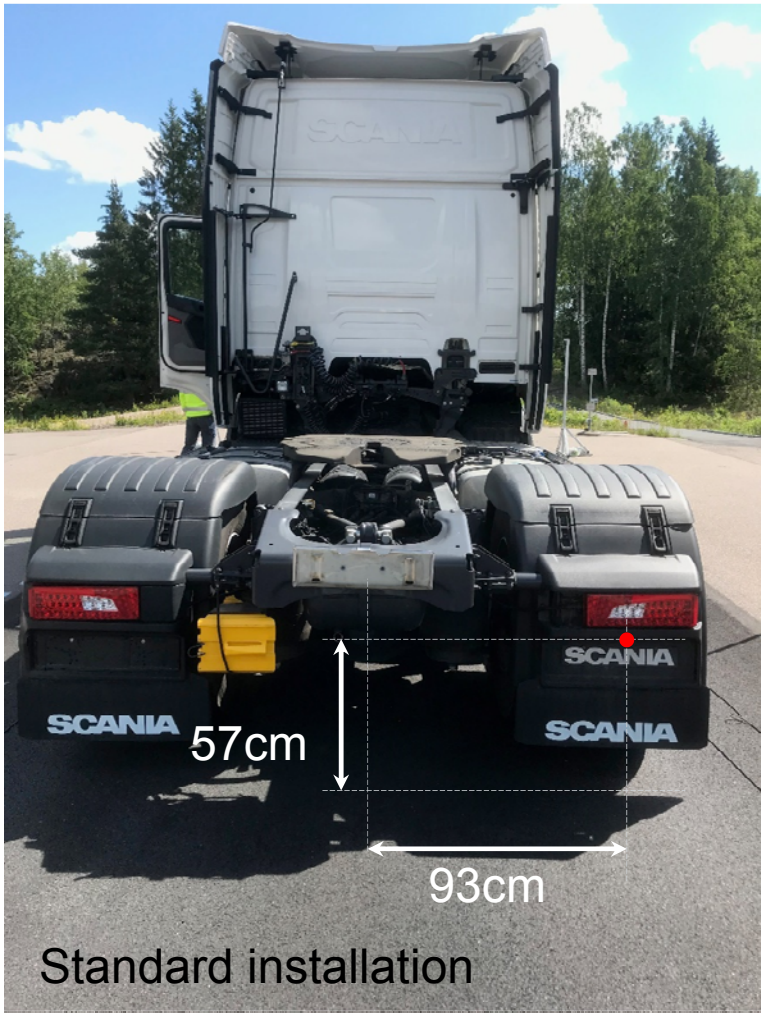
Reverse Warning Sound Device

Sound Device without noise reduction

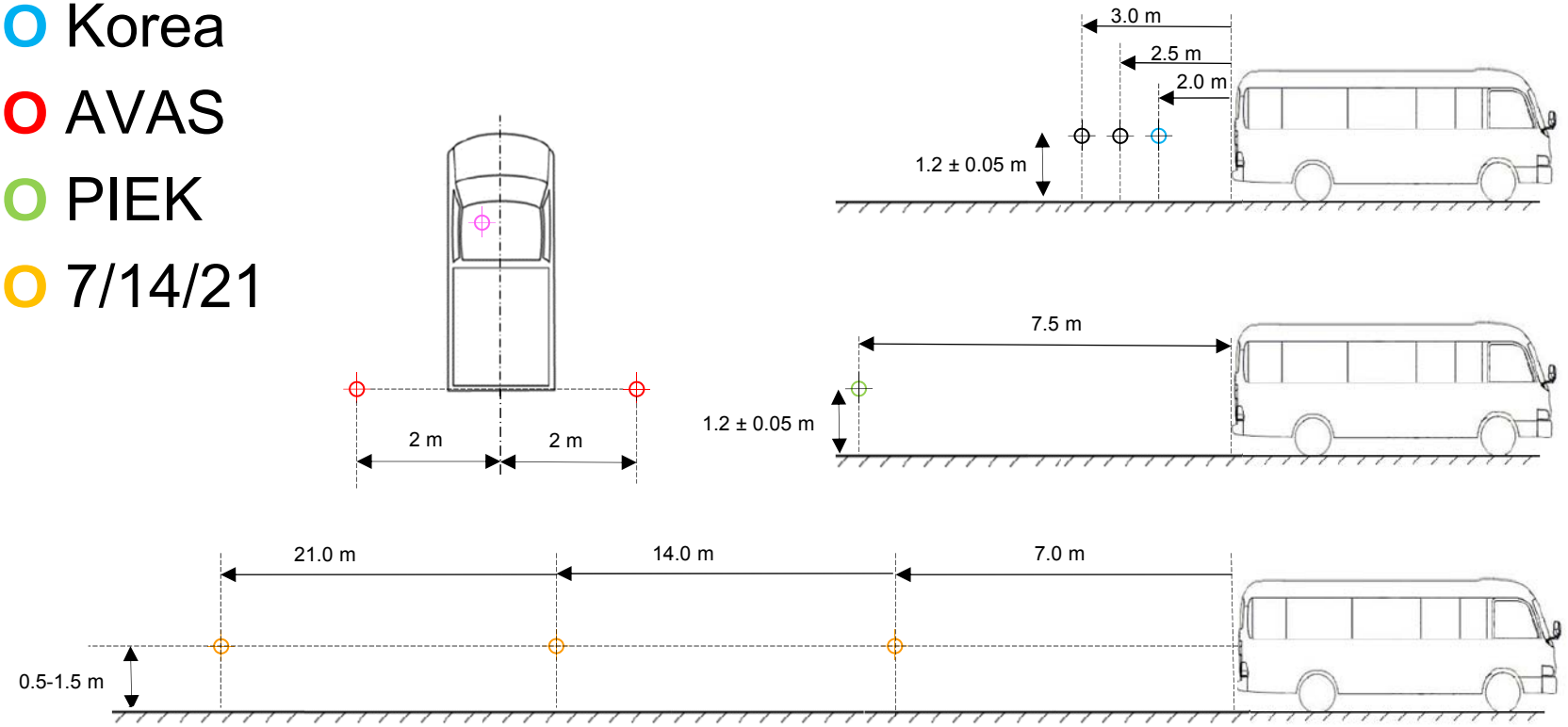
Outdoor Sound Measurement

Device Installation



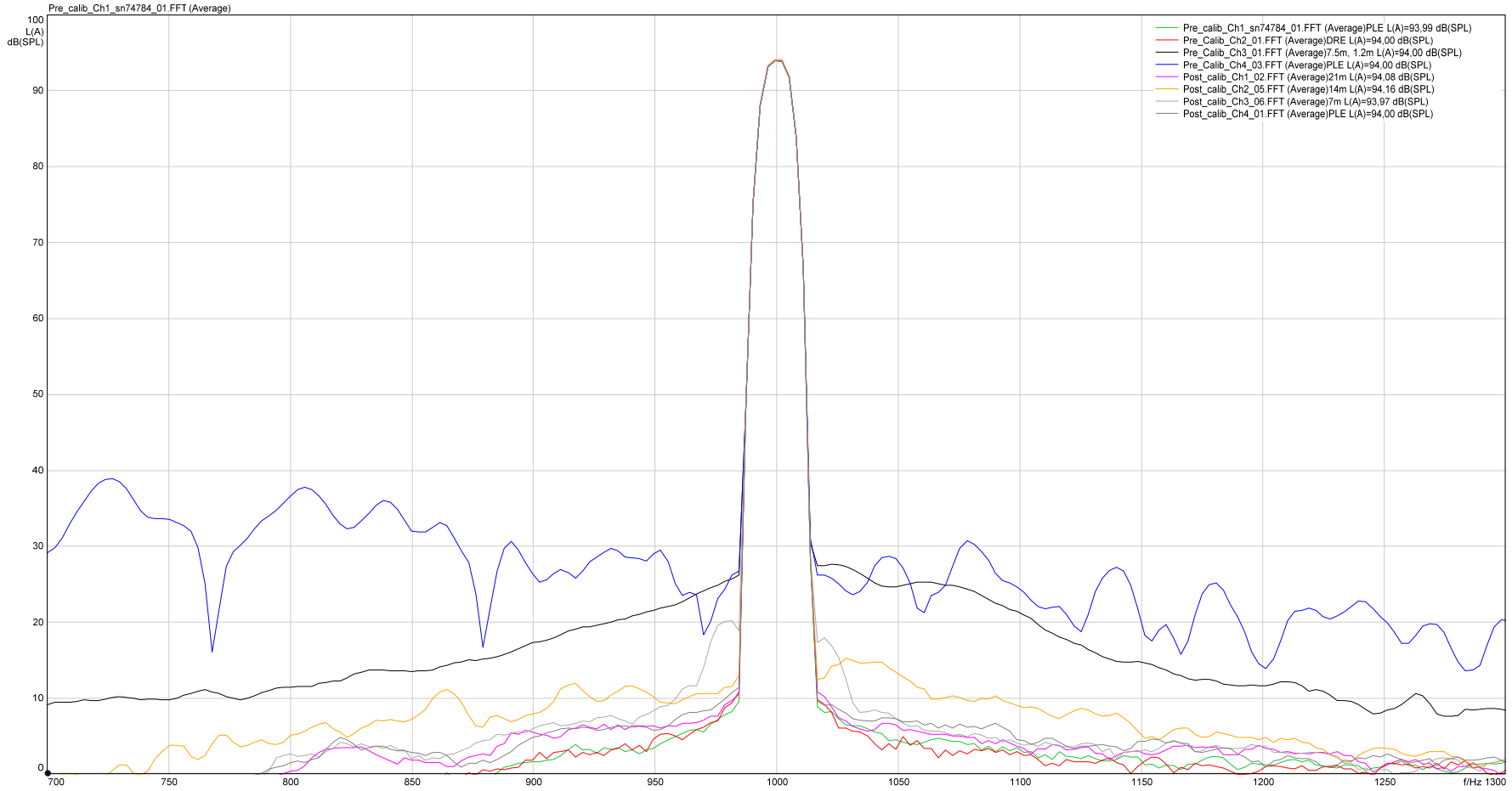
Microphone Positions

- Korea
- AVAS
- PIEK
- 7/14/21



All results are calculated with integration time constant τ=*125ms* (”Fast”)

Pre-/Post-Calibration



Korea

Specification

KMVSS Art. 53-2: QRTV (2017.07)

Article 53-2 (Rear pedestrian safety device)
(1) The vehicle shall be equipped with at least any one of each of following safety devices. The school bus shall be equipped with all the devices applicable to Item1 and Item3.
1. Rear-monitor system with which an observation rod (30 millimeters in diameter and 500 millimeters in height) installed in an area of 1,000 mm on left/right side and 300 ~ 2,000 mm behind the center of the rear side can be seen.
2. Approach-warning sound system notifying the driver that the pedestrian closes to the rear side of vehicle when driving in rearward direction.
