Inapod Phone Booth

Sound Isolation Performance

23/02/2023

Ref: 301351157

PREPARED FOR:

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Revision Schedule

Revision No.	Date	Description	Prepared by	Quality Reviewer	Independent Reviewer
001	23/02/2023	Issue	Hadie Artiel	Jonathan Salim	Elle Hewett

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1. Introduction

The purpose of this document is to convert sound isolation test results for the for Inapod acoustic phone booth (S-Pod) from American (ASTM) standard results (NIC) to result terminology more suited to the Australian market (D_w).

The original sound isolation tests were undertaken at TUV SUD PSB reverberation room, located at No1 Science Park Singapore 118221 on the 16th of January 2019. The original tests undertaken in Singapore were tested and classified against American Society for Testing and Materials (ASTM) standards, specifically:

- ASTM E596-96 (Reapproved 2009) 'Standard test method for Laboratory Measurement of Noise Reduction of Sound Isolating Enclosures, and
- ASTM E413 – 04 'Classification for Rating Sound Insulation'.

The above method of testing measured 1/3 octave Noise Reduction (NR) values from 100Hz to 5kHz and classified the performance as a single figure NIC (Noise Isolation Class).

This report converts the NIC result into a single figure D_w (Weighted Level Difference) using similar Australian/European standards being:

- AS ISO140.4-2006 'Acoustics – Measurement of sound insulation in buildings and of building elements Part 4: Field measurements of airborne sound insulation between rooms'.
- AS ISO 717.1-2020 'Acoustics – Rating of sound insulation in buildings and of building elements – Part : Airborne sound insulation'

Figure 2 shows an image of the Inapod Phone Booth and Figure 2 shows the typical dimensions taken from the original test report.

Figure 1: Image of phone booth (S-Pod)

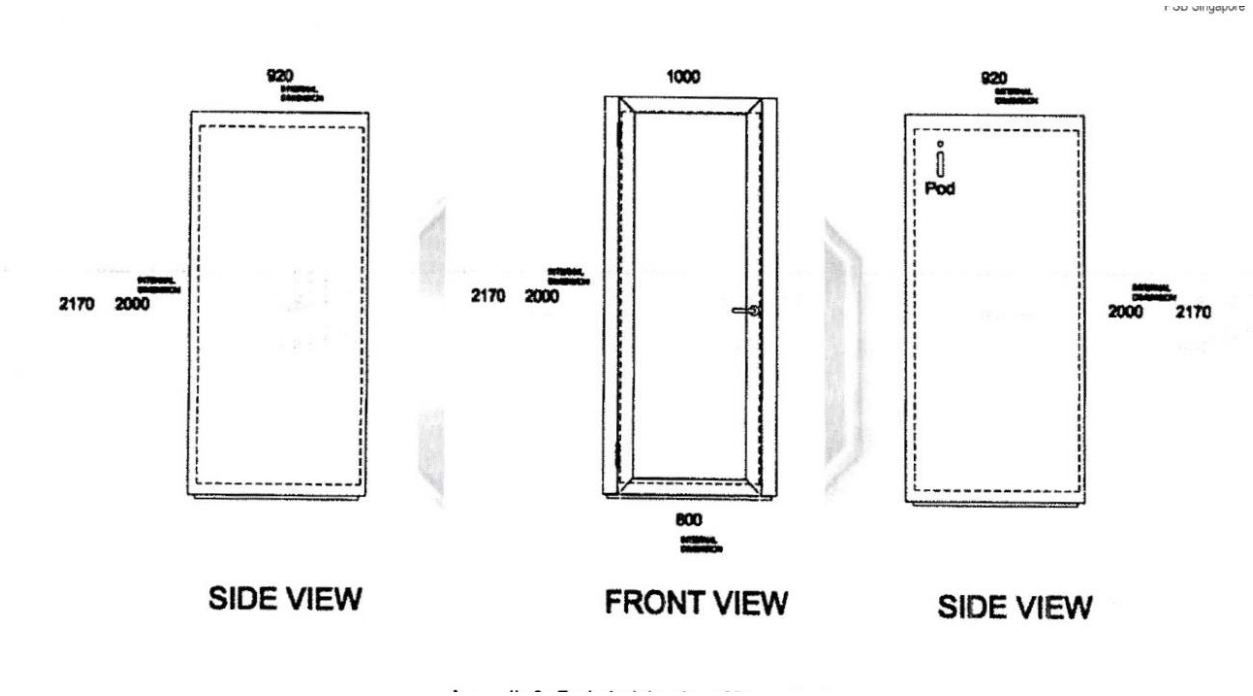


Figure 2: Typical phone booth dimensions – Inapod Test Report

1.1 Technical References

The following documentation has been used to prepare this report:

