

LLC "Acoustic materials and technologies"

Certificate of recognition of measuring capabilities No.PT-161/22

Protocol of acoustic measurements
effectiveness of sound-insulating casings for heat pumps
produced by IR SOM LLC

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Director

Kontar V.S.

Acoustic engineer

Burynsky S.V.

February 6, 2024

Kyiv
2024

1. Initial data

On February 1, 2024, from 2:00 p.m. to 5:00 p.m., the measurement of the effectiveness of sound-insulating casings for heat pumps produced by IR SOM LLC was carried out.



Fig. 1. Conducting measurements

2. Measuring equipment

1. Acoustic multifunctional meter "ECOPHYSICS" with pre-amplifier No. 154368 and microphone MK-265 No. 6509.
Certificate of state metrological attestation No. 22-01/30222, valid until January 22, 2025.
2. Test signal emitter: LOOK-LINE D 303 dodecahedron

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3. Purpose of measurements

1. Determining the noise reduction efficiency of casings.
2. Determination of the most successful design.

4. Conditions for conducting measurements

Measurements of the effectiveness of noise reduction by casings were carried out using a test noise source - a dodecahedron, pink noise (Pink Noise 50-20000Hz) was used as a test signal.

The dodecahedron was installed in the middle of the casing. The measuring points were located at a distance of 1000 mm from each face of the casing and at a height of 1500 mm from the floor surface (see Fig. 2, 3, 5). The position of the dodecahedron was unchanged, and measurements were made at fixed measurement points with and without the shroud installed.

After obtaining the noise characteristics at each measuring point, average values were found in each octave frequency band and at the equivalent level.