3. Rearward-warning sound system notifying the pedestrian the vehicle in rearward motion.
(2) Rearward-warning sound system shall meet each the following requirements pursuant to Clause 1 Item 3.
1. The warning sound shall be operated and paused repeatedly. And the sound of same tone shall be generated at regular intervals.
2. The warning sound shall meet each of the following requirements of sub-para, upon 2 meters test from the rear side.
a. 60 dB(A) or more and 85 dB(A) or less for PC, small-sized bus/truck, and special purposed vehicle
b. 65 dB(A) or more and 90 dB(A) or less for vehicles other than sub-para a'
3. The tone of warning sound shall have the maximum volume where one-third octave band is between 500Hz and 4000Hz.

Acceptance criteria:

- $65 < L_p < 90$ dB(A)
- tone within 500Hz and 4kHz 1/3oct band

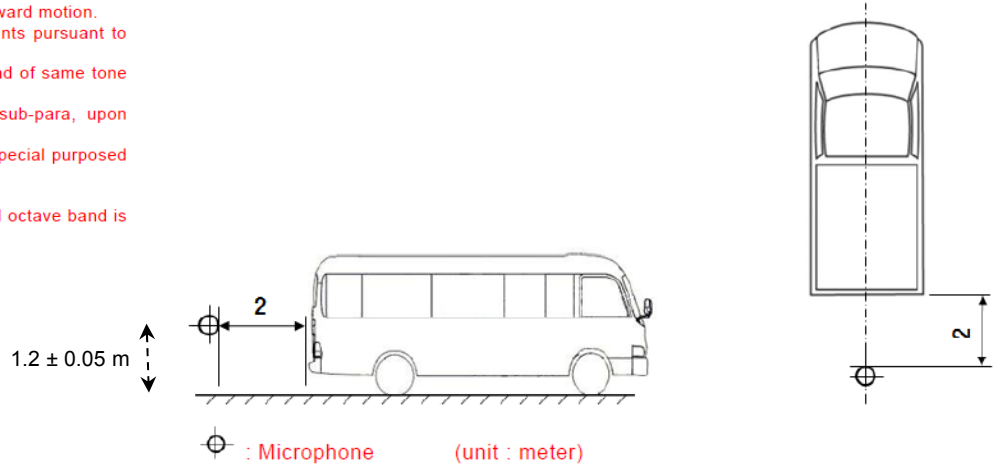


Figure 2. the method of installing the microphone for rear warning sound system

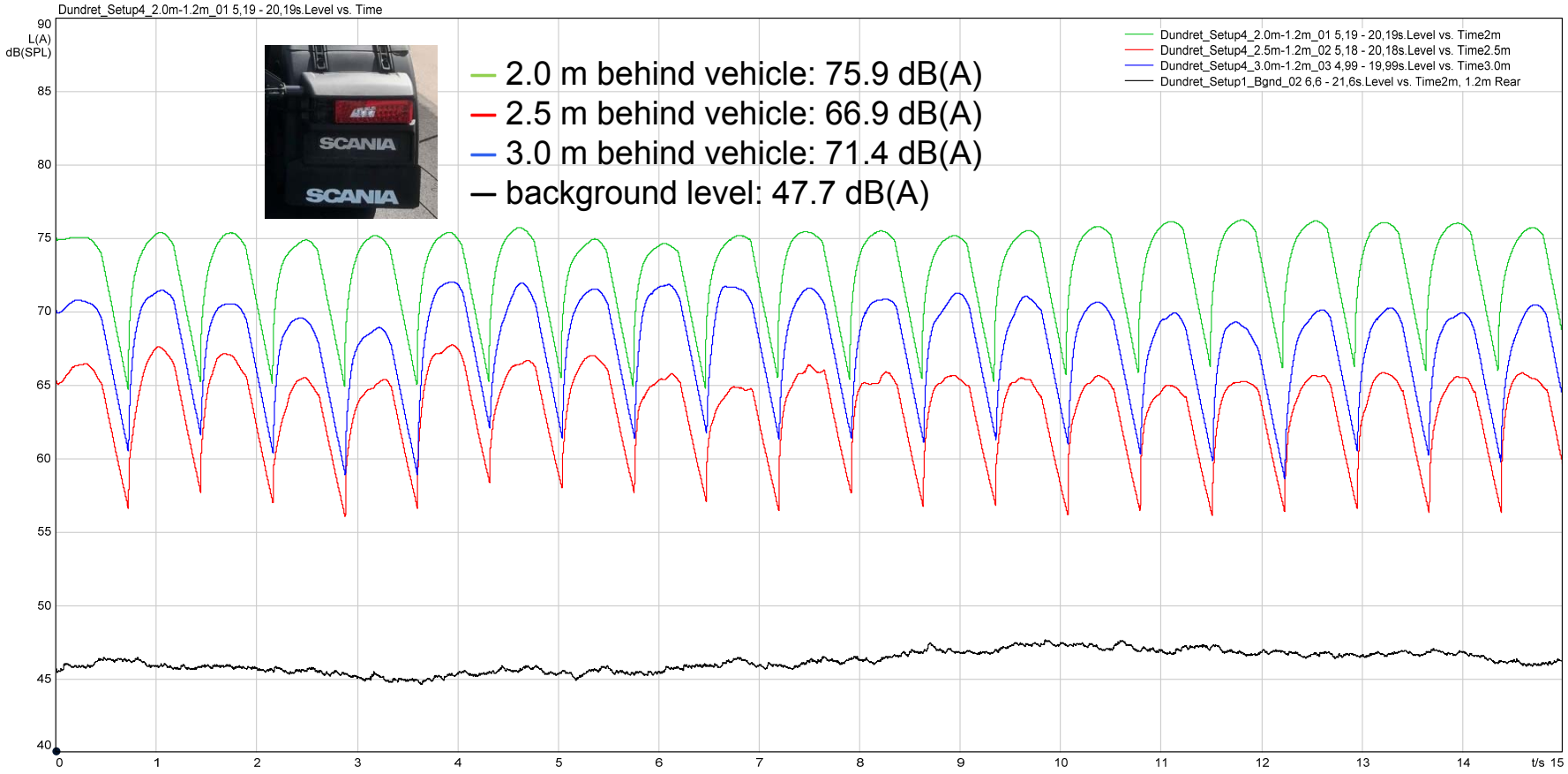
Setup

Summary (Standard installation)

