



COMPUTATIONAL EME COMPLIANCE ASSESSMENT OF THE GENESEE MODEL AAM29JNN9YA1AN MOBILE RADIO.

June 18, 2026

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Introduction

This report summarizes the computational [numerical modeling] analysis performed to document compliance of the Genesee Model Number #AAM29JNN9YA1AN Mobile Radio and vehicle-mounted antennas with the United States Federal Communications Commission (FCC) and Innovation, Science and Economic Development (ISED) Canada guidelines for human exposure to radio frequency (RF) emissions. The devices operate in the following frequency bands:

Regions	Device	Bands	Frequency Band (MHz)
US FCC	LMR VHF	LMR VHF	150.8-173.4
ISED Canada	LMR VHF	LMR VHF	138-174

This computational analysis supplements the measurements conducted to evaluate the compliance of the exposure from this mobile radio with respect to applicable *reference levels*, which in the following will be referred to as *maximum permissible exposure* (MPE) limits.¹ A total of 4 test conditions that did not conform with FCC MPE limits, and 10 test conditions did not conform with ISED MPE limits were considered to

¹ This choice is made for process efficiency, since “MPE” is used in the United States. In this way, chances of making editorial mistakes that may then require extended interactions with the report examiner are reduced.

determine whether those conditions complied with the *specific absorption rate* (SAR) limits for general public exposure (1.6 W/kg averaged over 1 gram of tissue and 0.08 W/kg averaged over the whole body) set forth in FCC guidelines [2] and Health Canada guidelines [1].

Employing SAR simulation reduction considerations, a total of 10 configurations (requiring a total of 20 numerical simulations) have been performed, all of them addressing the exposure of the bystander and back seat passenger to the VHF mobile radio featuring trunk-mount and roof-mount antennas.

For all simulations a commercial code (XFDTD™ v7.6.0, by Remcom Inc, State College, PA, USA) based on the Finite-Difference-Time-Domain (FDTD) methodology was employed to carry out the computational analysis. It is well established and recognized within the scientific community that SAR represents the *basic restriction* for RF energy exposure up to 6 GHz and that MPE limits are in fact derived from SAR limits. Accordingly, the SAR computations provide a scientifically valid and more relevant estimate of RF energy exposures.

Method

The XFDTD™ v7.6.0 computational suite enable simulating the heterogeneous full human body model defined according to the IEC/IEEE 62704-2:2017 standard and derived from the so-called Visible Human [3], discretized in 3 mm cubic-edge voxels. The IEC/IEEE 62704-2:2017 dielectric properties for 39 body tissues are automatically assigned by XFDTD™ at the specific simulation frequency. The “seated” man model representing the passenger was obtained from the standing model by modifying the articulation angles at the hips and the knees. Details of the computational method and model are provided in the Appendix A to this report. The evaluation of the computational uncertainties and results of the benchmark validations are provided in the Appendix B attached to this report. The related IEC/IEEE 62704-2:2017 standard numerical uncertainty budget for exposure simulations with vehicle mounted wire antennas operating at the simulated frequencies is summarized in the Appendix B.

The XFDTD code validation performed by Remcom Inc. according to the IEEE/IEC 62704-2:2017 standard requirements is also provided in conjunction with this report.

The car model has been imported into XFDTD™ from the CAD file of the sedan vehicle defined in the IEEE/IEC 62704-2:2017 standard, having dimensions 4.98 m (L) x 1.85 m (W) x 1.18 m (H), and discretized with the minimum resolution of 3 mm and the maximum resolution of 8 mm. Figure 1 below shows both the vehicle CAD model and a picture of the actual vehicle.



Figure 1: Picture of the vehicle and corresponding CAD model used in XFDTD™ simulations

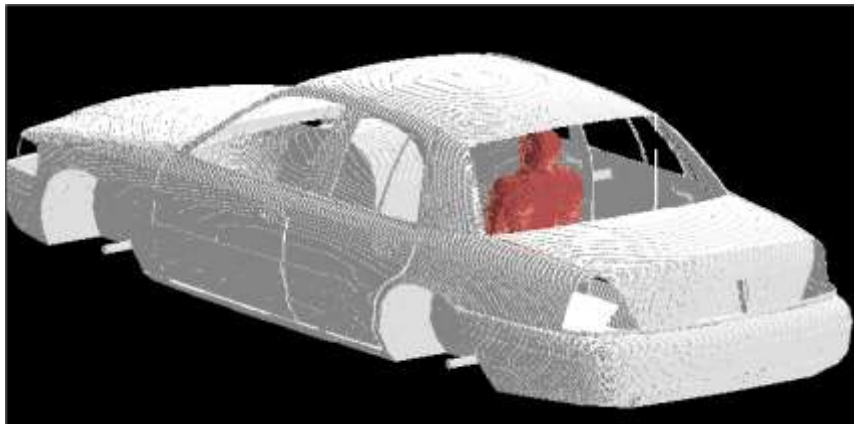
For back seat passenger exposures, the antenna is positioned on the trunk at 85 cm distance from the passenger model head when the passenger model is located in the center of the back seat, replicating the experimental conditions used in MPE

measurements. Figure 2 and Figure 3 shows the XFDTD™ computational models used for passenger exposure to trunk and roof mount antennas.

