Mario Narbekov, Johan Hallimäe 15.04.2024

Modular Cabin

Client: Kipsik OÜ
Ordered: 05.04.2024
Contact person: Kalle Kask

ACOUSTIC MEASUREMENTS OF MODULAR CABIN

1 INTRODUCTION

Acoustical measurements were ordered on 05.04.2024 by Kipsik OÜ representative Kalle Kask. Measurements were conducted on 10.04.2024 at 10:00-12:00.

The purpose of the measurements was to determine airborne sound isolation, speech reduction properties and reverberation time of Modular Cabin.

Measurements and calculations were performed in accordance with EVS-EN ISO 16283-1:2014, EVS-EN ISO 717-1:2020, ISO 23351-1:2020 and ISO-354 standards.

Measurement location	Mäealuse 10/5, Tallinn
Room	Warehouse
Time and date	Wednesday, 10.04.2024, 10:00-12:00
Measurer	Mario Narbekov

2 MEASUREMENT EQUIPMENT & CALIBRATION DATES

Measurements were conducted using „Brüel & Kjær 2250“ sound level meter, which corresponds to class 1 measurement equipment. The microphone was calibrated before and after the measurements.

Device	Supplier and model	Serial nr	Calibration date
Sound source	01dB LS02	DS.14090	-
calibrator	Brüel & Kjær 4231	2253338	07.09.2023 [AKUKON]
microphone	Brüel & Kjær 4966	3271301	22.03.2024 [HBK]
SLM	Brüel & Kjær 2250	3004362	22.03.2024 [HBK]

3 SPEECH LEVEL REDUCTION INDEX

3.1.1 Specimen definition

Furniture ensembles and enclosures are assembled on site using elements, which can be transferred into any room through normal-sized passage doors. They are not treated as a fixed part of the building and are beyond the scope of building regulations. These products are typically assembled in a finished room and not during the construction of the building.

The following method is applicable for entire furniture ensembles or enclosures, which form a unity that servers one or several occupants, and which are also used to provide improved speech privacy. The method is not intended for single components used in workstations (acoustic screens etc).

3.1.2 Measurement method

The sound power level is measured in two scenarios:

- Without the product
  - The test signal is produced in an empty room while the product is absent
- With the product
  - The test signal is produced inside the product in the occupant's position

Reverberation is measured in the room with and without the product. Background noise is measured in the same positions as sound power level with the product in the room and without. Level reduction is the difference of the sound power levels measured in the two scenarios in 1/1-octave frequency bands from 125 Hz to 8000 Hz. Speech level reduction is a single-numbered quantity that expresses the corresponding reduction in A-weighted sound power level of standard speech within the entire frequency range from 125 Hz to 8000 Hz.

The lowest one-third-octave band frequency of interest is 125 Hz, meaning the room has to have a minimum volume of 150 m^3. Measured cabin and conditions are shown on photos 1 and 2.

Photo 1. Cabin with sound source inside (front side).

Photo 2. Sound source position without specimen.

3.1.3 Environment and conditions

Volume of room	~ 1139 m^3
Total surface area	~ 696 m^2
Microphone positions	6
Test Specimen	Modular Cabin

3.2 Measurement results

The level reduction depends strongly on the ratio of covered area to the total area of the external envelope of the test specimen. Enclosures, which have coverage over 99%, typically produce $D_{S,A}$ results between 15dB and 30dB. Furniture ensembles, which have coverage under 30%, typically produce $D_{S,A}$ results between 0 dB and 5dB.

Adequate target values of $D_{S,A}$ cannot be unambiguously given since the perceived acoustic performance in situations depends on various factors: the distance from the product, the speech effort used by the occupant inside the product, the speech level reduction, the acoustic conditions of the surrounding room and background noise level.

Speech level reduction index for the different furniture models were measured and calculated according to the ISO 23351-1 standard. The measurement results are presented in table 1.

Table 1. Speech level reduction index $D'_{S,A}$

Furniture model	$D'_{S,A}$, dB	Measurement report
1. Modular Cabin	**25.8**	*Akukon* 240767 – M01

** Background noise might have an effect on measurement results.*

4 AIRBORNE SOUND REDUCTION INDEX

Measurements and calculations were performed in accordance with EVS-EN ISO 16283-1, EVS-EN ISO 717-1 standards.