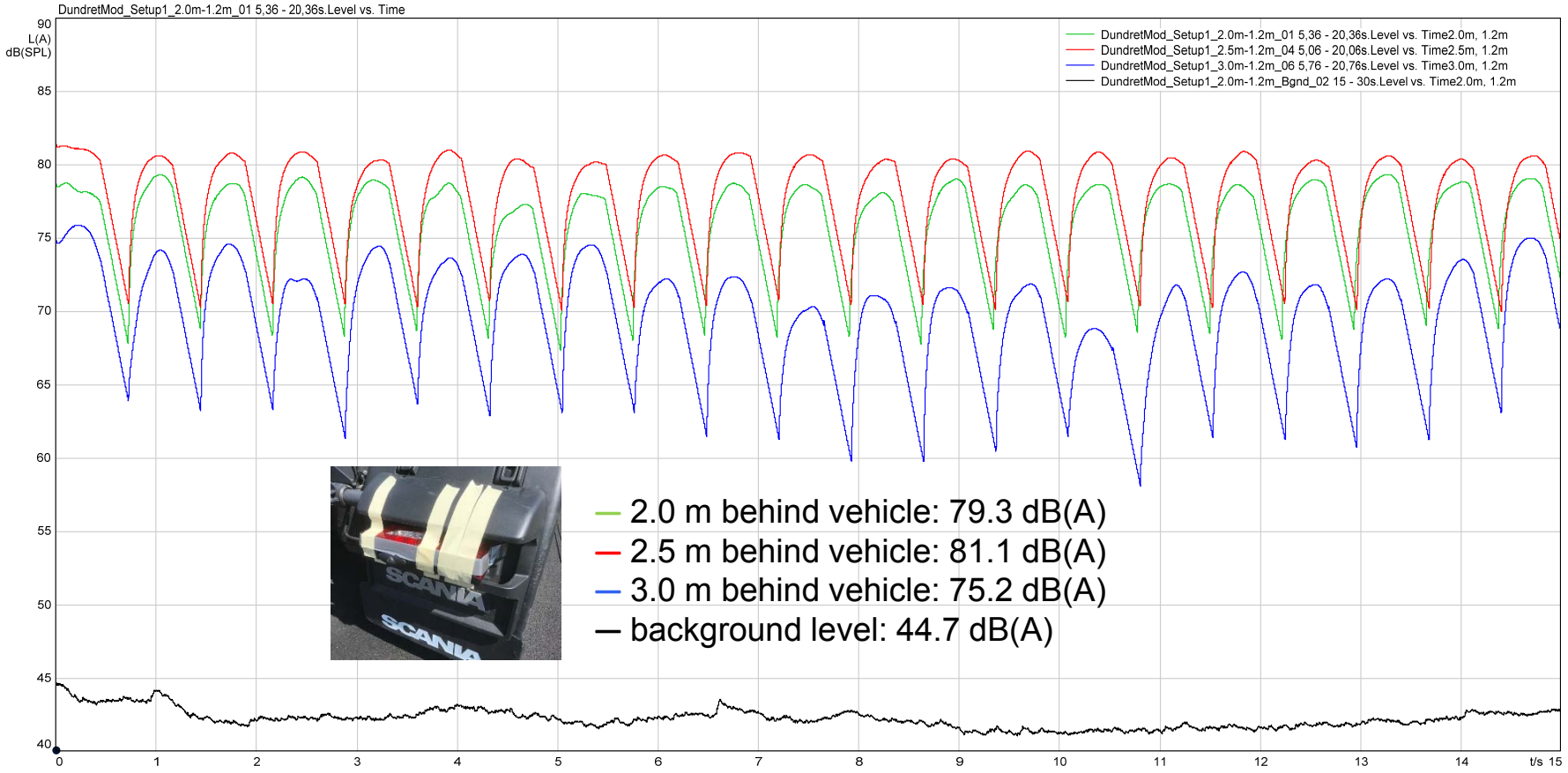
SOUND LEVEL					
No	Ambient noise [dB(A)]	Measured value [dB(A)]	Result [dB(A)]	Requirements [dB(A)]	Judgement
1	47.7	75.8	75.9	$65 \leq L_{AF} \leq 90$	OK
2		75.6			
3		76.3			

SOUND TONE			
No	The highest 1/3 octave center frequency [Hz]	Requirements [Hz]	Judgement
1	3150	500 ≤ B ≤ 4000	OK
2	3150		
3	3150		

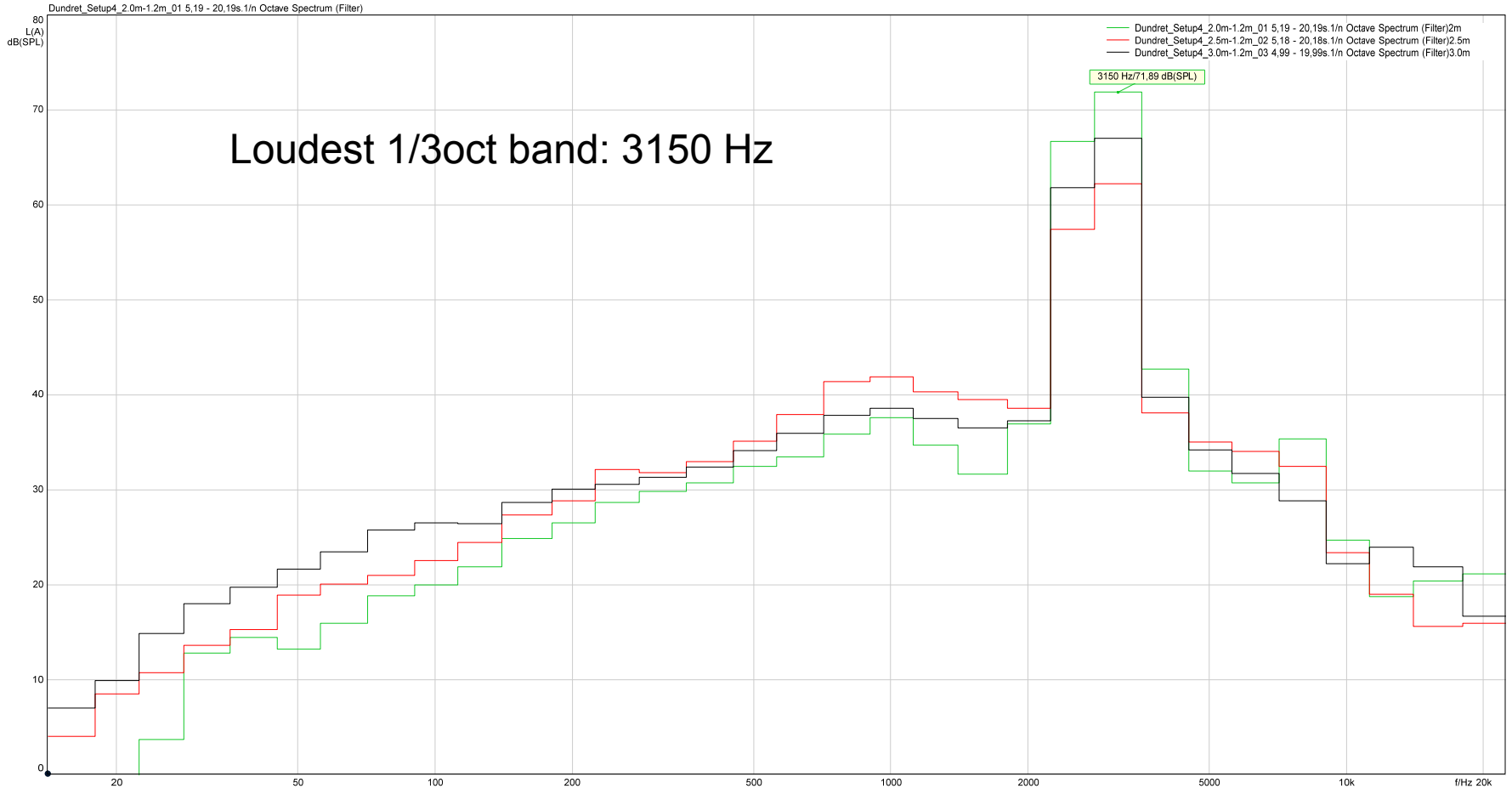
Results: Standard installation



Results: 90 degree rotation



Results: Frequency Band



AVAS

Specification

KMVSS Art. 53-3: R138 (AVAS)