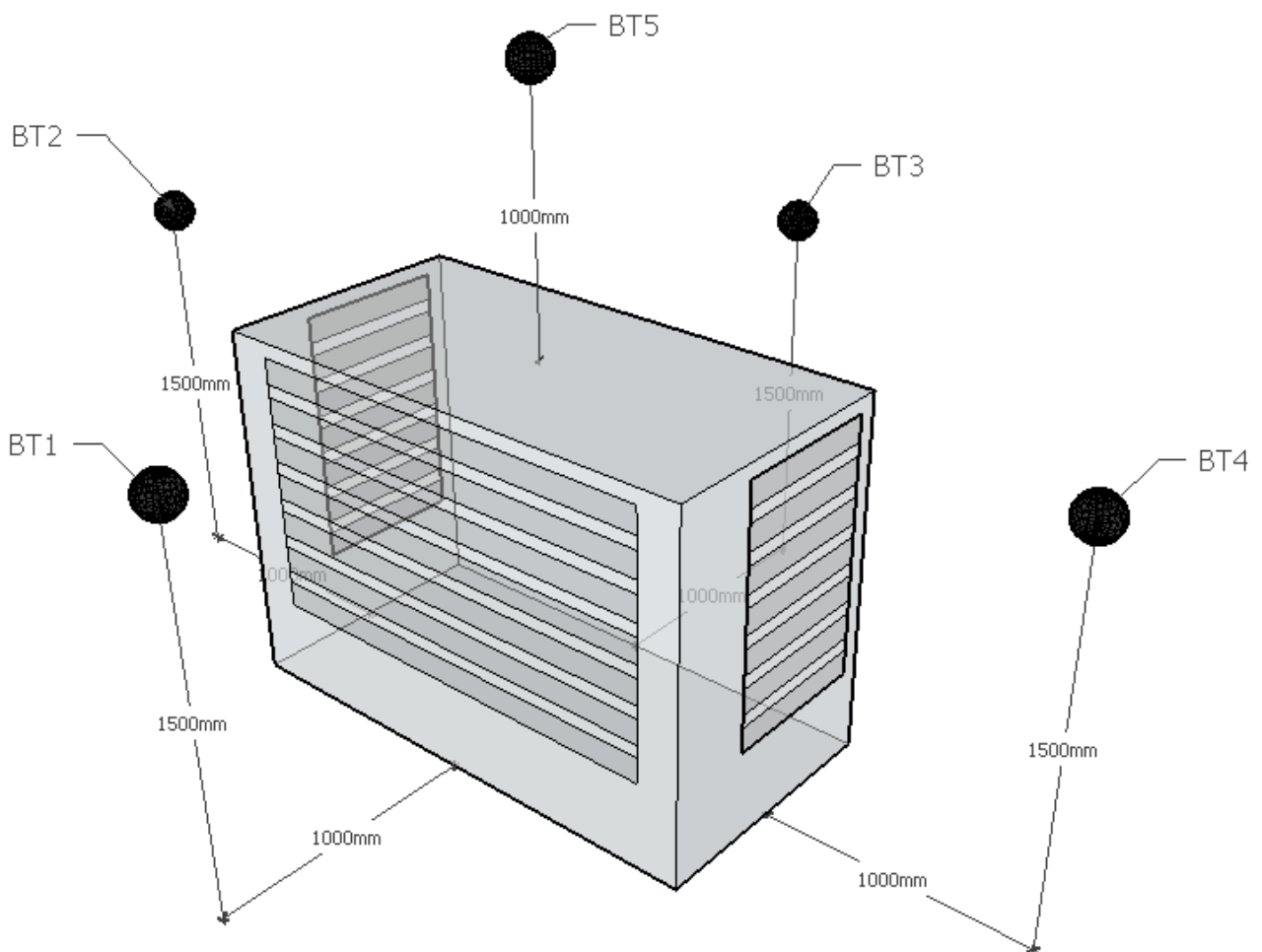


Fig. 2. Scheme of placement of measuring points

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Fig. 5. Casing version 2

Table 2. The results of measurements of the efficiency of the jacket version 2

Measurement conditions	Sound pressure levels, dB in octave frequency bands with geometric mean frequencies, Hz							levels sound L_{Equiv} , dBA
	125	250	500	1000	2000	4000	8000	
Without casing	90	89	91	89	90	90	86	97
With cover version 2	83	86	84	75	76	73	70	84
Noise reduction performance dB	7	4	7	14	15	17	15	12

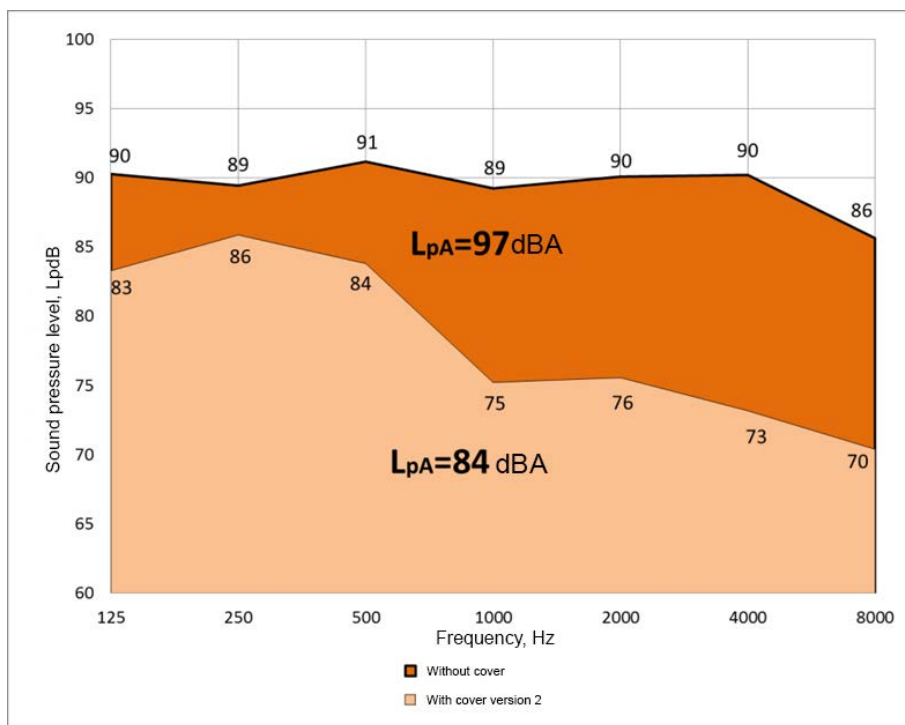


Fig. 6. Results of measurements of the effectiveness of the jacket version 2

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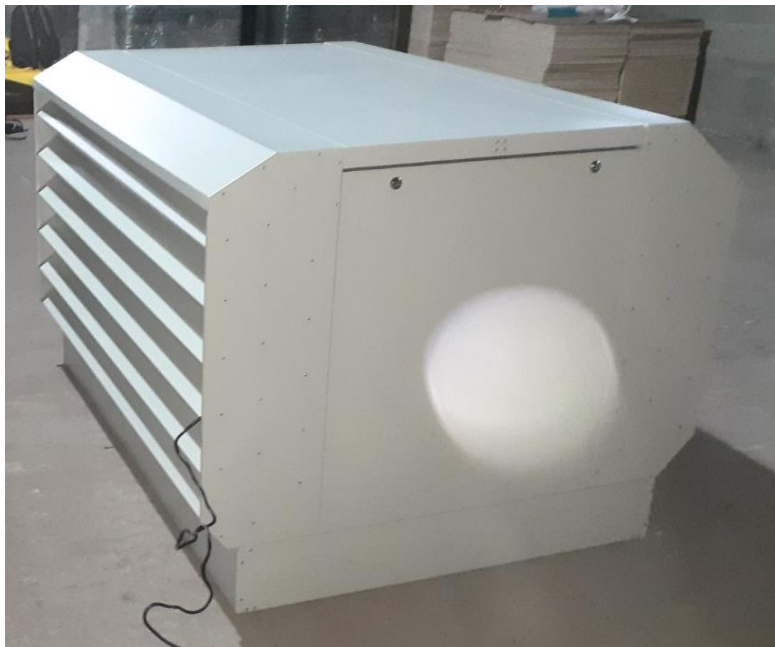


