass ☐	Fail ☐

C. PASSENGER ADDRESS (PA) SYSTEM TESTS

1. Using the cockpit and cabin hand microphones, perform PA announcements per steps below (reference AMM task 44-12-00-00A-300B-A, Step 1.C(2) to 1.C(6)):
 - 1.1. Do a pre-recorded announcement (PRAM) test (all zones):
 - (a) Set the pre-recorded announcement at the CAP to ON. Make sure that you hear the pre-recorded announcement clearly from the speakers.
 - 1.2. Do a PA announcement on the cabin interphone system from each of the attendant stations:
 - (a) Make sure that the pre-recorded announcement at the CAP continues.
 - (b) Remove the attendant station handset from the handset cradle.
 - (1) Make sure that you hear a dial tone from the handset.
 - (2) Make sure that you see more than one dial code on the LCD display.
 - (3) Make sure that the backlights for the handset LCD and buttons are ON.
 - (c) Push the up/down side button on the handset.
 - (1) Make sure that the LCD screen shows the dial code directory.
 - (d) Push the up/down side button to scroll until you see the dial code for PA ALL on the LCD screen.
 - (1) Select the PA ALL dial code.
 - (2) Push the Enter button (middle side button).
 - (e) Push and hold the PTT button on the handset.
 - (f) Speak into the handset microphone.
 - (1) Make sure that the PRAM announcement stops and you hear your PA announcement clearly from the cabin speakers.
 - (g) Set the handset back in the cradle.
 - (1) Make sure that you hear the PRAM announcement again.
 - (h) Do the PA announcement from each of the attendant station handsets.
 - (1) Make sure that the PRAM announcement stops and you hear the PA announcement from the attendant station clearly from the cabin speakers.
 - (2) Make sure that the PRAM announcement continues when you set the handset back in the cradle.
 - (i) Set the PRAM announcement to OFF.

- 1.3. Do a PA priority announcement test from the flight compartment handset (all zones):
 - (a) Two persons are necessary for this test. One person at the flight compartment handset and the other person at the attendant station.
 - (b) Have one person make a PA ALL announcement from the attendant station handset.
 - (c) While the attendant station announcement continues, have the second person make a PA ALL PRIORITY announcement from the flight compartment handset.
 - (1) Make sure that the PA ALL announcement from the flight compartment handset overrides the PA ALL announcement from the attendant station handset.
 - (d) Set the handsets back in the handset cradles.
2. While operating the cell phones, verify the announcement is heard in the cabin without any adverse effect on the PA system. For example, an adverse effect could be described as repetitive "... dit-dit-dit ... dit-dit-dit ...", pops, hums, clicks, crackles, low frequency rumble, hiss, warbling, low/high frequency beats, volume variations, noise heard in the handset speakers.

EMI Test results:

Pos.	Observations	
1	Pass ☐	Fail ☐
2	Pass ☐	Fail ☐
3	Pass ☐	Fail ☐
4	Pass ☐	Fail ☐

D. COCKPIT VOICE RECORDER (CVR) & FLIGHT DATA RECORDER (FDR) SYSTEM TESTS

1. Perform the steps below to perform cockpit voice recorder sound test while operating the cell phones (reference AMM Task 31-31-00-00A-300B-A):
 - 1.1. Push the "CVR Test" button on the CVR Control Panel for a minimum of three (3) seconds.
 - 1.2. Make sure that a 1 kHz test tone is heard from the flight compartment speakers for approximately three (3) seconds.
 - 1.3. Make sure that the EICAS shows no flight-recorder-related faults.
2. Verify there are no adverse effects on the audio channels. For example, an adverse effect could be described "... dit-dit-dit ... dit-dit-dit ...", pops, hums, clicks, crackles, low frequency rumble, hiss, warbling, low/high frequency beats, volume variations, noise heard in the cockpit speakers or the audio channels.
3. Verify no FDR failure messages shown on EICAS

EMI Test results:

Pos.	Observations	
1	Pass ☐	Fail ☐
2	Pass ☐	Fail ☐
3	Pass ☐	Fail ☐
4	Pass ☐	Fail ☐

E. ELECTRONIC FLIGHT BAG (EFB) SYSTEM TESTS

1. Select MAIN MENU on the Display Unit (DU);
2. While operating the cell phones, perform the steps below (reference AMM task 46-11-00-29A-300B-A) and make sure no interference in the display image and application function is observed:
NOTE: The same sequence of steps is used for the first officer's EFB.