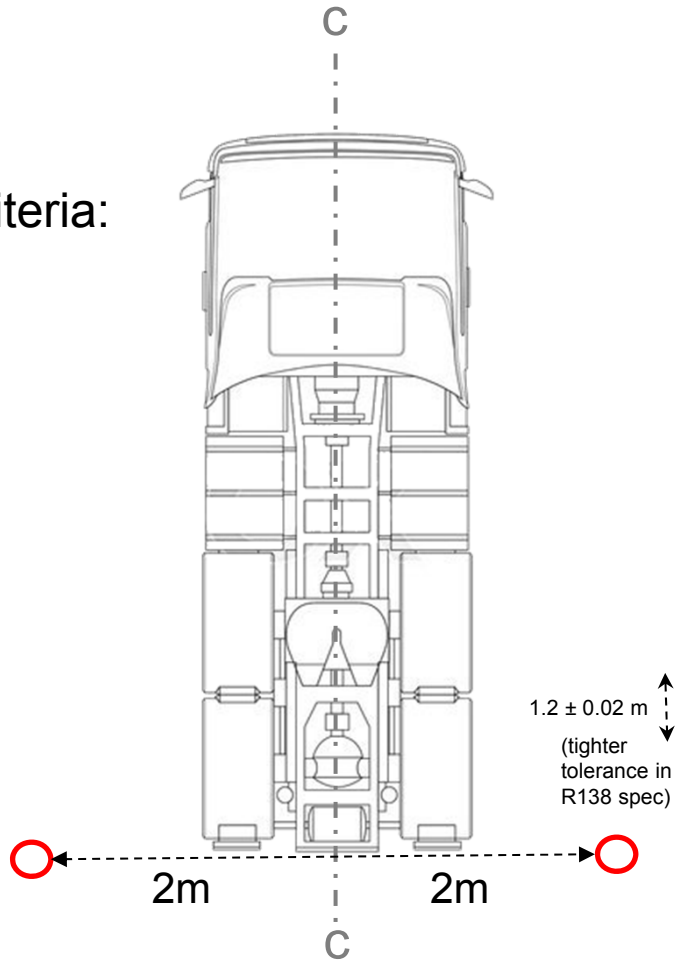
Article 53-3 (Acoustic Vehicle Alerting System(AVAS) for Quiet Road Transport Vehicles(QRTV))
The AVAS compliant with each of following items shall be equipped in QRTV (vehicle using the electric energy such as EV, FCEV, HV etc.). However, if the vehicle not equipped with an AVAS fulfils the overall levels as specified in Table 6-33 below with a margin of +3 dB(A), it may be regarded as meeting the requirements.
1. The AVAS shall operate in the speed range of at least 20 km/h or less from the start.
2. The warning sound pursuant to item 1 shall meet the requirements specified in each of the following sub-paras.
   a. The overall sound shall be not less than the overall minimum sound level requirements specified in Table 6-33.
   b. The alarm has at least two of the one-third octave bands applicable to the minimum sound level requirements pursuant to Table 6-33. At least one of these bands shall be below or within the 1,600 Hz one-third octave band.
3. The warning sound shall have frequency shift characteristics applicable to the each of the following items to inform road users about the change in vehicle speed when driving in forward direction.
   a. The warning sound emitted by the vehicle shall vary proportionally with speed within each individual gear ratio by an average of at least 0.8 % per 1 km/h in the speed range from 5 km/h to 20 km/h.
   b. The warning sounds meeting the requirements of the sub-para a. shall be within the frequency range in Table 6-33, at least one of them shall meet the requirements of the frequency shift characteristics.
4. The overall sound level shall not exceed 75 dB(A) when driving in forward direction.
5. The function enabling the driver to deactivate the warning sound (warning sound off-switch) shall not be installed.
6. AVAS equipped with various type of warning sounds, shall meet the requirements specified in Item 1 thru Item 5.

Minimum Sound Level Requirements in dB(A) (Article 53-3)

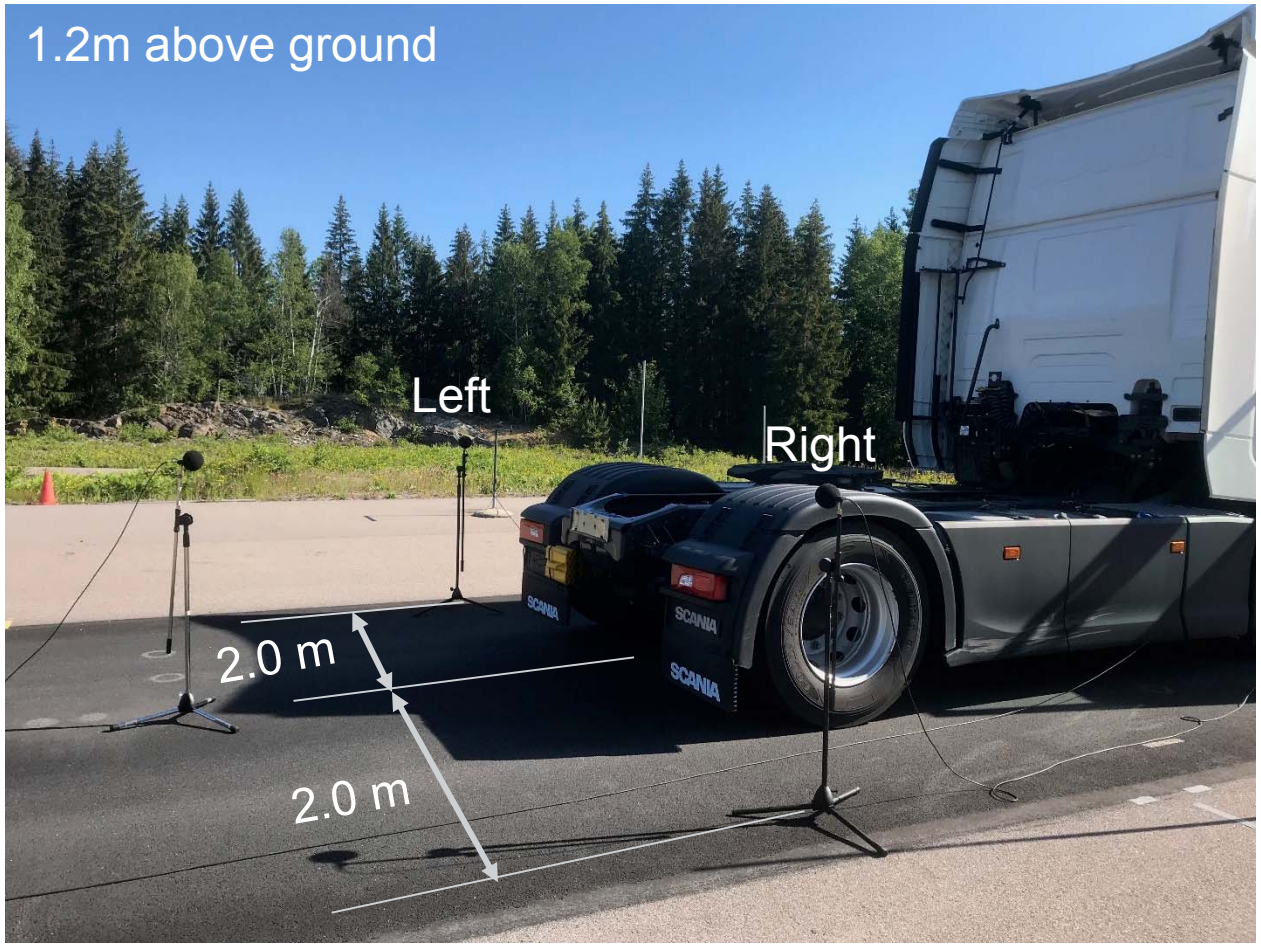
Frequency in Hz		10km/h in Forward Direction [dB(A)]	20km/h in Forward Direction [dB(A)]	Rearward [dB(A)]
Column 1	Column 2	Column 3	Column 4	Column 5
Overall		50	56	47
1/3rd Octave Bands	160	45	50	
	200	44	49	
	250	43	48	
	315	44	49	
	400	45	50	
	500	45	50	
	630	46	51	
	800	46	51	
	1000	46	51	
	1250	46	51	
	1600	44	49	
	2000	42	47	
	2500	39	44	
	3150	36	41	
	4000	34	39	
	5000	31	36	