Fig. 7. Casing version 3

Table 3. The results of measurements of the efficiency of the jacket version 3

Measurement conditions	Sound pressure levels, dB in octave frequency bands with geometric mean frequencies, Hz							levels sound L_{Equiv} , dBA
	125	250	500	1000	2000	4000	8000	
Without casing	90	89	91	89	90	90	86	97
With cover version 3	87	82	80	76	76	74	73	84
Noise reduction performance dB	3	7	12	13	14	16	13	13

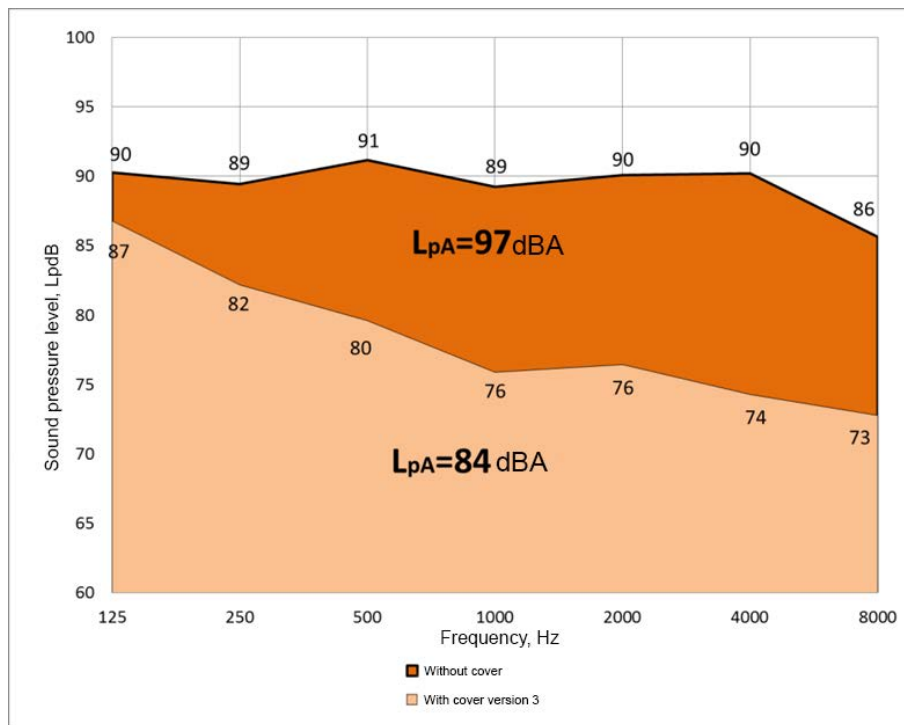


Fig. 8. The results of measurements of the effectiveness of the jacket version 3

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6. Conclusions

1. The noise reduction efficiency of the casing "Version 2.2" is **15 dB** by equivalent noise level.
2. The noise reduction efficiency of the casing "Version 2" is **12 dB** by equivalent noise level.
3. The noise reduction efficiency of the "Version 3" casing is **13 dB** by equivalent noise level.
4. According to the results of the tests, noise protection covers produced by IR SOM LLC can be used to reduce the noise impact of engineering equipment for various purposes.

Acoustic engineer

Burynsky S.V.