Results of the measurements are shown in table 2.

Table 2. Airborne sound reduction index R'_w (C; C_{tr}), dB

Description	R'_w (C; C_{tr})	Protocol
2. Between warehouse and cabin, front side	**30** (-1; -2)	*Akukon* 240767-M02-26664
3. Between warehouse and cabin, rear side	**31** (0; -2)	*Akukon* 240767-M03-26665
4. Between warehouse and cabin, all sides	**34** (-1; -2)	*Akukon* 240767-M04-26666

4.1.1 Spectrum adaptation terms *C* and C_{tr}

As of the requirements of ISO 717-1 spectrum adaption terms *C* and C_{tr} are used. The adaption terms may be used to assess the sound insulation in respect to the different noise sources.

Spectrum adaption term *C* takes into account living activities (talking, music, radio, TV).

5 REVERBERATION TIME

The measurements were performed in accordance with EVS-EN ISO 354.

Reverberation time T is time, in seconds, that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped. During measurements inner back wall was covered with acoustic elements.

Results are shown in table 3.

Table 3. Measured reverberation time T, 1/1 octave bands

	Measured reverberation time, [sec]					
Location	125 Hz	250 Hz	500 Hz	1kHz	2kHz	Protocol
5. Modular Cabin	0.6	0.4	0.3	0.2	0.2	*Akukon* 240767-M05-26667

Johan Hallimäe
Consultant

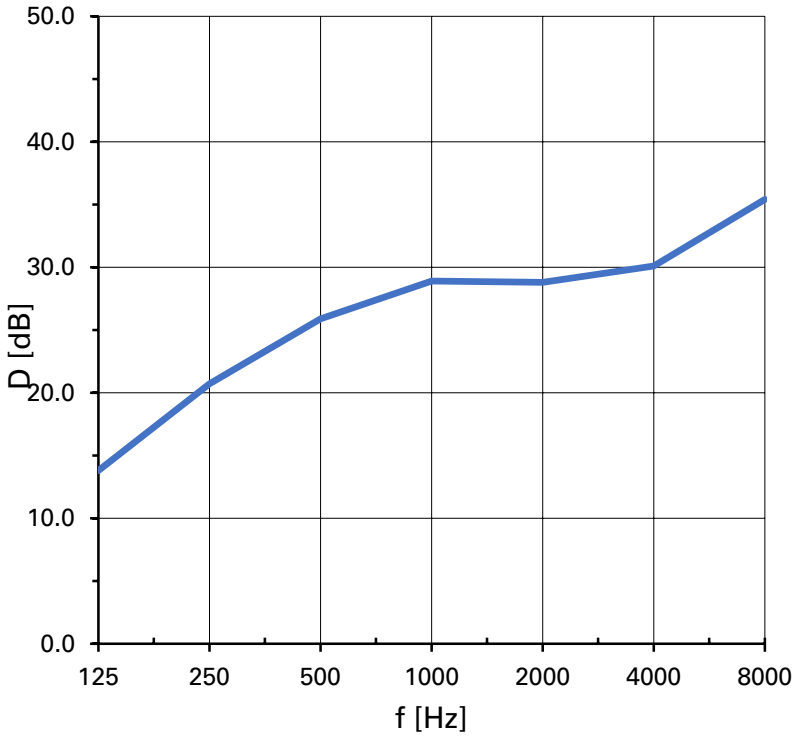
Mario Narbekov
Consultant

Determination of speech level reduction according to ISO 23351-1

Customer: Kipsik OÜ
Order date: 06.02.2024
Contact person: Kalle Kask
Measuring point: Mäealuse 10/5
12618 Tallinn
Test date: 07.03.2024

Specimen: Modular Cabin
Comments:

Frequency	Speech level reduction
f	*D*
Hz	**dB**
125	13.8
250	20.7
500	25.9
1000	28.9
2000	28.8
4000	30.1
8000	35.4
$D'_{S,A}$	**25.8**



Key

f	1/1 -octave frequency band, in Hz
D	level reduction, in dB
$D_{S,A}$	speech level reduction, in dB