Acceptance criteria:

- see Table



Setup

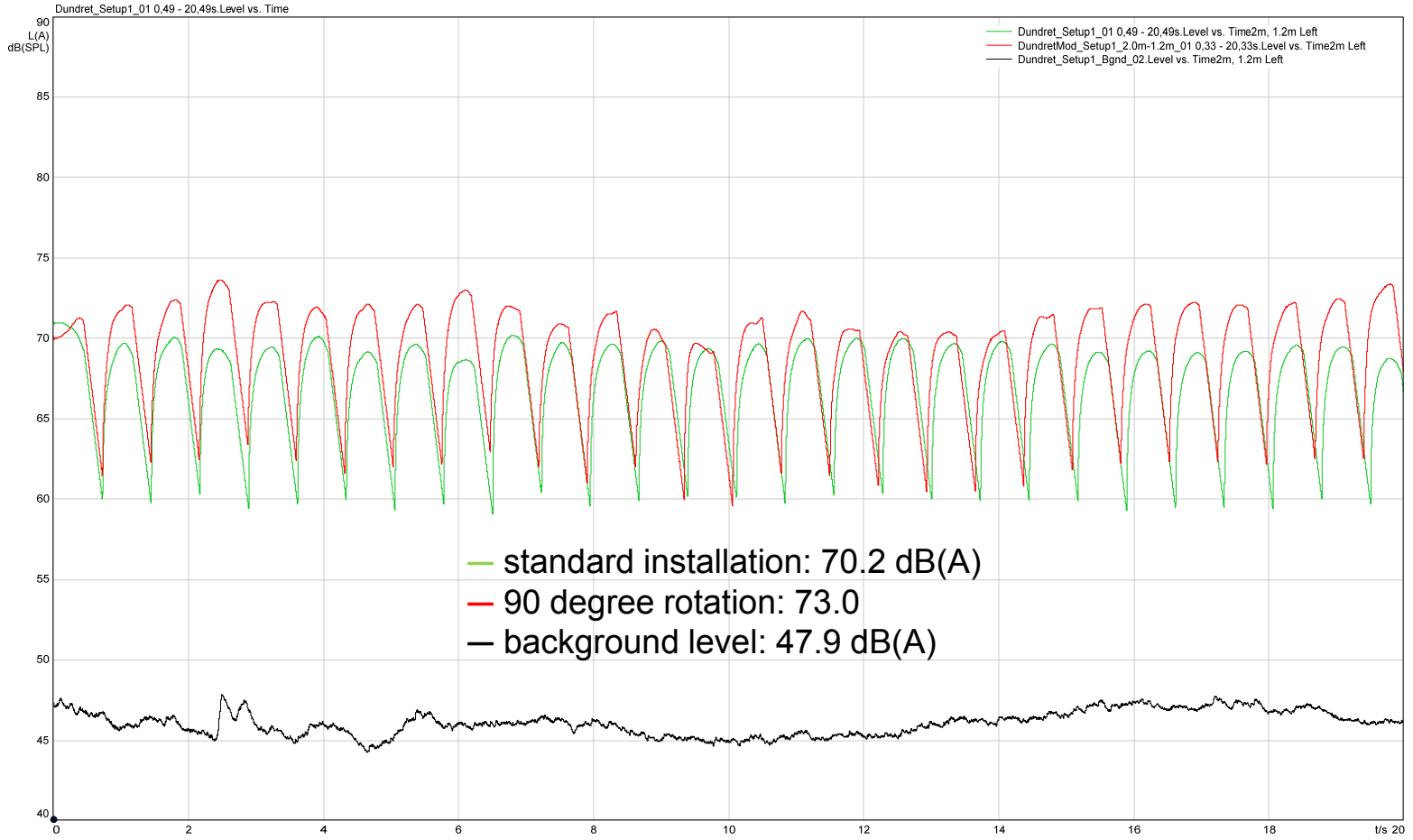


Summary (Standard installation)

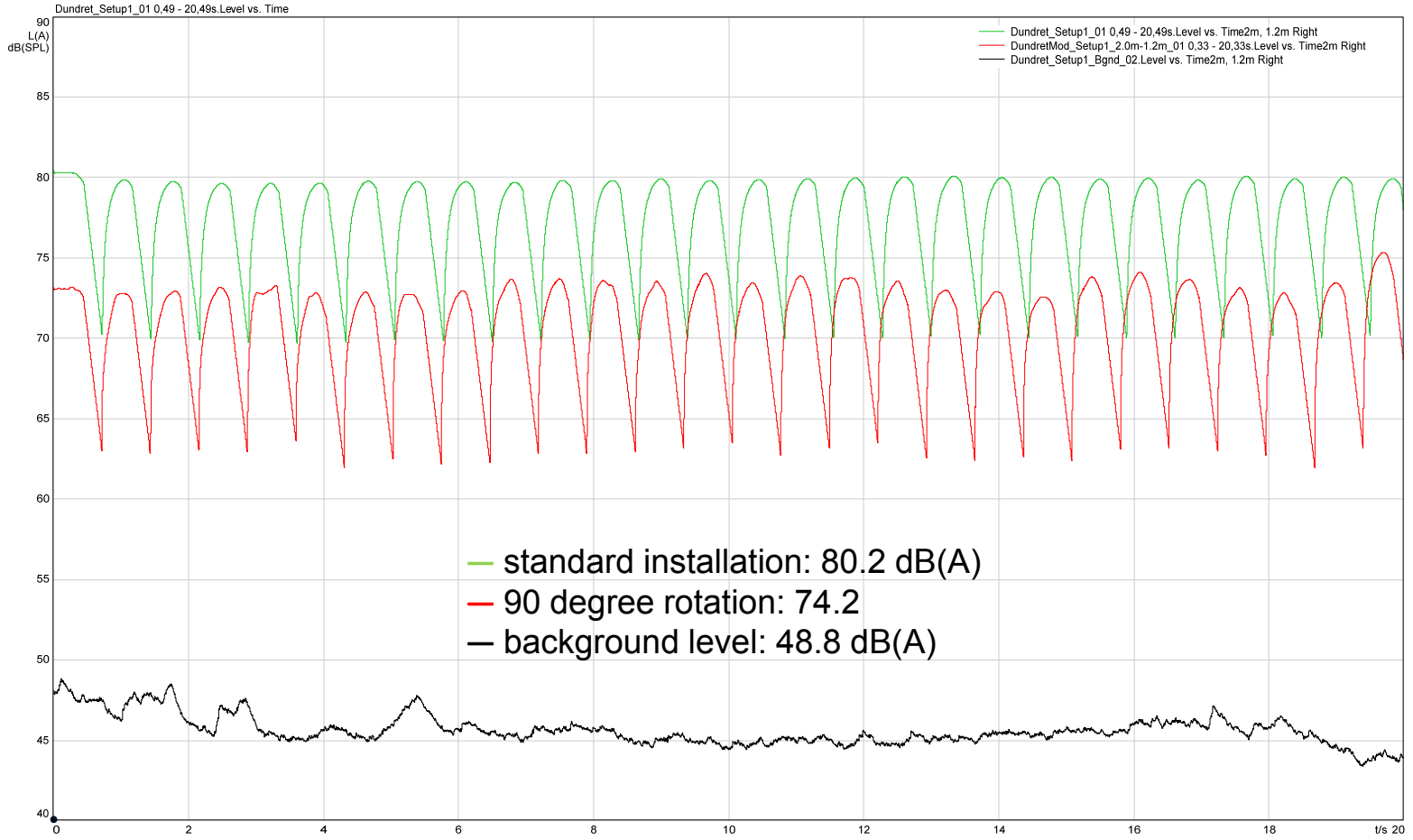
SOUND LEVEL							
No	Ambient noise [dB(A)]		Measured value [dB(A)]		Result [dB(A)]	Requirements [dB(A)]	Judgement
	Left	Right	Left	Right			
1	47.9	48.8	71.0	80.4	70	> 50	OK
2			70.2	80.0			
3			70.0	80.1			
4			69.6	80.1			