For bystander exposure, the antenna position is in the center of trunk, as to replicate the experimental conditions used in MPE measurements. Figure 4 and 5 shows some of the XFDTD™ computational models use for bystander exposure.

According to the IEC/IEEE 62704-2:2017 standard a lossy dielectric slab featuring 30 cm thickness, relative dielectric constant 8 and conductivity 0.01 S/m has been introduced in the computational model to properly account for the effect of the ground (pavement) on exposure.

The computational code employs a time-harmonic field excitation to produce a steady-state electromagnetic field in the exposed body model. Subsequently, the corresponding SAR distribution is automatically processed in order to determine the whole-body SAR and peak spatial average SAR distribution.



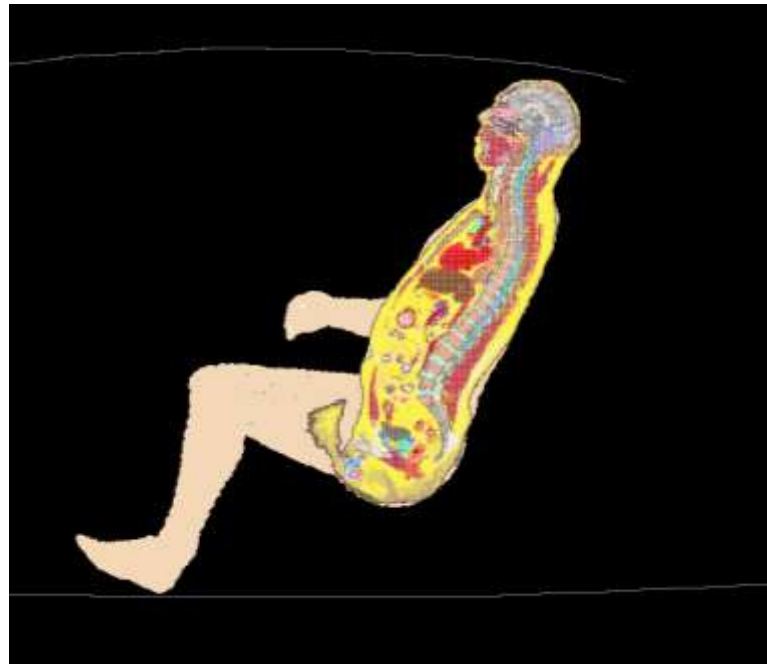
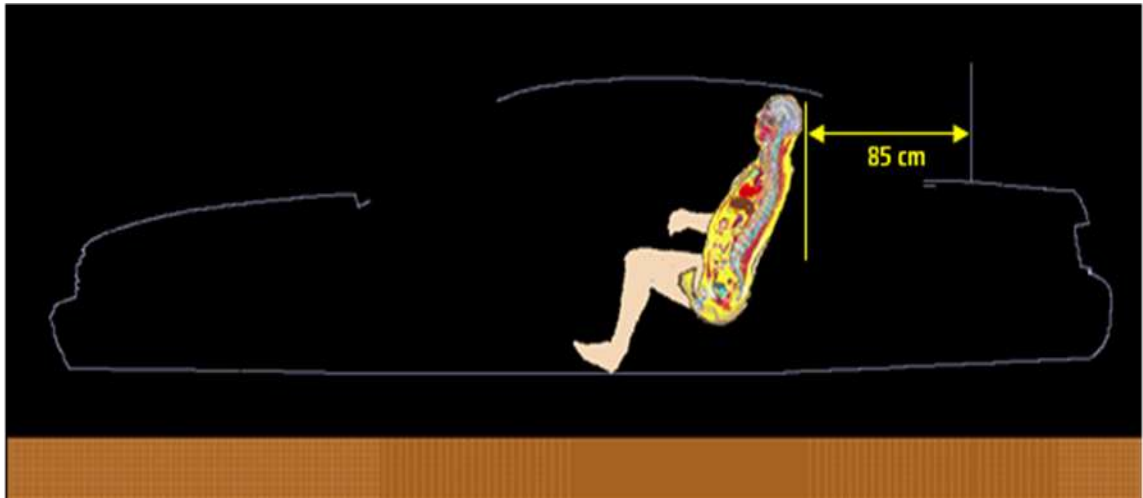


Figure 2: Passenger (back seat) model exposed to a trunk-mount antenna: XFDTD™ geometry.
The antenna is installed at 85 cm from the passenger located in the center of the back seat.