Composed by
Mario Narbekov

Confirmed by
Johan Hallimäe

Modular Cabin

Field measurement of airborne sound insulation between rooms

According to the standards EVS-EN ISO 16283-1:2014 and EVS-EN ISO 717-1:2020

Client:	Kipsik OÜ Mäealuse 10/5 12618 Tallinn
Contact:	Kalle Kask
Order:	05.04.2024
Date of test:	10.04.2024
Location:	Mäealuse 10/5 12618 Tallinn

FINAS
Finnish Accreditation Service
T229 (EN ISO/IEC 17025)

Measurement object

Front side of the cabin

Measurement date and location

The measurement was made on 10.04.2024 at Mäealuse 10/5, 12618 Tallinn.

Measurement equipment

sound level meter	Brüel & Kjær 2250	sn. 3004362
microphone capsule	Brüel & Kjær 4966	sn. 3271301
sound level calibrator	Brüel & Kjær 4231	sn. 2253338
sound source	01dB LS02	sn. DS.14090

According to ISO 12999-1:2014, the measurement of the airborne noise emitted by the object is based on an uncertainty of ± 0,9 dB (k = 1, two-way confidence interval) of the insulation index R'_w.

Tallinn 15.04.2024,

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Field measurement of airborne sound insulation between rooms

According to the standards EVS-EN ISO 16283-1:2014 and EVS-EN ISO 717-1:2020

Sending room:
Mäealuse 10/5 warehouse
Receiving room:
Modular Cabin, Front side
Area of structure:
7 m²
Receiving room volume:
6 m³
Sending room volume:
1139 m³

Observations

Airborne sound insulation:

1/3 oct Hz	*R′* dB
50	13.2
63	17.2
80	20.0
100	30.6
125	27.0
160	24.3
200	21.3
250	25.6
315	28.3
400	28.5
500	27.2
630	27.2
800	29.3
1000	29.1
1250	29.9
1600	30.3
2000	30.4
2500	29.9
3150	31.6
4000	31.6
5000	32.1

Airborne sound insulation R'_w (C; C_{tr}): **30 (-1;-2) dB**
Deviation 1250 Hz: 4.1 dB

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Modular Cabin

Field measurement of airborne sound insulation between rooms

According to the standards EVS-EN ISO 16283-1:2014 and EVS-EN ISO 717-1:2020

Client:	Kipsik OÜ Mäealuse 10/5 12618 Tallinn
Contact:	Kalle Kask
Order:	05.04.2024
Date of test:	10.04.2024
Location:	Mäealuse 10/5 12618 Tallinn

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Measurement object

Rear side of the cabin

Measurement date and location

The measurement was made on 10.04.2024 at Mäealuse 10/5, 12618 Tallinn.

Measurement equipment

sound level meter	Brüel & Kjær 2250	sn. 3004362
microphone capsule	Brüel & Kjær 4966	sn. 3271301
sound level calibrator	Brüel & Kjær 4231	sn. 2253338
sound source	01dB LS02	sn. DS.14090

According to ISO 12999-1:2014, the measurement of the airborne noise emitted by the object is based on an uncertainty of ± 0,9 dB (k = 1, two-way confidence interval) of the insulation index R'_w.

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Field measurement of airborne sound insulation between rooms