*If **L_p > 47 + 3 dB(A)**, no dedicated AVAS system is needed for rearward operation*

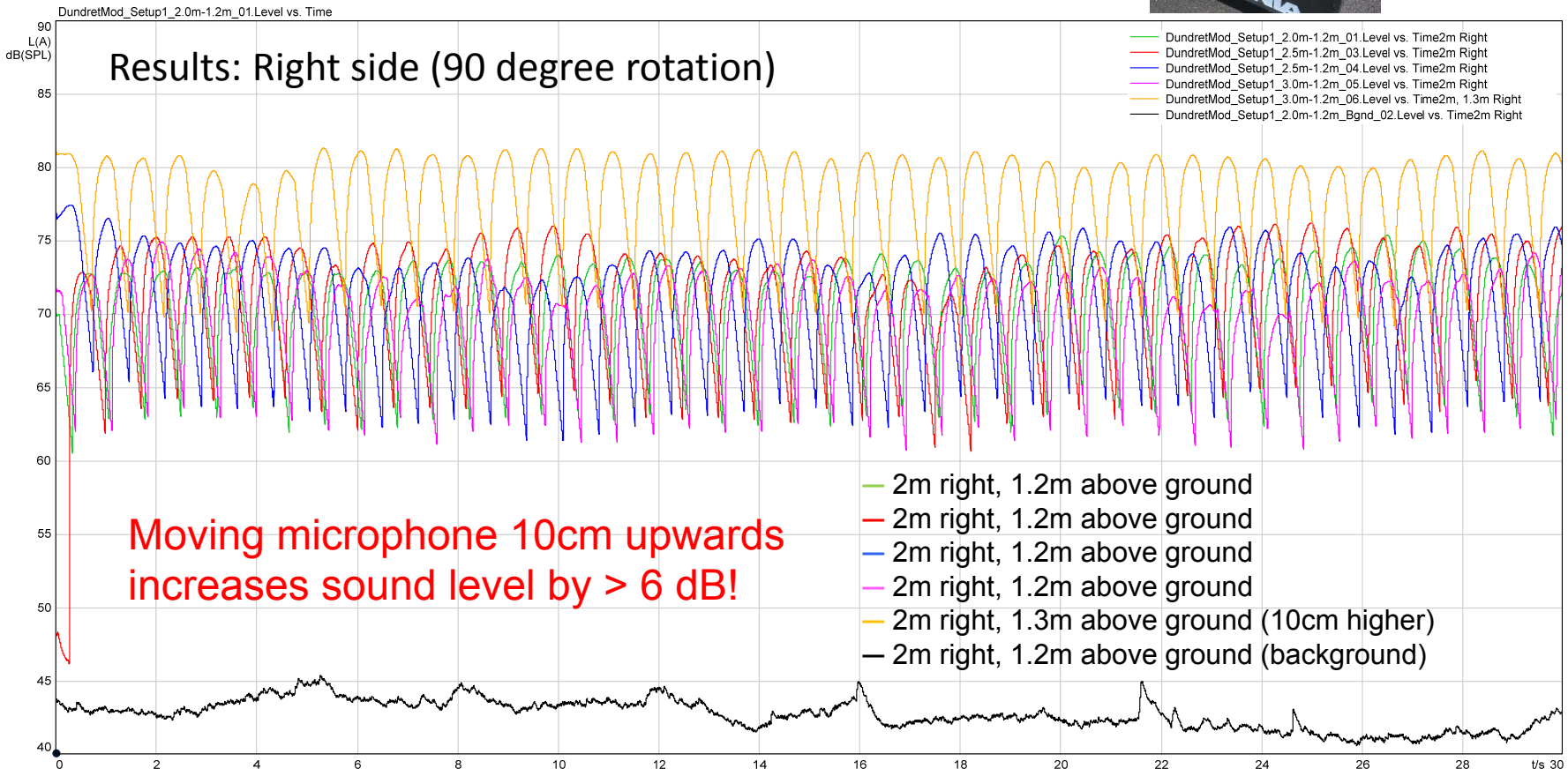
Results: Left side



Results: Right side



Observation



PIEK

Specification

PIEK (2018)

4.4 Reversing alarm system and blind spot warning

The measurement is only carried out if the system can be used when manoeuvring during loading and unloading. If applicable, the measurement will be carried out in PEAK mode, which automatically reduces the volume emitted by the warning signal. If the system is not present or is switched off automatically in 'PEAK mode', the measurement does not need to be taken.

The following procedure must be completed for measuring the sound signal:

- Only the towing vehicle will be measured, i.e. without trailers or articulated elements.
- The vehicle is stationary during the test, and the warning systems for reversing and turning right (blind spot) are measured. The warning systems are operating separately for this. See Figure 4.4 for the measurement setup.
- Reversing: The noise from the reversing alarm system is measured three times at a distance of 7.5m from the rear of the vehicle (signal duration 30 seconds).
- Turning right: The noise is measured three times at a distance of 7.5m from the side of the vehicle, directly across from the cabin's rear (signal duration 30 seconds).

The highest value from each measurement point is determined separately and rounded to a whole number in accordance with Section 3.3; these are the measurement results.

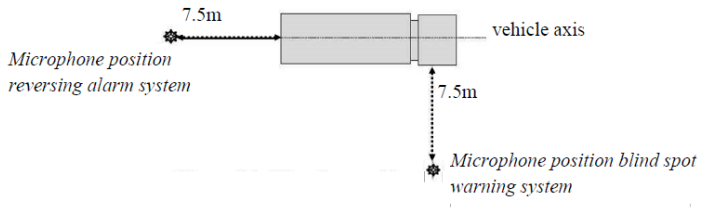


Figure 4.2: Microphone positions for measurements of reverse and blind spot warning systems

Acceptance criteria:

- L_p < 72 dB(A)

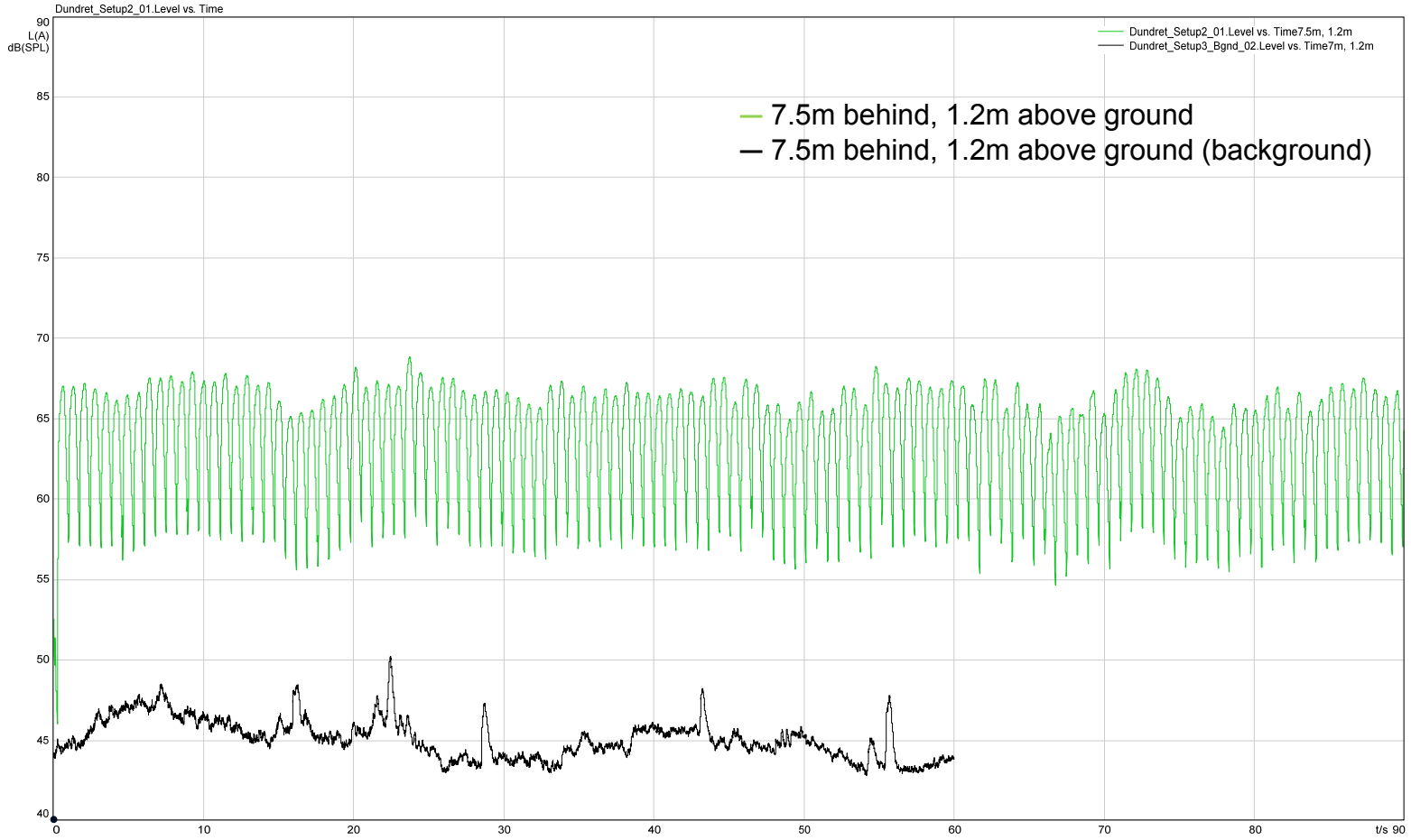
Setup

Summary (Standard installation)