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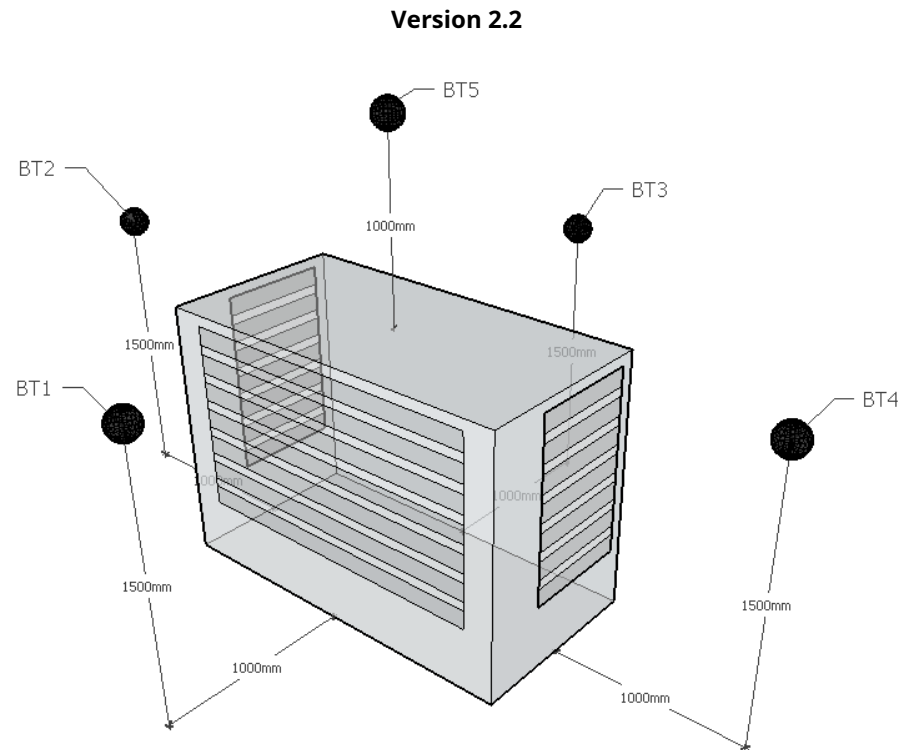


Fig. 9. Scheme of placement of measuring points around the casing version 2.2

Table.4. Results of measurement of noise levels at measurement points around the casing version 2.2 in octave frequency bands

Measuring point	Sound pressure levels, dB in octave frequency bands with geometric mean frequencies, Hz								Sound levels L _{Equiv} , dBA
	63	125	250	500	1000	2000	4000	8000	
VT 1	95	86	83	85	79	80	76	76	87
VT 2	92	83	77	77	74	75	72	69	81
VT 3	93	80	78	75	66	69	67	63	77
VT 4	92	83	78	77	74	73	70	68	80
VT 5	93	83	77	72	67	69	67	65	77
Average	93	83	79	80	74	75	72	70	82
Medium without casing	89	90	89	91	89	90	90	86	97
Efficiency	- 4	7	10	11	15	15	19	15	15 dB

Version 2.2

Table.5. Results of measurement of noise levels at measurement points around the casing version 2.2 in third-octave frequency bands

Measuring point	Sound pressure levels, dB in third-octave frequency bands with geometric mean frequencies, Hz																							
	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10k
VT 1	89	92	89	84	81	73	80	75	77	81	83	73	73	72	76	74	75	76	69	69	73	74	69	69
VT 2	89	88	85	78	80	75	74	71	72	74	74	70	68	71	69	68	68	72	69	65	65	64	62	65
VT 3	91	88	81	77	75	75	76	69	69	72	70	65	61	61	61	63	64	65	64	61	61	59	58	58
VT 4	88	87	85	79	79	75	76	73	71	73	73	71	68	70	69	68	66	70	66	66	64	64	63	63
VT 5	90	89	83	78	80	78	75	69	71	68	68	65	63	61	61	64	64	65	63	61	61	61	59	59
Average	89	89	85	80	79	76	77	72	73	76	77	70	68	69	71	69	70	72	67	65	68	68	64	65
Average without casing	83	84	85	86	87	83	83	85	85	86	87	86	86	84	83	85	85	86	88	84	84	80	80	82
Efficiency	-7	-6	0	6	7	8	7	13	12	10	10	16	17	15	13	16	15	14	21	18	16	13	16	18