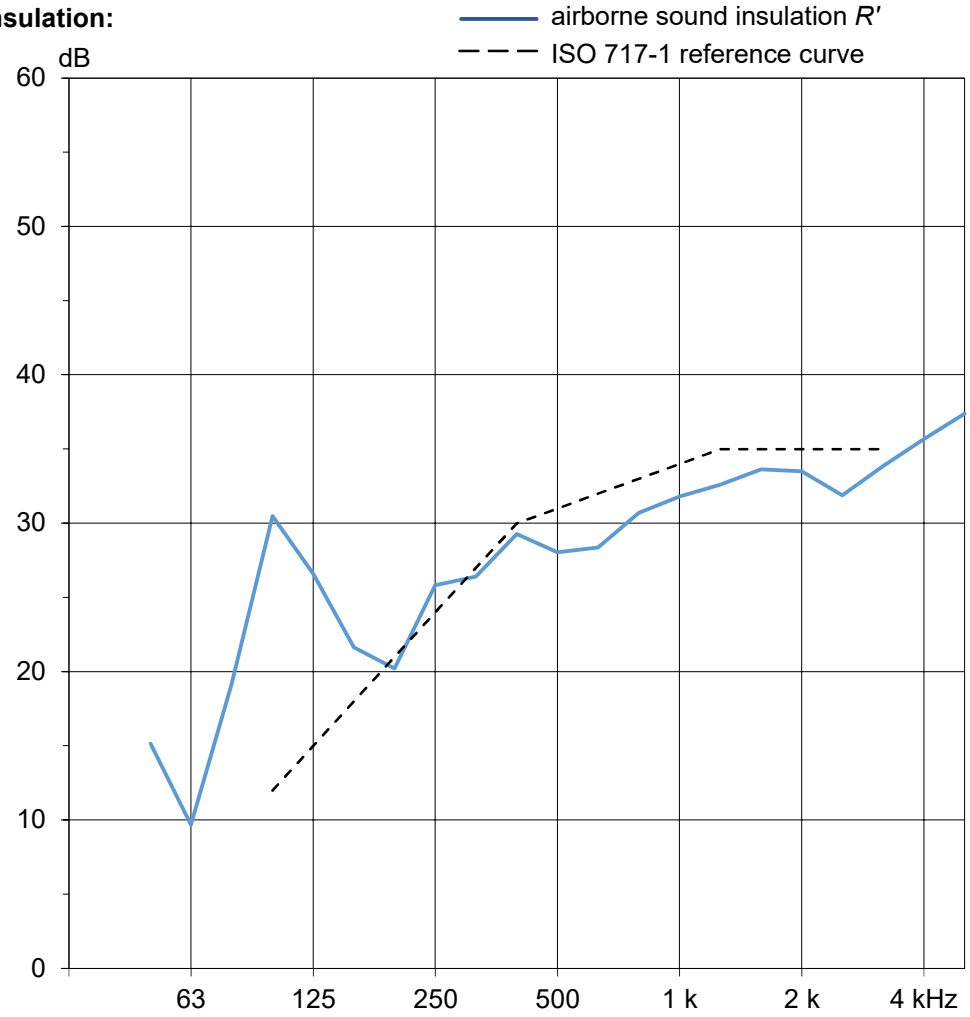
According to the standards EVS-EN ISO 16283-1:2014 and EVS-EN ISO 717-1:2020

Sending room:
Mäealuse 10/5 warehouse
Receiving room:
Modular Cabin, Rear side
Area of structure:
7 m²
Receiving room volume:
6 m³
Sending room volume:
1139 m³

Observations

Airborne sound insulation:

1/3 oct Hz	*R′* dB
50	15.1
63	9.7
80	19.1
100	30.5
125	26.6
160	21.6
200	20.2
250	25.8
315	26.4
400	29.3
500	28.0
630	28.4
800	30.7
1000	31.8
1250	32.6
1600	33.6
2000	33.5
2500	31.9
3150	33.8
4000	35.7
5000	37.4



Airborne sound insulation R'_w (C; C_{tr}): **31 (0;-2) dB**
Deviation 630 Hz: 3.6 dB

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Modular Cabin

Field measurement of airborne sound insulation between rooms

According to the standards EVS-EN ISO 16283-1:2014 and EVS-EN ISO 717-1:2020

Client:	Kipsik OÜ Mäealuse 10/5 12618 Tallinn
Contact:	Kalle Kask
Order:	05.04.2024
Date of test:	10.04.2024
Location:	Mäealuse 10/5 12618 Tallinn

FINAS
Finnish Accreditation Service
T229 (EN ISO/IEC 17025)

Measurement object

All sides of the cabin

Measurement date and location

The measurement was made on 10.04.2024 at Mäealuse 10/5, 12618 Tallinn.

Measurement equipment

sound level meter	Brüel & Kjær 2250	sn. 3004362
microphone capsule	Brüel & Kjær 4966	sn. 3271301
sound level calibrator	Brüel & Kjær 4231	sn. 2253338
sound source	01dB LS02	sn. DS.14090

According to ISO 12999-1:2014, the measurement of the airborne noise emitted by the object is based on an uncertainty of ± 0,9 dB (k = 1, two-way confidence interval) of the insulation index R'_w.