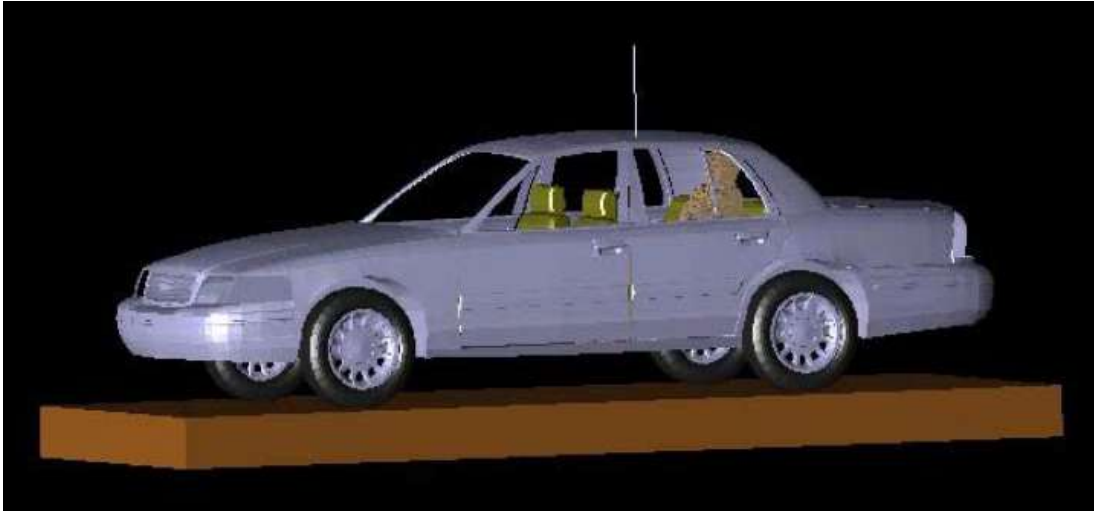


Figure 3: Passenger (back seat) model exposed to a roof-mount antenna: XFDTD™ geometry.

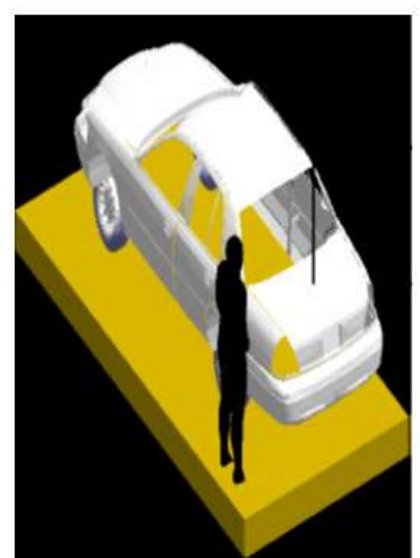
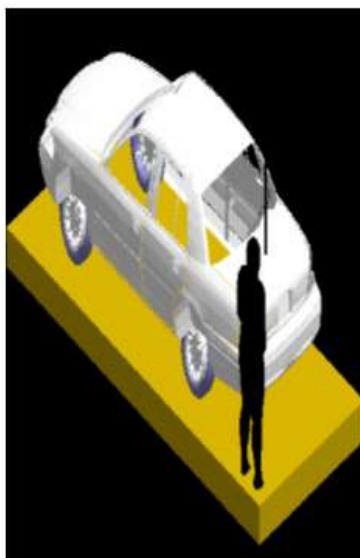
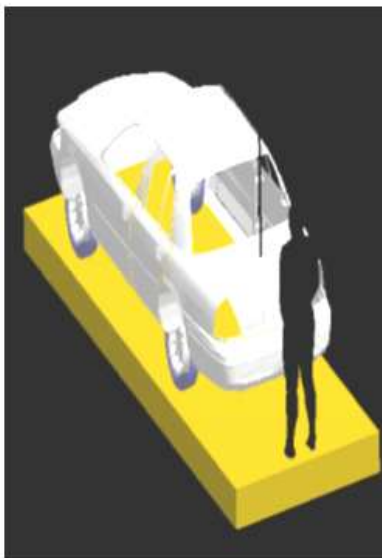


Figure 4: Bystander model exposed to a trunk-mount antenna: XFDTD™ geometry.

Bystander is located at the back, on the corner or at the side of the car replicating the measurement conditions.



Figure 5: Top view of bystander exposure model four different locations relative to the vehicle model that replicate the measurement conditions.

The maximum average output power from the mobile radio antenna is 30W (136–174 MHz). Since the ohmic losses in the vehicle materials, as well as the mismatch losses at the antenna feed-point, are neglected, while source-based time averaging (50% talk time for push-to-talk operation) for the VHF mobile radio were employed, all computational results are normalized to half of the VHF mobile radio maximum average net output power, i.e., 15W, minus the corresponding minimum insertion loss in excess of 0.5 dB of the feed cables supplied with the antennas, in accordance with the IEC/IEEE 62704-2:2017 standard provisions.

Results of SAR Computations for Car Passengers

The test conditions requiring SAR computations are summarized in Table 1 (Passengers) and Table 2 (Bystander), together with the antenna data, the SAR results, and power density (P.D.) as obtained from the MPE measurements in the corresponding test conditions. The conditions are for antennas mounted in the center of the trunk and roof. The antenna length listed in the tables includes the height of the 1.8 cm magnetic mount base used in MPE measurements to position the antenna on the vehicle. The same length was then used in the corresponding simulation model.

The passenger is located in the center or on the side of the rear seat corresponding to the respective configurations defined in the IEC/IEEE 62704-2:2017 standard. The bystander is located at the measurement distance from the transmit antenna as described in the MPE report and assessed for front and rear exposure.

All the transmit frequency, antenna length, and passenger/bystander location reported in Table 1 and Table 2 have been simulated individually. These tables also include the interpolated adjustment factor and corresponding SAR scaled values following the requirements of the IEC/IEEE 62704-2:2017 standard.