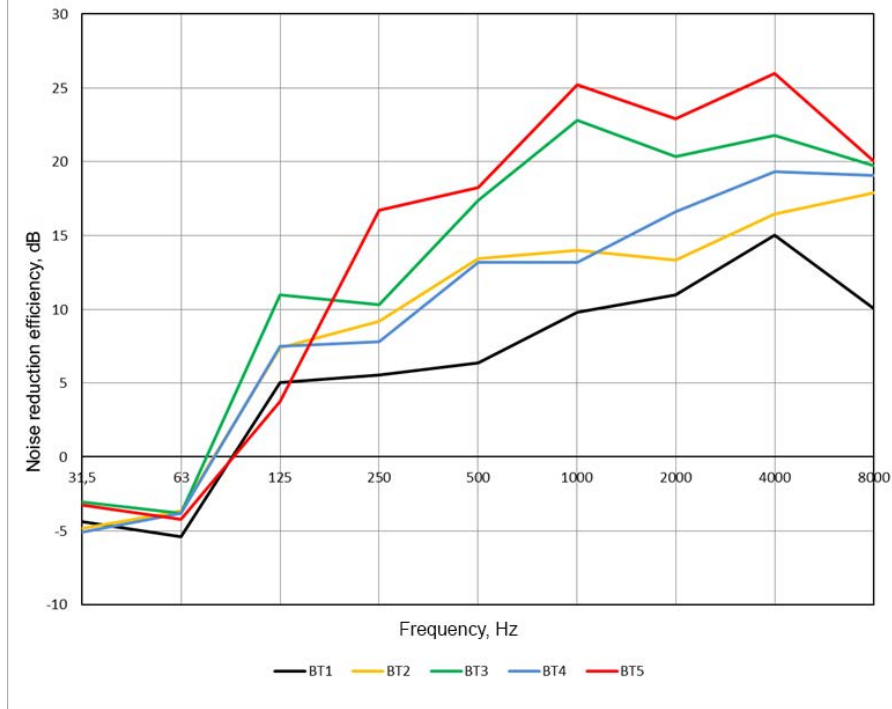


Fig. 10. Noise reduction performance at measurement points around the casing version 2.2 in octave frequency bands

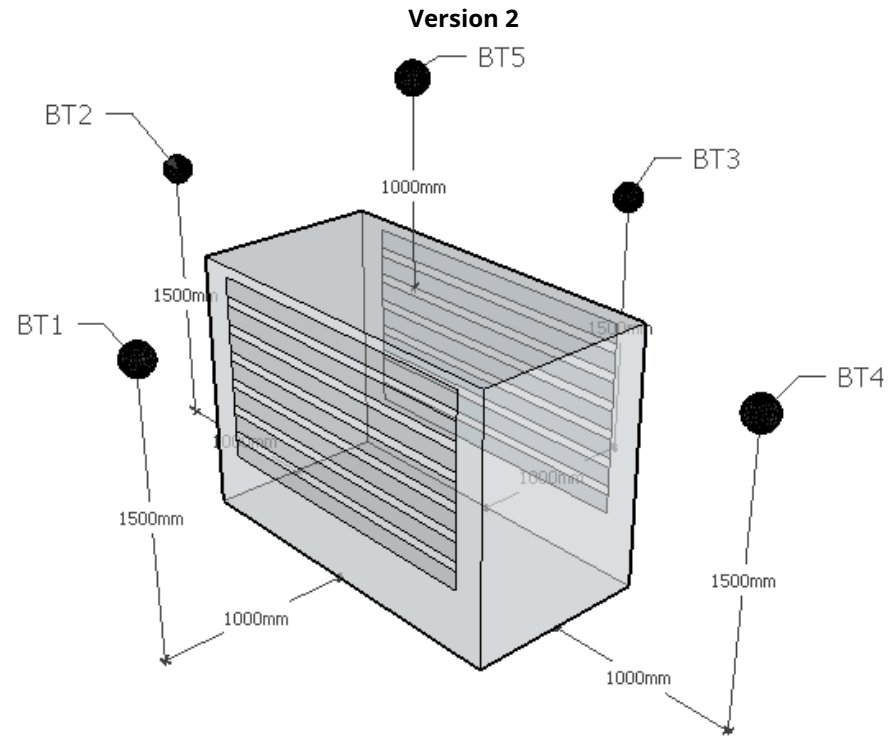


Fig. 11. Scheme of placement of measuring points around the casing version 2

Table.6. Results of measurement of noise levels at measurement points around the casing version 2 in octave frequency bands

Measuring point	Sound pressure levels, dB in octave frequency bands with geometric mean frequencies, Hz								Sound levels L _{Equiv} , dBA
	63	125	250	500	1000	2000	4000	8000	
VT 1	94	84	86	87	78	78	75	73	87
VT 2	93	83	85	80	72	74	72	68	82
VT 3	94	84	88	87	78	78	75	72	87
VT 4	93	83	84	80	71	73	72	68	82
VT 5	93	83	85	78	67	70	69	65	80
Average	94	83	86	84	75	76	73	70	84
Medium without casing	89	90	89	91	89	90	90	86	97
Efficiency	- 5	7	4	7	14	15	17	15	12 dB

Version 2

Table.7. Results of measurement of noise levels at measuring points around the casing version 2 in third-octave frequency bands

Measuring point	Sound pressure levels, dB in third-octave frequency bands with geometric mean frequencies, Hz																							
	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10k
VT 1	86	91	89	83	77	70	79	84	80	84	82	76	73	74	72	75	73	73	73	68	69	69	67	69
VT 2	88	90	87	80	79	71	83	81	75	76	76	73	69	68	65	67	70	69	67	66	67	64	63	63
VT 3	91	90	86	83	76	71	82	85	81	85	82	77	74	73	73	74	70	74	72	68	71	70	67	66
VT 4	89	89	87	81	78	73	81	80	75	77	75	72	67	68	63	66	67	70	69	65	67	64	62	62
VT 5	90	89	85	79	78	76	79	83	77	76	73	69	62	63	60	64	65	67	65	63	63	61	59	61
Average	89	90	87	81	78	73	81	83	78	81	79	74	71	71	69	71	70	71	70	67	68	67	65	65
Average without casing	83	84	85	86	87	83	83	85	85	86	87	86	86	84	83	85	85	86	88	84	84	80	80	82
Efficiency	- 6	- 6	- 2	5	9	10	2	2	7	5	8	12	15	13	14	14	15	15	18	17	15	14	15	17