Tallinn 15.04.2024,

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Field measurement of airborne sound insulation between rooms

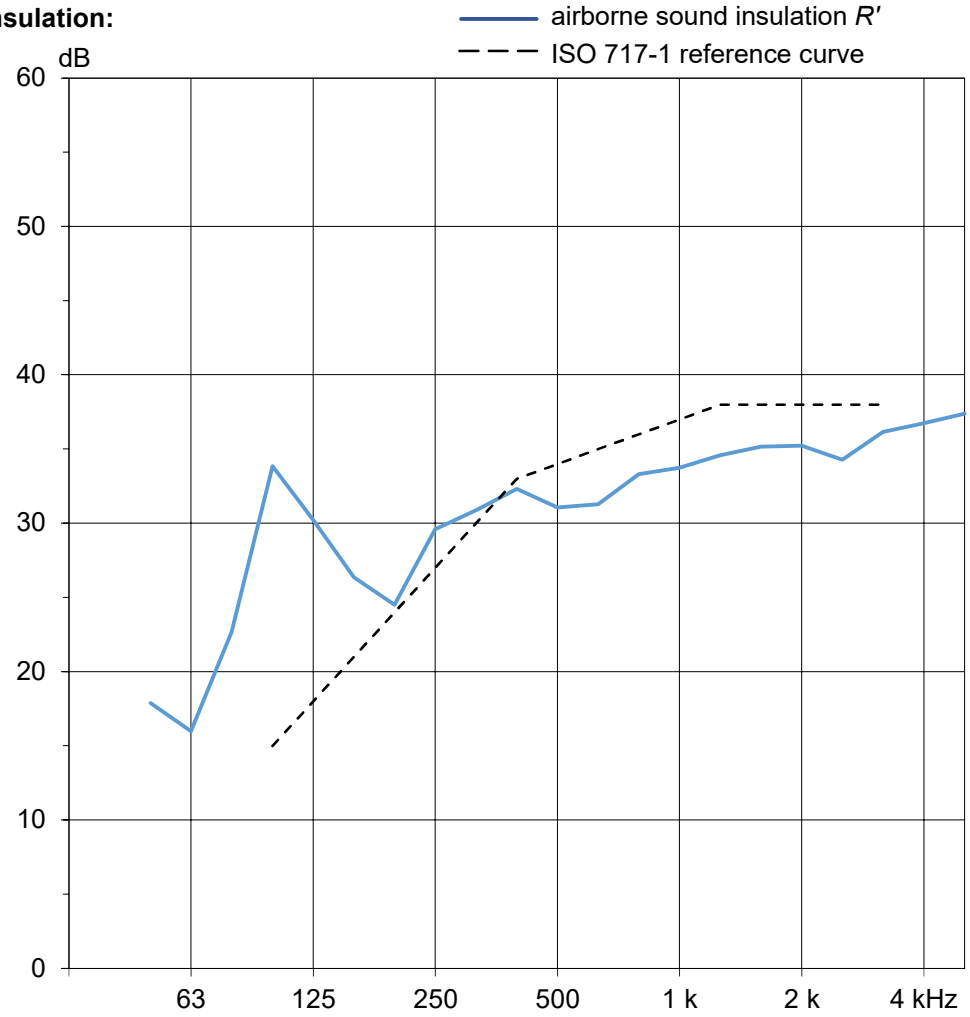
According to the standards EVS-EN ISO 16283-1:2014 and EVS-EN ISO 717-1:2020

Sending room:
Mäealuse 10/5 warehouse
Receiving room:
Modular Cabin, All sides
Area of structure:
18 m²
Receiving room volume:
6 m³
Sending room volume:
1139 m³

Observations

Airborne sound insulation:

1/3 oct Hz	*R'* dB
50	17.9
63	16.0
80	22.7
100	33.8
125	30.2
160	26.4
200	24.5
250	29.6
315	30.9
400	32.3
500	31.1
630	31.3
800	33.3
1000	33.7
1250	34.6
1600	35.2
2000	35.2
2500	34.3
3150	36.1
4000	36.7
5000	37.4