**Table 1a: Computed and Adjusted SAR Results for Back Seat Passenger Exposure
(VHF 150.8–173.4 MHz)**

(Configurations exceeding FCC MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm ²)	Exposure Location	Computations SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1-g	WB	1-g	WB	1-g	WB
Roof	HAD4008A, 1/4 Wave (150.8-162MHz)	47.3	162.0000	0.20	Back Center	0.01	0.001	1.35	1.90	0.02	0.001
					Back Side	0.03	0.001	1.03	2.42	0.03	0.002
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	107.3	158.0125	0.21	Back Center	0.12	0.005	1.91	2.41	0.23	0.013
					Back Side	0.09	0.004	4.14	2.99	0.36	0.013
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	98.3	165.0125	0.35	Back Center	0.16	0.007	1.93	2.42	0.31	0.017
					Back Side	0.11	0.005	4.09	2.98	0.46	0.016
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	90.6	173.0125	0.31	Back Center	0.14	0.007	1.94	2.43	0.28	0.018
					Back Side	0.11	0.006	4.03	2.97	0.46	0.019

Note:

Bold Blue – the highest adjusted SAR results for the respective frequency bands.

* - Antenna length trimmed to frequency.

**Table 1b: Computed and Adjusted SAR Results for Back Seat Passenger Exposure
(ISED Canada VHF 138–174 MHz)**

(Configurations exceeding ISED MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm2)	Exposure Location	Computations SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1-g	WB	1-g	WB	1-g	WB
Roof	HAD4008A, 1/4 Wave (150.8-162MHz)	47.3	#162.0000	0.20	Back Center	0.01	0.001	1.35	1.90	0.02	0.001
					Back Side	0.03	0.001	1.03	2.42	0.03	0.002
Roof	HAD4009A, 1/4 wave (162-174MHz)	44.8	165.0125	0.17	Back Center	0.01	0.001	1.37	1.89	0.01	0.001
					Back Side	0.03	0.001	1.04	2.43	0.03	0.002
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	107.3	#158.0125	0.21	Back Center	0.12	0.005	1.91	2.41	0.23	0.013
					Back Side	0.09	0.004	4.14	2.99	0.36	0.013
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	98.3	#165.0125	0.35	Back Center	0.16	0.007	1.93	2.42	0.31	0.017
					Back Side	0.11	0.005	4.09	2.98	0.46	0.016
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	90.6	#173.0125	0.31	Back Center	0.14	0.007	1.94	2.43	0.28	0.018
					Back Side	0.11	0.006	4.03	2.97	0.46	0.019

Note:

Bold Blue – the highest adjusted SAR results for the respective frequency bands.

* - Antenna length trimmed to frequency.

Note: # Same SAR simulation configuration as FCC US.

**Table 2: Computed and Adjusted SAR Results for Bystander Exposure
(ISED Canada VHF 138–174 MHz)**

(Configurations exceeding ISED MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm2)	Exposure Location	Computations SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1-g	WB	1-g	WB	1-g	WB
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	130.0	138.0000	0.14	0 deg Front	0.08	0.004	1.32	2.04	0.11	0.008
				0.14	0 deg Rear	0.15	0.004	1.32	2.04	0.19	0.008
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	120.3	144.0000	0.14	0 deg Front	0.10	0.005	1.31	1.97	0.13	0.009
				0.14	0 deg Rear	0.17	0.005	1.31	1.97	0.23	0.009
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	115.8	150.8000	0.14	0 deg Front	0.11	0.005	1.30	1.90	0.14	0.009
				0.14	0 deg Rear	0.18	0.005	1.30	1.90	0.24	0.009
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	115.8	150.8000	0.15	45 deg Front	0.13	0.004	1.30	1.90	0.16	0.009
				0.15	45 deg Rear	0.12	0.004	1.30	1.90	0.15	0.007
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	98.3	158.0125	0.14	90 deg Front	0.18	0.008	1.32	1.91	0.24	0.014
				0.14	90 deg Rear	0.19	0.007	1.32	1.91	0.25	0.013

Note:

Bold Blue – the highest adjusted SAR results for the respective frequency bands.

* - Antenna length trimmed to frequency.

The SAR distribution in the passenger exposure condition that gave highest adjusted 1-g SAR for the Genesee VHF mobile radio (FCC US, ISED Canada) is reported in Figure 4. (165.0125MHz, passenger in the side of the back seat, HAD4022A antenna installed on the trunk).