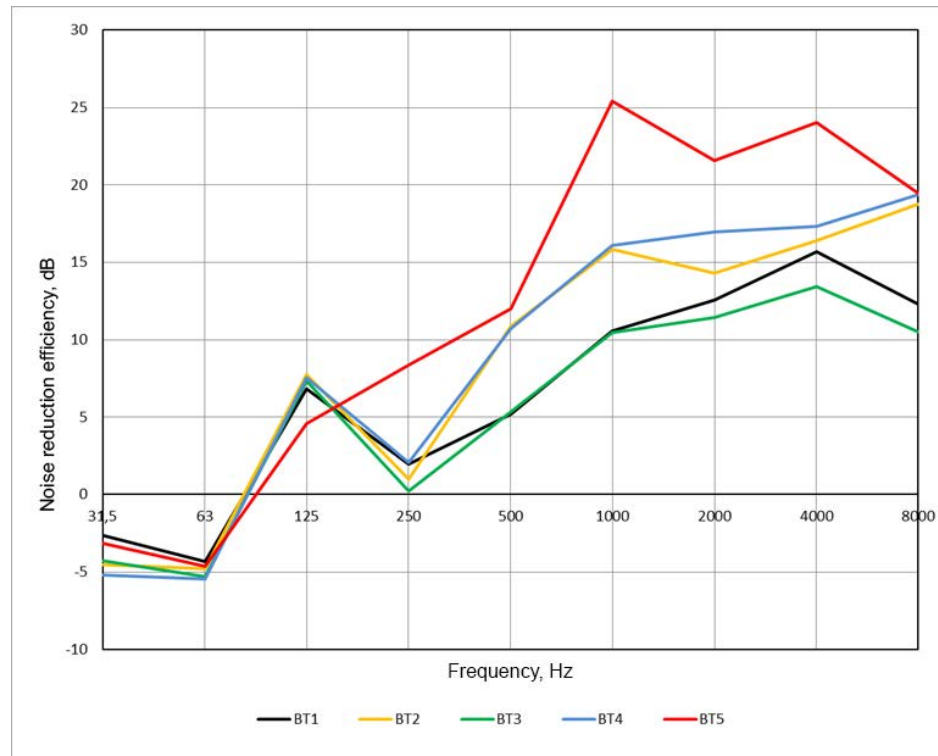


Fig. 12. Noise reduction performance at measurement points around the version 2 shroud in octave frequency bands

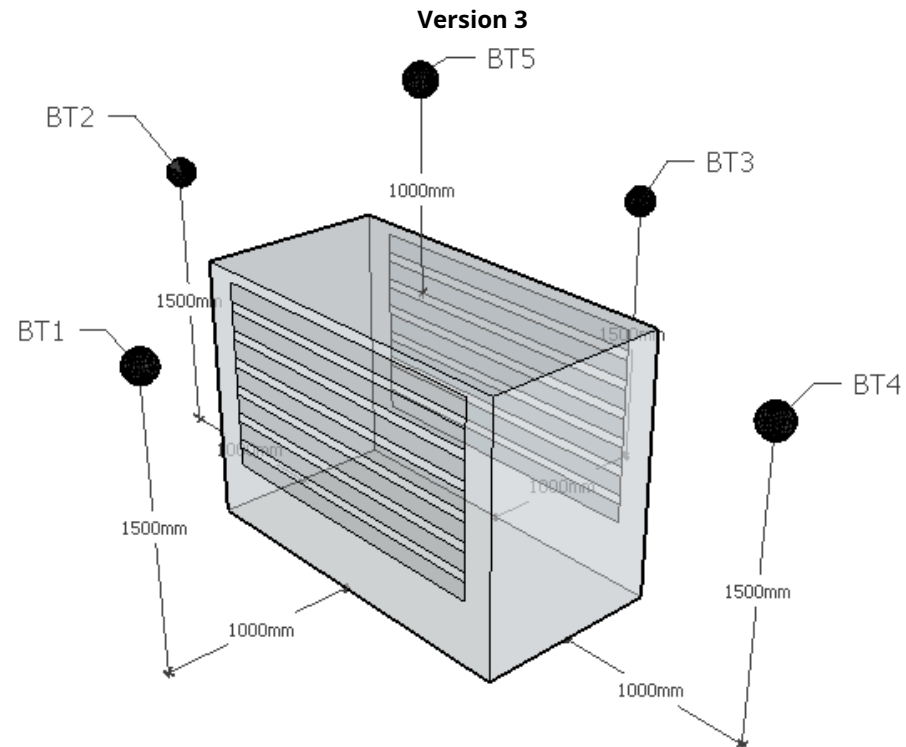


Fig. 13. Scheme of placement of measuring points around the cormorant version 3

Table.8. Results of measurement of noise levels at measurement points around the casing version 3 in octave frequency bands