- 2.1. Make sure that the EFB MAIN MENU page shows on the captain's DU.
- 2.2. Push the bezel key (or the touchscreen button) for the first application.
 - (a) Make sure that the application starts.
 - (b) Push the MENU bezel button to go back to the MAIN MENU page.
 - (c) Continue to push the bezel key (or the touchscreen button) for each application on the main menu.
 - (1) Make sure that the application starts.
 - (2) Push the MENU bezel button to go back to the MAIN MENU page.

3. Make sure all active and selectable applications can be launched.

EMI Test results:

Pos.	Observations			
1	L EFB	Pass ☐	Fail ☐	
	R EFB	Pass ☐	Fail ☐	
2	L EFB	Pass ☐	Fail ☐	
	R EFB	Pass ☐	Fail ☐	
3	L EFB	Pass ☐	Fail ☐	
	R EFB	Pass ☐	Fail ☐	
4	L EFB	Pass ☐	Fail ☐	
	R EFB	Pass ☐	Fail ☐	

F. VHF COMMUNICATIONS SYSTEM (VHF COM) TESTS

1. Select 3 VHF stations spread evenly on the VHF COMM Spectrum (118.00 – 127.5 – 136.975) and carry out operation of the Left, Right and Center VHF's (Receive only), (reference AMM task 23-12-00-00A-300B-A). Note that the Center VHF must be switched to voice mode;
2. Operate the cell phones and monitor the Left, Right and Center VHF's (Receive only).
3. Verify that no aural interference is heard in the headset. For example, an adverse effect could be described "... dit-dit-dit ... dit-dit-dit ...", pops, hums, clicks, crackles, low frequency rumble, hiss, warbling, low/high frequency beats, volume variations, noise heard in the headset or the cockpit speakers.

EMI Test results:

Pos.	Observations			
1	L VHF	Pass ☐	Fail ☐	
	R VHF	Pass ☐	Fail ☐	
	C VHF	Pass ☐	Fail ☐	
2	L VHF	Pass ☐	Fail ☐	
	R VHF	Pass ☐	Fail ☐	
	C VHF	Pass ☐	Fail ☐	
3	L VHF	Pass ☐	Fail ☐	
	R VHF	Pass ☐	Fail ☐	
	C VHF	Pass ☐	Fail ☐	
4	L VHF	Pass ☐	Fail ☐	
	R VHF	Pass ☐	Fail ☐	
	C VHF	Pass ☐	Fail ☐	