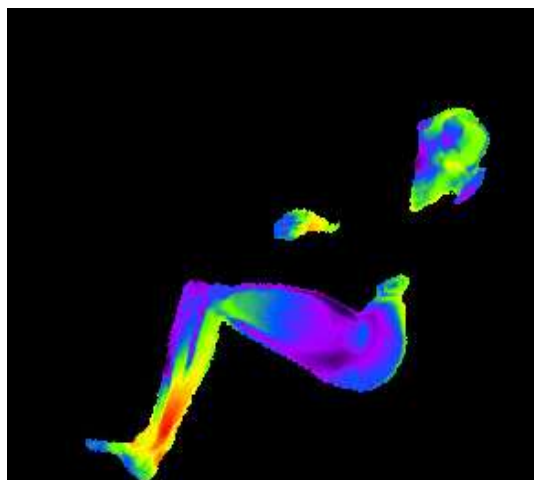
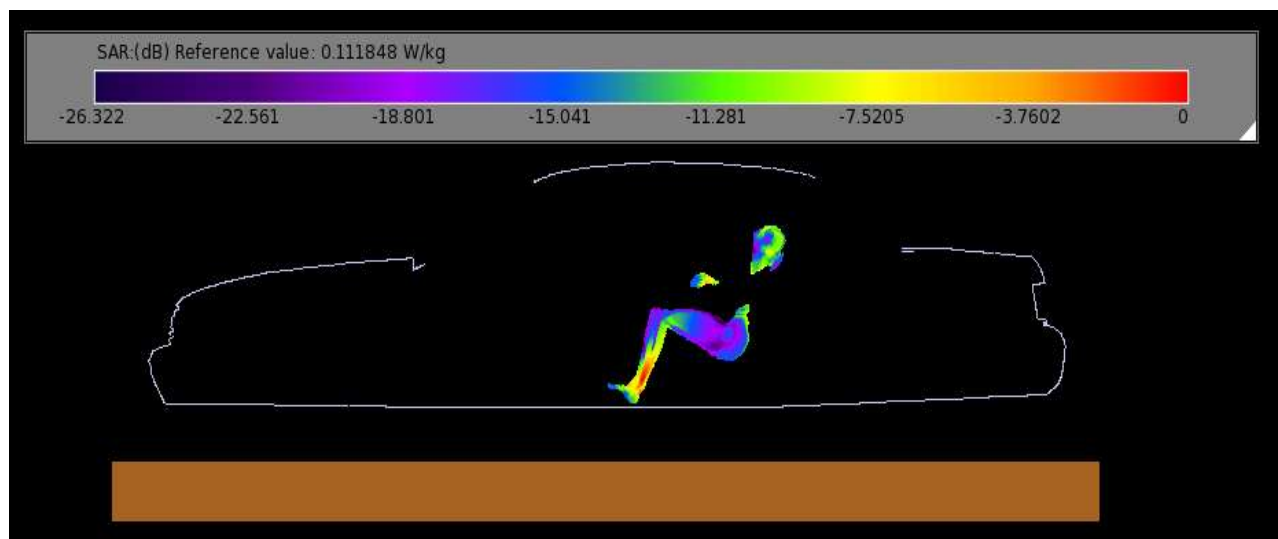
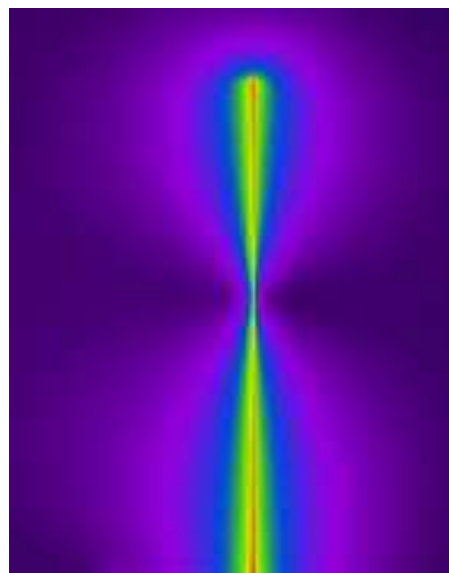
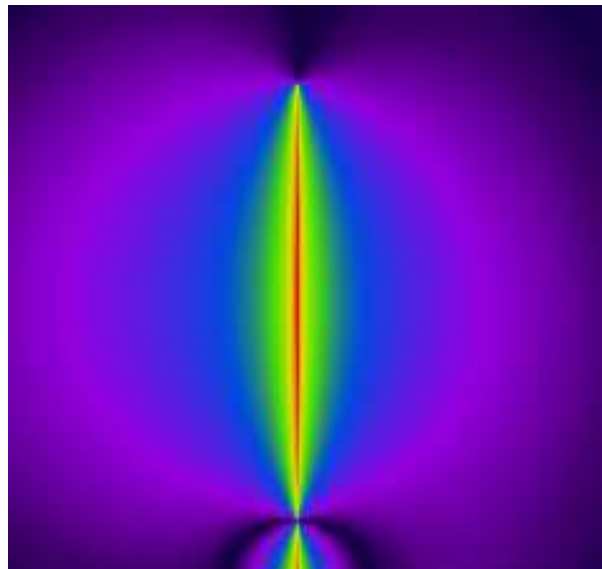
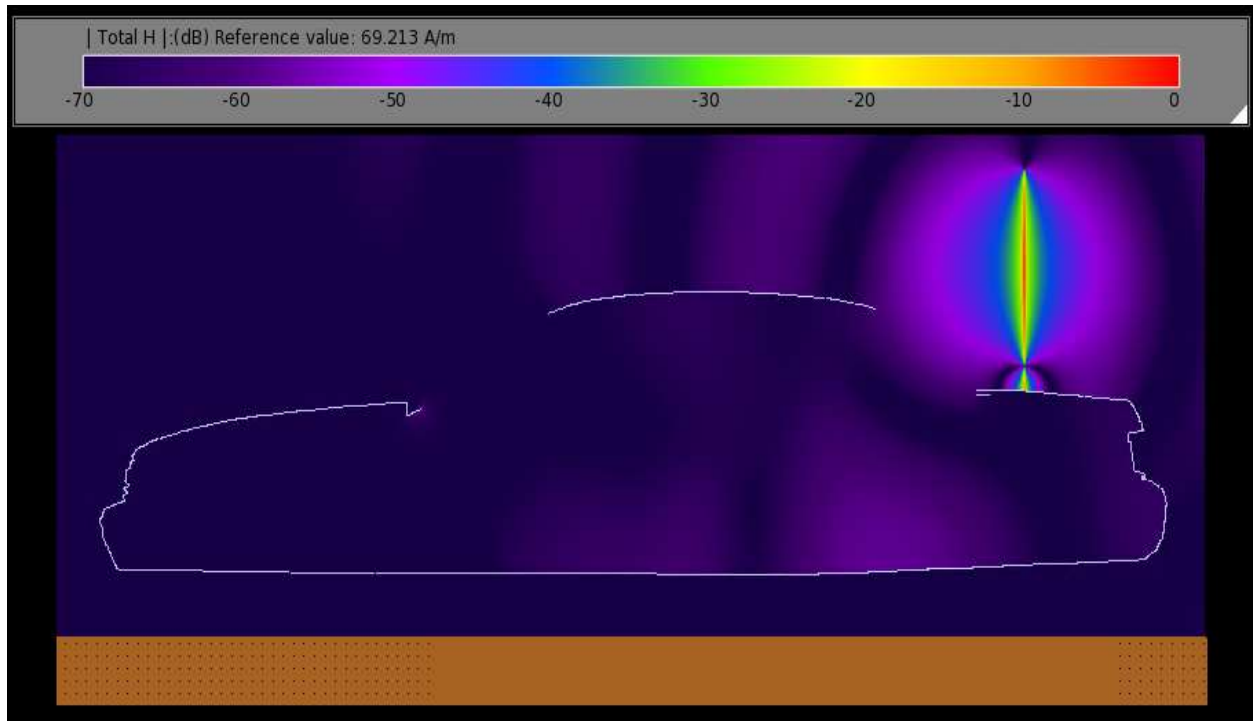