Measuring point	Sound pressure levels, dB in octave frequency bands with geometric mean frequencies, Hz								Sound levels L _{Equiv} , dBA
	63	125	250	500	1000	2000	4000	8000	
VT 1	94	87	85	82	78	79	77	75	86
VT 2	93	84	81	75	71	72	70	65	79
VT 3	94	87	83	83	79	79	77	77	86
VT 4	94	87	78	75	71	72	70	67	79
VT 5	94	87	82	75	73	72	70	66	80
Average	94	87	82	80	76	76	74	73	84
Medium without casing	89	90	89	91	89	90	90	86	97
Efficiency	- 5	3	7	12	13	14	16	13	13 dB

Version 3

Table.9. Results of measurement of noise levels at measurement points around the casing version 3 in octave frequency bands

Measuring point	Sound pressure levels, dB in third-octave frequency bands with geometric mean frequencies, Hz																							
	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10k
VT 1	86	91	89	86	82	75	75	74	84	80	73	72	70	73	76	76	72	75	74	70	72	70	70	72
VT 2	90	90	85	82	79	72	79	74	71	72	70	66	65	65	67	67	66	67	67	63	63	61	59	60
VT 3	90	90	86	85	84	74	79	79	77	80	80	71	72	77	72	73	75	75	73	71	72	74	69	72
VT 4	90	90	86	86	81	75	75	75	69	73	70	67	65	67	67	66	66	69	67	64	63	62	61	63
VT 5	91	90	84	82	84	79	80	77	73	71	70	68	70	69	67	66	66	70	68	64	64	63	60	60
Average	90	90	86	84	82	76	78	76	78	77	75	70	69	72	71	72	71	72	71	68	69	69	66	68
Average without casing	83	84	85	86	87	83	83	85	85	86	87	86	86	84	83	85	85	86	88	84	84	80	80	82
Efficiency	-7	-7	-1	2	4	7	6	9	7	9	12	16	16	12	12	13	14	14	17	16	14	11	14	14

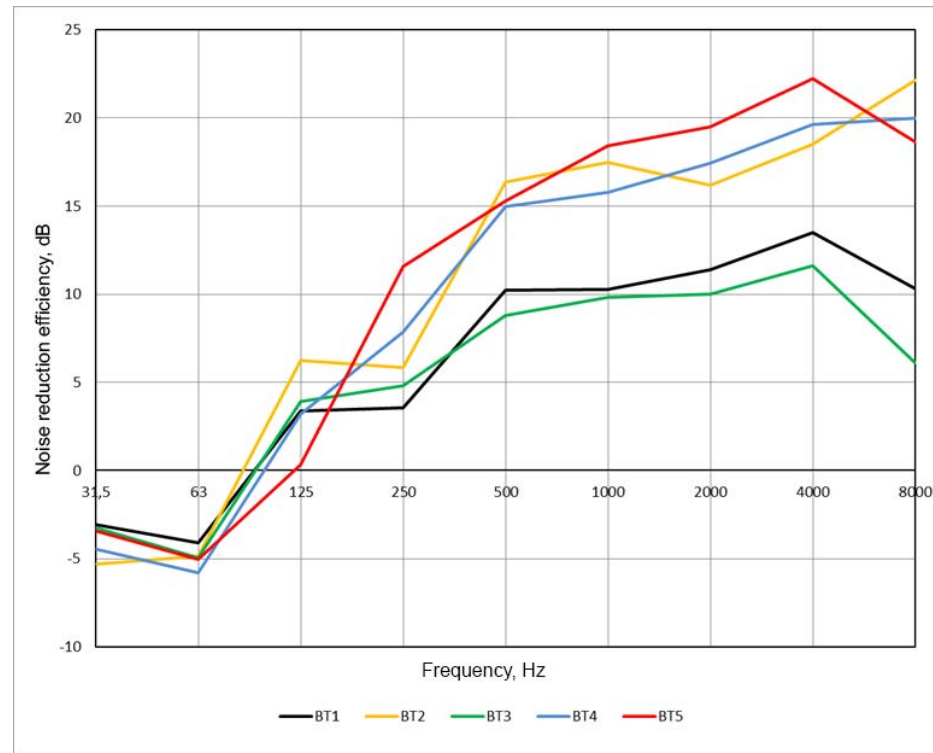


Fig. 14. Noise reduction performance at measurement points around the version 3 shroud in octave frequency bands

Table.10. Comparison of noise reduction effectiveness of casings of different designs in third-octave frequency bands.