SOUND LEVEL					
No	Ambient noise [dB(A)]	Measured value [dB(A)]	Result [dB(A)]	Requirements [dB(A)]	Judgement
1	52.2	68.9	69	< 72	OK
2		68.3			
3		68.1			

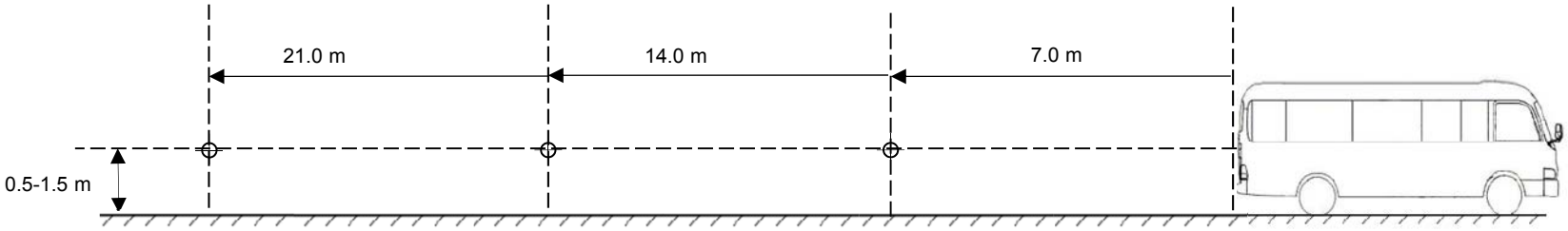
If the system is not present or is switched off automatically in 'PEAK mode', the measurement does not need to be taken.

Results: 7.5m behind truck



7/14/21 m

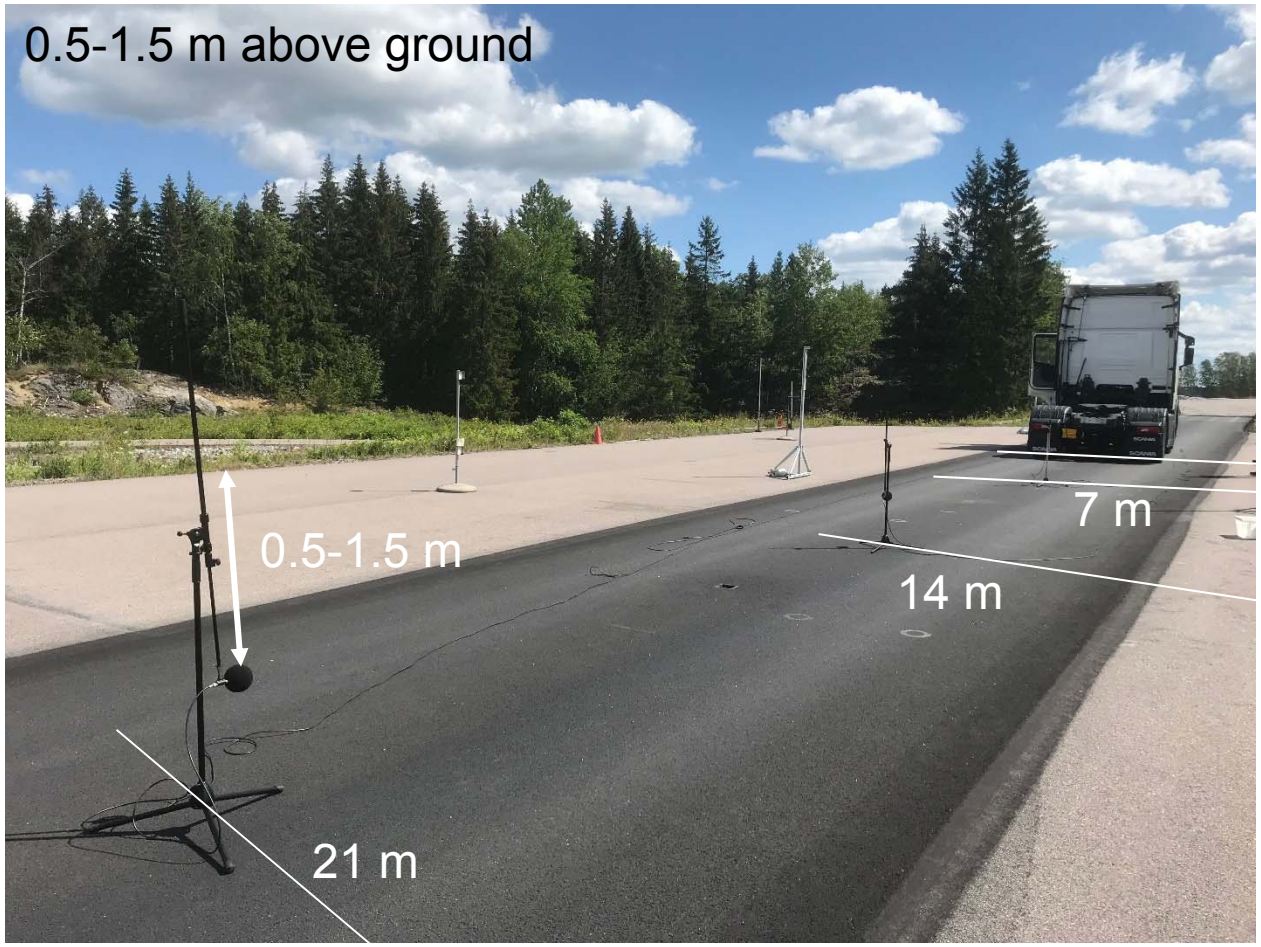
Specification



Adjust height in steps of 0.1 m, from 0.5 to 1.5 m

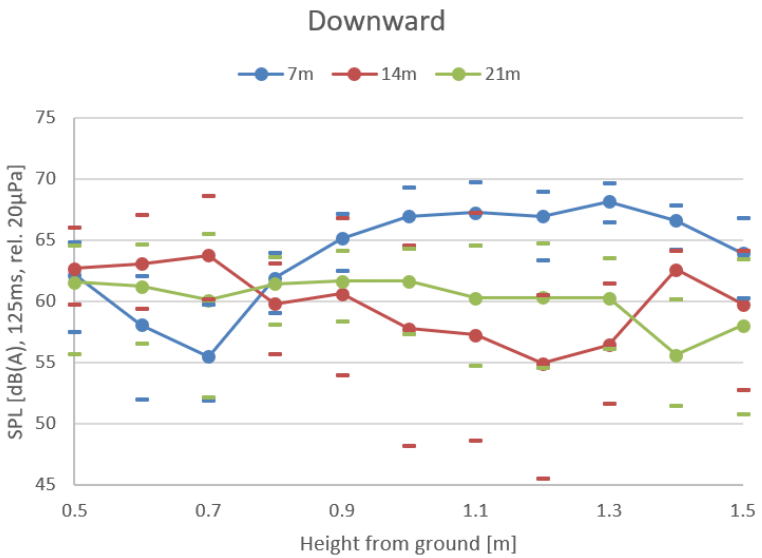
14m simulating semi-trailer distance
21m simulating multi-trailer distance