Figure 4. SAR distribution at 165.0125MHz in the passenger model located in the side of the back seat, produced by the trunk-mount HAD4022A antenna. The SAR distribution plot is relative to the plane where the peak 1-g average SAR for this exposure condition occurs.

The plots in Figure 5 illustrate the E and H field distributions in the plane of the antenna corresponding to the exposure condition resulting in the SAR distribution in Figure 4.



a)



b)

Figure 5. (a) E-field magnitude distribution corresponding to exposure condition of Figure 4, and (b) H-field magnitude distribution corresponding to exposure condition of Figure 4.

The SAR distribution in the bystander exposure condition that gave highest adjusted 1-g SAR for the Genesee VHF mobile radio (ISED Canada) is reported in Figure 6. (158.0125MHz, bystander facing 90-degree rear, HAD4022A antenna installed on the trunk).

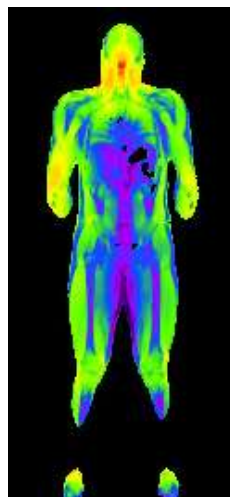
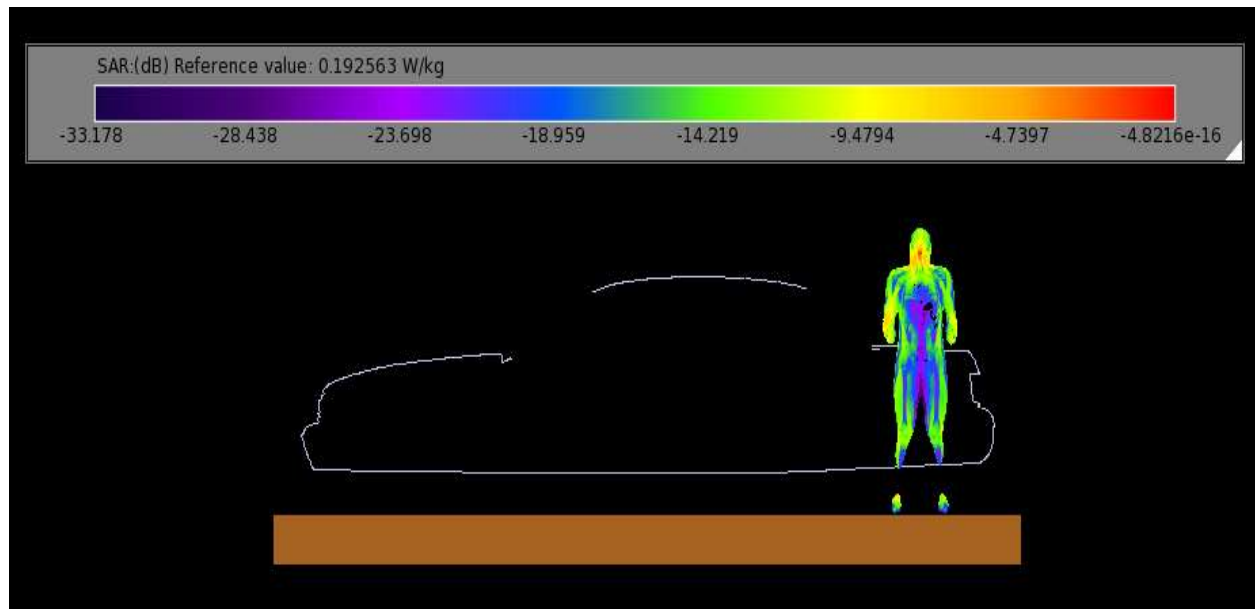
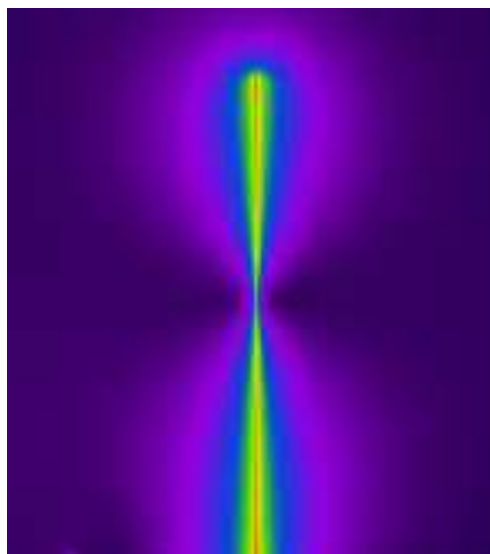
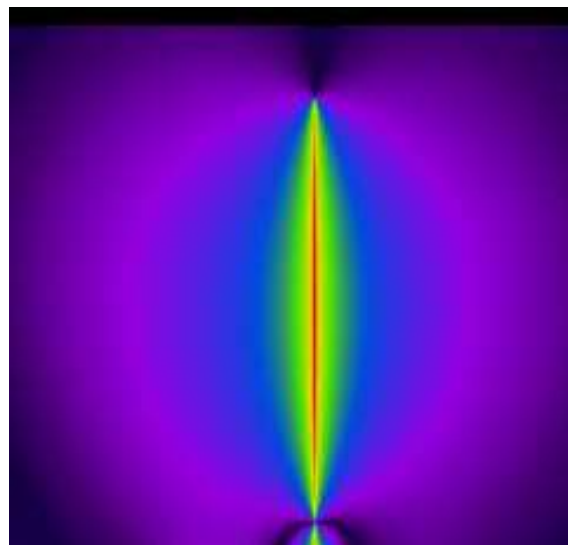
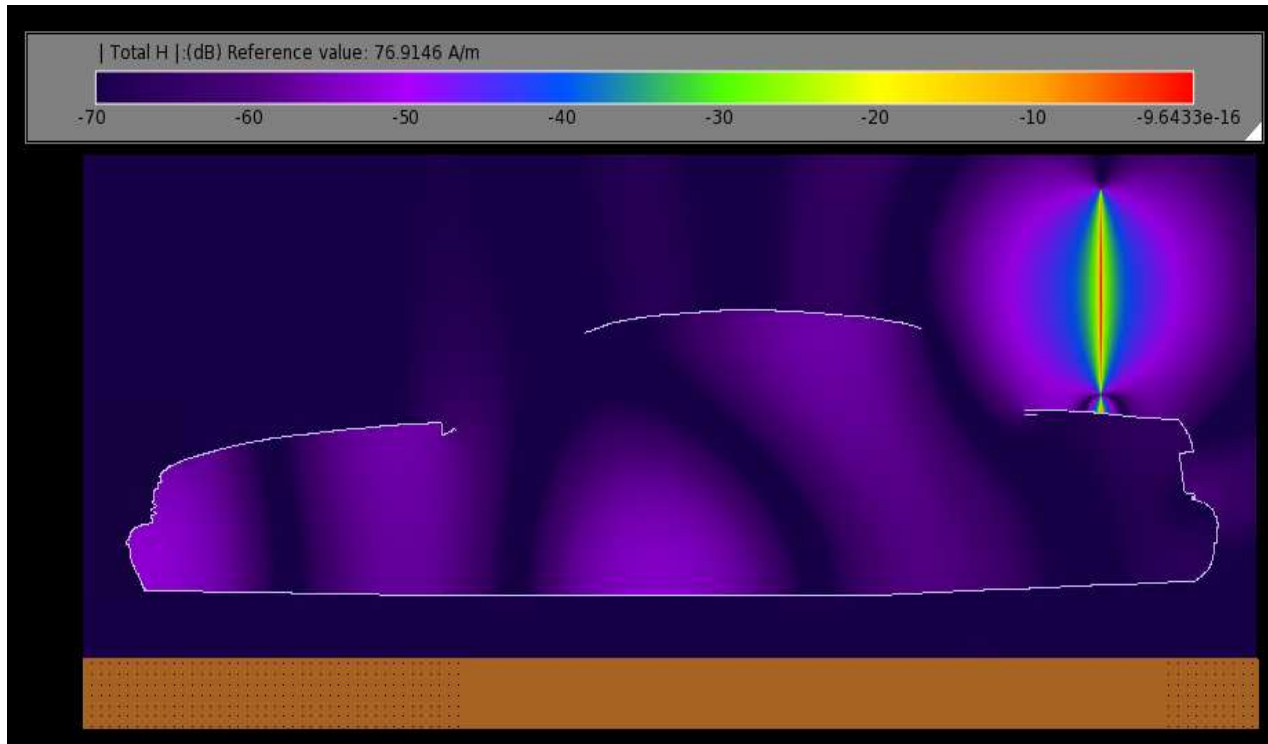


Figure 6. SAR distribution at 158.0125 MHz in the bystander model facing 90-degree rear, produced by the trunk-mount HAD4022A antenna. The SAR distribution plot is relative to the plane where the peak 1-g average SAR for this exposure condition occurs.