G. ENGINE RUN & EICAS TEST

1. Move the aircraft to an area where engine run can be carried out safely and the aircraft is prepared for engine operation (reference AMM task B787-A-G71-00-00-08A-012B-A and B787-A-G71-00-00-08B-721B-A);
2. Ensure that aircraft is in the following configuration:
 - APU: "ON"
 - Flaps/Slats: "Retracted"
 - Hydraulics: "ON"
 - Packs: "OFF"
 - Gear: "Down and locked"
 - Pneumatics: "OFF"
 - IRS: "Aligned"
3. Start both Left and Right Engines following the steps below (reference AMM Task G71-00-00-04A-110A-A):
 - 3.1. Set the L FUEL PUMPS FWD and AFT switches, on the P5 panel, to ON.
 - 3.2. Set the R FUEL PUMPS FWD and AFT switches, on the P5 panel, to ON.
 - 3.3. Make sure that the forward thrust levers are in the idle position.
 - 3.4. Make sure that the reverse thrust levers are in the forward thrust (down) position.
 - 3.5. Start the APU. (reference AMM Task B787-A-49-11-00-00A-110A-A)
 - 3.6. Make sure that the APU GEN L and APU GEN R switches are in the ON position.
 - 3.7. Put the ENGINE L START and ENGINE R START switches to the START position at the same time.
 - 3.8. Put the FUEL CONTROL L and FUEL CONTROL R switches to the RUN position.
 - 3.9. Operate engines at idle speed.
4. Operate the cell phones and verify no fluctuations can be seen on Fuel System or EICAS Fuel Indication on MFDs;
5. Monitor Engine systems and verify no change is detected in the readings on N1, N2, Fuel Flow and EGT EICAS indications while the cell phones are operated (reference AMM Task G71-00-00-01A-030A-A);
 - 5.1. The EGT limit for ground starts is 1382°F (750°C) for all engine models.
 - 5.2. The rotor speed limit is outlined below per engine models:
 - (a) Engine models GENx-1BXXG03 and GENx-1BXXG04;
 - (1) The maximum N1 rotor speed is 2726 rpm (106.5%).
 - (2) The maximum N2 rotor speed is 13425 rpm (118%).
 - (b) Engine models GENx-1BXX/P1G01;
 - (1) The maximum N1 rotor speed is 2778 rpm (108.5%).
 - (2) The maximum N2 rotor speed is 13539 rpm (119%).
 - (c) Engine models GENx-1BXX/P2G01 and GENx-1BXX/P2G02;
 - (1) The maximum N1 rotor speed is 2778 rpm (108.5%).
 - (2) The maximum N2 rotor speed is 13368 rpm (117.5%).
6. Verify Engine do not shut down.
7. Verify all EICAS pages and verify no alarms are triggered from any system through the EICAS, with special attention to the following systems:
 - Nose Wheel Steering system
 - Brakes system
 - Anti-Skid system
 - Hydraulics systems

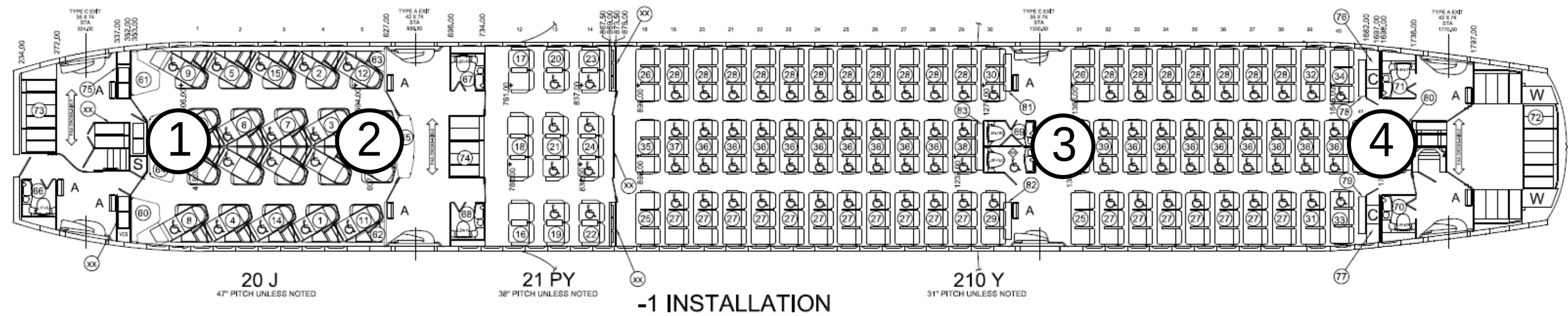
EMI Test results:

Pos.			Observations
1	Pass ☐	Fail ☐	
2	Pass ☐	Fail ☐	
3	Pass ☐	Fail ☐	
4	Pass ☐	Fail ☐	

*** END OF TESTS ***

APPENDIX B

1. B787-800 Cabin Layout and Test Locations



APPENDIX C

1. Test accomplishment record

Aircraft FIN:

Aircraft Registration:

Test start Date & Time:

Test finish Date & Time:

Location:

Test witnessed by:

Engineering:

Maintenance:

Transport Canada
(optional)

Attach a copy of the test results to this sheet. Also fill in calibration dates of all equipment used.