Casing type	Noise reduction efficiency, dB in third-octave frequency bands with geometric mean frequencies, Hz																							
	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10k
Option 2.2	-7	-6	0	6	7	8	7	13	12	10	10	16	17	15	13	16	15	14	21	18	16	13	16	18
Option 2	-6	-6	-2	5	9	10	2	2	7	5	8	12	15	13	14	14	15	15	18	17	15	14	15	17
Option 3	-7	-7	-1	2	4	7	6	9	7	9	12	16	16	12	12	13	14	14	17	16	14	11	14	14

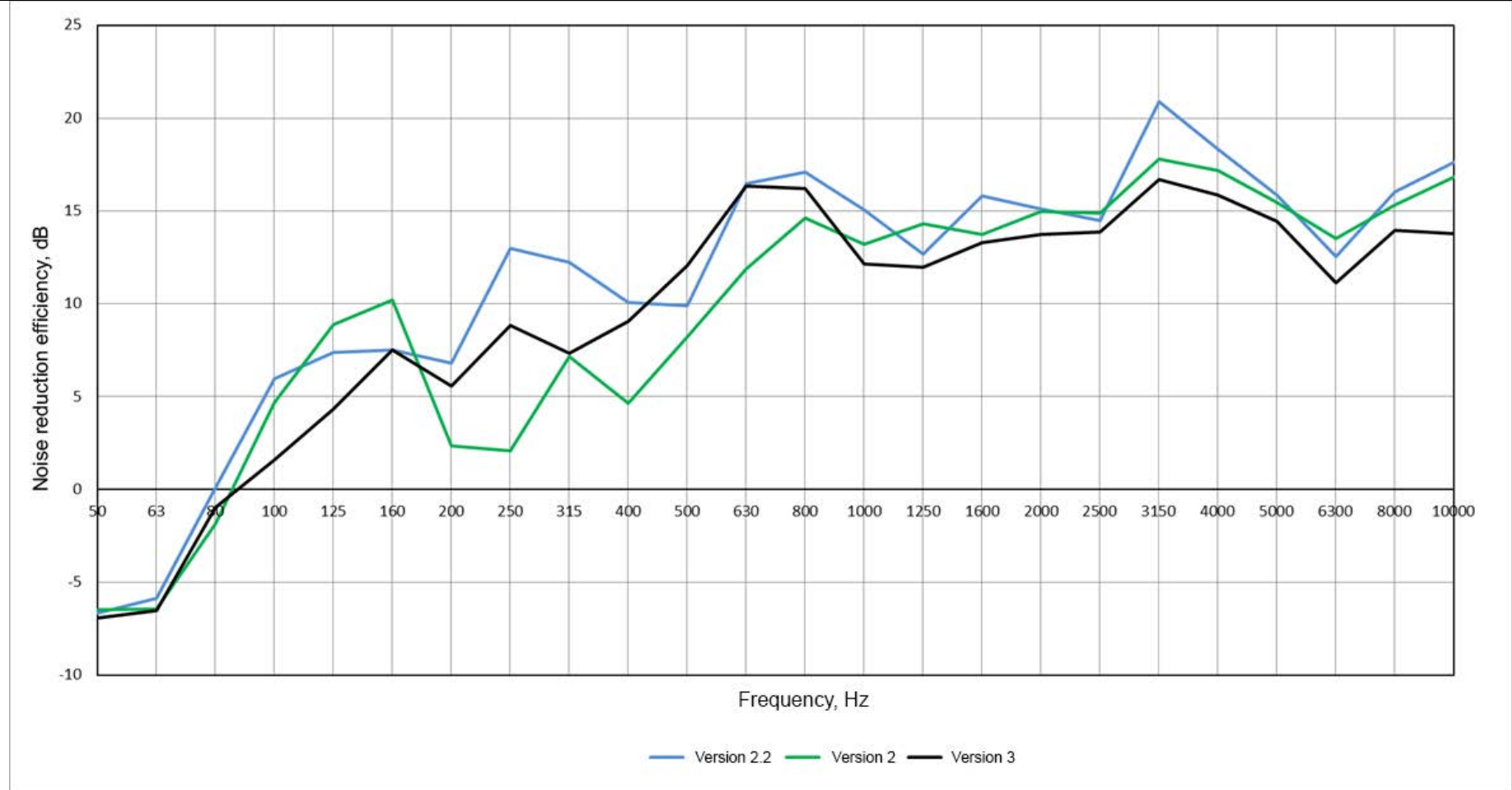


Fig. 15. Comparison of noise reduction effectiveness of casings of different designs in third-octave frequency bands.