The plots in Figure 7 illustrate the E and H field distributions in the plane of the antenna corresponding to the exposure condition resulting in the SAR distribution in Figure 6.



a)



b)

Figure 7. (a) E-field magnitude distribution corresponding to exposure condition of Figure 6, and (b) H-field magnitude distribution corresponding to exposure condition of Figure 6.

SAR Simulation Reduction Considerations

Per the Response to Inquiry to FCC Tracking Number 528198, for a particular antenna that has more than one configuration which exceeds the MPE limit, SAR evaluations shall begin with the highest MPE configuration (mount location and frequency channel). If the SAR value is less than 50% of the SAR limit, no further SAR evaluation is needed for that antenna.

If the highest MPE configuration SAR value is above 50% of the SAR limit, a subsequent SAR simulation shall be performed on the subsequent highest MPE configuration (ranked in descending percentage of the MPE limit). If the subsequent adjusted SAR value is below 75% of the limit, no further SAR evaluation is needed for that antenna, otherwise further SAR simulations for the remaining antenna configurations shall continue until the adjusted SAR value is below 75% of the SAR limit.

Table 3 and Table 4 below lists all the configurations that did not conform to applicable MPE limits (ranked in descending percentage of the MPE limit), to which the aforementioned SAR simulation reduction considerations were applied.

**Table 3a: SAR Simulation Reduction Considerations for Back Seat Passenger
(FCC US)**

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm2)	FCC Limit (mW/cm2)	% To FCC Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1-g	WB	
Roof	HAD4008A, 1/4 Wave (150.8-162MHz)	162.00000	0.20	0.20	100.3	Back Center	0.02	0.001	
						Back Side	0.03	0.002	
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	165.01250	0.35	0.20	174.3	Back Center	0.31	0.017	
						Back Side	0.46	0.016	
		173.01250	0.31	0.20	153.0	Back Center	0.28	0.018	
						Back Side	0.46	0.019	
		158.01250	0.21	0.20	103.1	Back Center	0.23	0.013	
						Back Side	0.36	0.013	

**Table 3b: SAR Simulation Reduction Considerations for Back Seat Passenger
(ISED Canada)**

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm2)	ISED Limit (mW/cm2)	% To ISED Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1-g	WB	
Roof	HAD4008A, 1/4 Wave (150.8-162MHz)	162.00000	0.20	0.13	155.3	Back Center	0.02	0.001	
		156.40000	0.18	0.13	138.9	Back Side	0.03	0.002	
Roof	HAD4009A, 1/4 Wave (1621-174MHz)	165.01250	0.17	0.13	133.0	Back Center	0.01	0.001	The highest MPE configuration has SAR below 50% of the limit
		162.00000	0.17	0.13	130.5	Back Side	0.03	0.002	
		173.01250	0.15	0.13	116.1				
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	165.01250	0.35	0.13	270.0	Back Center	0.31	0.017	
						Back Side	0.46	0.016	
		173.01250	0.31	0.13	237.1	Back Center	0.28	0.018	
						Back Side	0.46	0.019	
		158.01250	0.21	0.13	159.7	Back Center	0.23	0.013	
						Back Side	0.36	0.013	

**Table 4: SAR Simulation Reduction Considerations for Bystander
(ISED Canada)**

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm2)	ISED Limit (mW/cm2)	% To ISED Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1-g	WB	
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	144.00000	0.14	0.13	111.2	0 deg Front	0.13	0.009	
						0 deg Rear	0.23	0.009	
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	150.80000	0.14	0.13	110.4	0 deg Front	0.14	0.009	
						0 deg Rear	0.24	0.009	
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	138.00000	0.14	0.13	110.3	0 deg Front	0.11	0.008	
						0 deg Rear	0.19	0.008	
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	144.00000	0.15	0.13	115.4	45 deg Front	0.17	0.008	
						45 deg Rear	0.13	0.008	
Trunk	*HAD4022A, 5/8 Wave (132-174MHz)	158.01250	0.14	0.13	108.3	90 deg Front	0.24	0.014	
						90 deg Rear	0.25	0.013	

Results of SAR Computations

Based on the simulated results provided in the data table, the maximum peak SAR values were evaluated. The overall adjusted maximum peak 1-g SAR for passenger is 0.46 W/kg and bystander is 0.25 W/kg which is safely below the 1.6 W/kg limit. Similarly, the overall adjusted maximum Whole-Body (WB) average SAR for passenger reaches a peak of 0.019 W/kg and bystander is 0.013 W/kg, remaining well under the 0.08 W/kg regulatory limit.

Conclusions

Under the test conditions described for evaluating passenger exposure to the RF electromagnetic fields emitted by vehicle-mounted antennas used in conjunction with these products, the present analysis shows that the computed SAR values are compliant with the FCC and ISED Canada general public 1-g and whole body SAR limits.

References

- [1] Health Canada Safety Code 6 (2015). Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz.
- [2] IEEE Standard C95.1-1999. *IEEE Standard for Safety Levels with Respect to Human Exposure to RF Electromagnetic Fields*, 3 kHz to 300 GHz.
- [3] http://www.nlm.nih.gov/research/visible/visible_human.html
- [4] ICNIRP (International Commission on Non-Ionising Radiation Protection) 1998. *Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)*. Health Phys. 74:494–522.
- [5] IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz. IEEE Std C95.1-2019 (Revision of IEEE Std C95.1-2005/ Incorporates IEEE Std C95.1-2019/Cor 1-2019) .