7/14/21m Setup



Results: 7m / 14m / 21m @ 0.5-1.5m

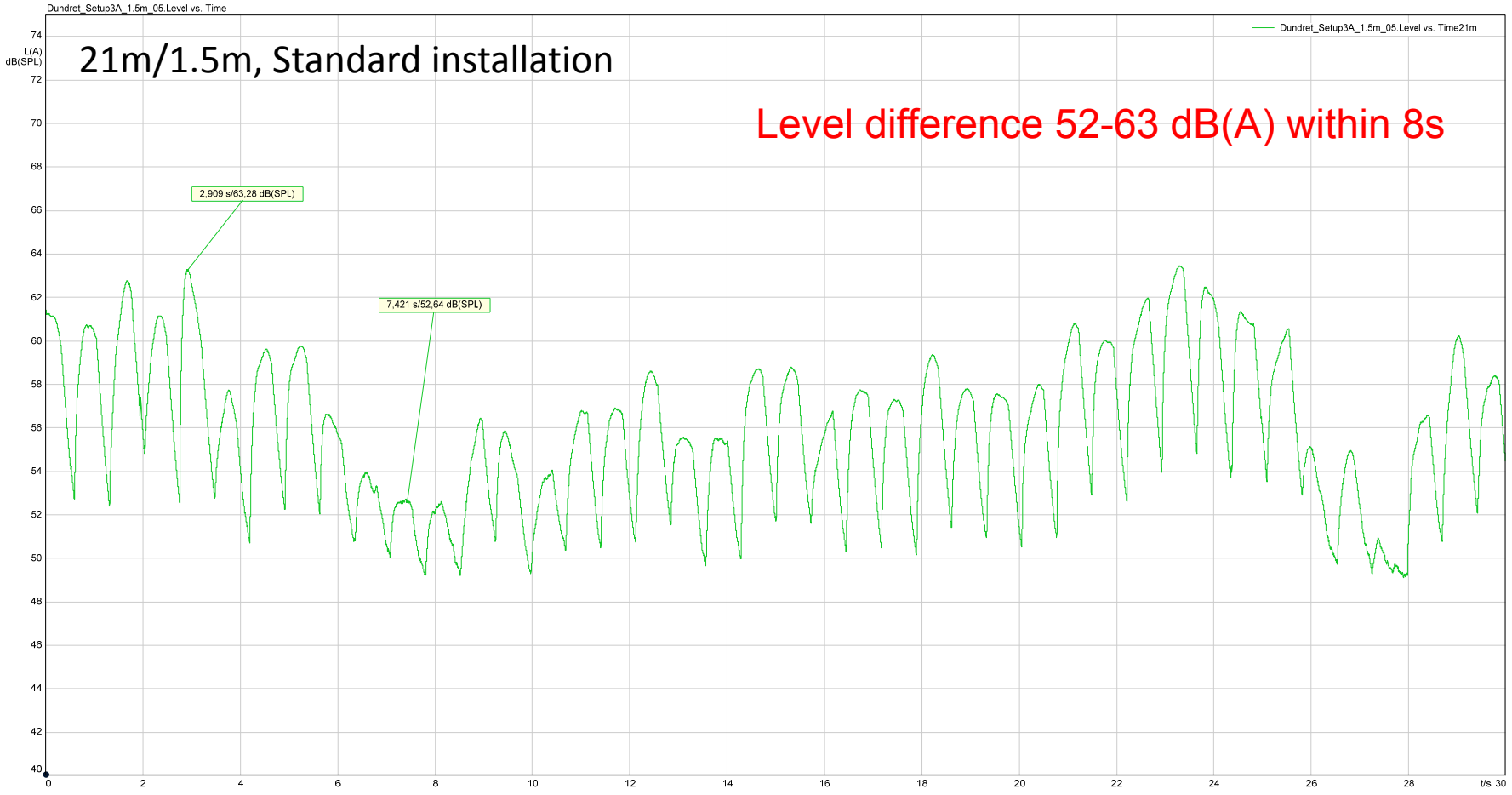
Standard installation



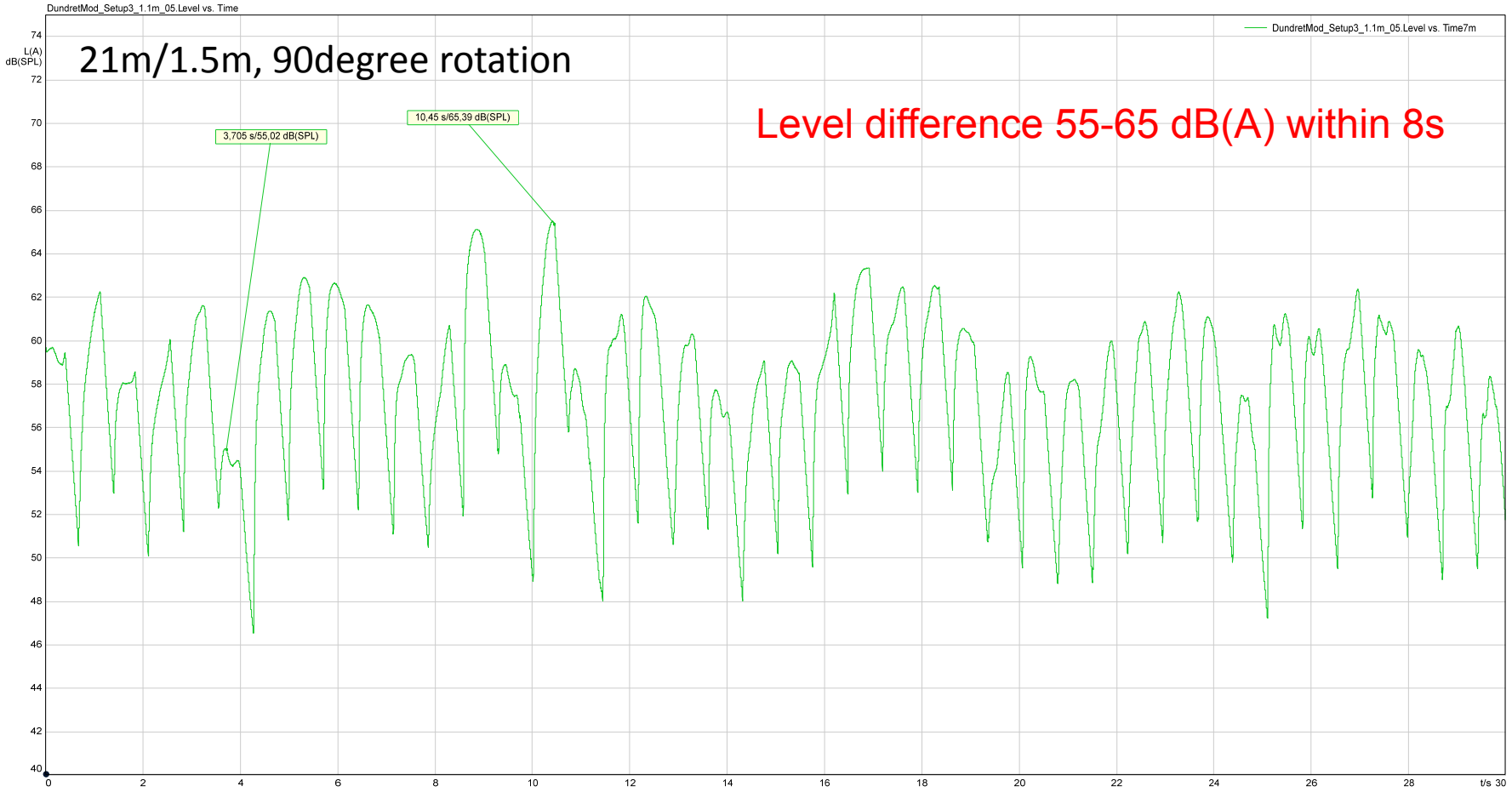
90 degree rotation

Each data point is an average of 40 peaks (30s)
Max/Min values (during 30s) indicated with bars

Observation



Observation



Conclusions – Standard Installation

- Sound source is strongly directive
- Tone frequency fluctuates over time; 2750-2900 Hz
- Tone frequency selection is unfortunate, close to cut-off frequency between 1/3 octave bands 2500 and 3150 ($f_{c/o}$ = 2818 Hz)

- Recommendations for further studies:
  - **Hemi-anechoic chamber** preferred (reduce environmental influence; wind, temperature, etc that may cause level and/or frequency fluctuations)
  - Use **external power source** (controlled voltage & current)
  - Choose a tone such that its centre frequency is laying within a 1/3 octave band

Thank You