Airborne sound insulation R'_w (C; C_{tr}): **34 (-1;-2) dB**
Deviation 2500 Hz: 3.7 dB

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Reverberation time measurements

According to standard EVS-EN ISO 354:2003

Customer:	Kipsik OÜ Mäealuse 10/5 12618 Tallinn
Order:	5.04.2024
Contact:	Kalle Kask
Date:	10.04.2024
Location:	Mäealuse 10/5 12618, Tallinn
Object:	Modular Cabin

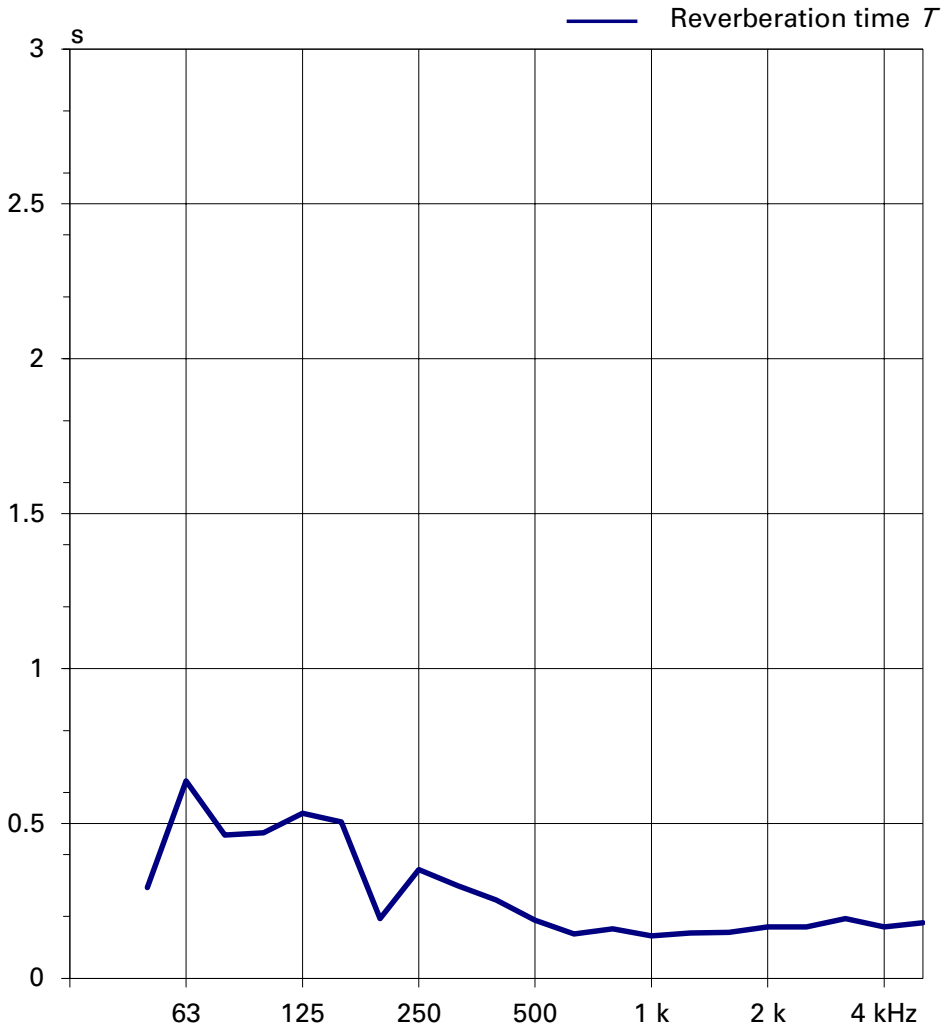
Notes:
Inner back wall was covered with acoustic panels

Room:
Modular Cabin

Nr of noise source positions: 2

Reverberation time:

Frequency Hz	*T* s
50	0.29
63	0.64
80	0.46
100	0.47
125	0.53
160	0.51
200	0.19
250	0.35
315	0.30
400	0.25
500	0.19
630	0.14
800	0.16
1000	0.14
1250	0.15
1600	0.15
2000	0.17
2500	0.17
3150	0.19
4000	0.17
5000	0.18



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