- ISO 140.4-2006 Acoustic – Measurements of sound insulation in buildings and of building elements
- ISO 717.1-2020 Acoustic – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation
- Inapod provided Test Report No 7191201823-MEC19-EMK_CR1
- ASTM E596-96 (Reapproved 2009) “Standard test method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures"
- ASTM E413 - 04 “Classification for Rating Sound Insulation”

2. Acoustic Assessment

A laboratory test of the acoustic performance of the phone booth was completed on behalf of Inapod by PSB Singapore. While the method used to calculate an NIC rating used by PSB in accordance with ASTM E596-96 slightly differs from those used to calculate a D_w rating with AS ISO 140.4-2006, the procedures for measuring L1 source and L2 receiver noise levels are considered comparable. Therefore, the measurement results presented in Test Report No 7191201823-MEC19-EMK_CR1 by PSB Singapore can be used to calculate the equivalent D_w rating.

The following subsections present an overview of the test method used by PSB Singapore, as detailed in their acoustic report and an overview of the rating method used to calculate the D_w rating for comparison.

A comparison of the two metrics is presented in Section 2.3 below.

2.1 PSB Singapore Test Method Report Excerpt

The enclosure and test equipment were set up inside a reverberation room. Measurement system was calibrated. Sound pressure level inside the phone booth was measured at 4 different microphone locations. Sound pressure level outside the phone booth was measured at 8 different microphone locations. A loudspeaker was placed at 2 separate locations outside the phone booth to generate white noise for the measurement. Noise reduction (NR) values was determined for each 1/3 octave frequency band from 100Hz to 5kHz based on the mean values of 2 different loudspeaker positions. Noise Isolation Class (NIC) was determined at 500Hz frequency of the shifted reference curve according to ASTM E413.

2.2 AS ISO 140.4-2006

During the previous acoustic assessment conducted by PBS Singapore, the average sound pressure level inside and outside the phone booth has been measured as shown in Table 2 below. The results from these measurements will be reused to calculate the level difference (D) in accordance with ISO 140.4-2006 which will later be weighed against the International Standard Organisation reference curve in ISO 717-1 to attain the weighted level difference (Dw).

Table 1: Measured average sound pressure level (Test Report No 7191201823-MEC19-EMK_CR1 by PSB Singapore)

One-third Octave Frequency (Hz)	Measured Sound Pressure Level, dB		
	Background Noise Level	Source Room (L1) Outside Phone Booth	Receiver Room (L2) Inside Phone Booth
100	46.0	80.65	73.46
125	42.9	83.31	66.17
160	41.7	84.23	67.73
200	36.3	85.15	64.59
250	36.2	85.40	63.01
315	25.0	83.52	54.98
400	29.5	81.94	52.75
500	18.5	82.87	51.94
630	13.8	84.45	52.35
800	10.6	84.30	51.30

One-third Octave Frequency (Hz)	Measured Sound Pressure Level, dB		
	Background Noise Level	Source Room (L1) Outside Phone Booth	Receiver Room (L2) Inside Phone Booth
1000	8.4	83.56	51.03
1250	8.9	81.79	49.13
1600	8.9	82.17	50.63
2000	8.2	84.15	50.29
2500	8.8	82.82	45.86
3150	9.0	85.18	45.29
4000	10.0	84.35	43.97
5000	11.0	83.43	43.70

Level difference (D), in decibels (dB), is calculated by subtracting the average sound pressure level (SPL_{AV}) In the source room by the SPL_{AV} in the receiving room :

$$D = L1 - L2$$

Where:

L1 is the average sound pressure level in the source room (Outside phone booth)

L2 is the average sound pressure level in the receiving room (Inside phone booth)

To attain the weighted level difference (Dw) from the level difference (D) the International Standard Organisation reference curve in ISO 717-1 is overlaid on the measured level difference third-octave bands. The Dw is where the 500Hz point on the reference curve is when the unfavorable deviations are at a maximum without exceeding 32. Please refer to 1)a)Appendix A for further details.

Table 2: Calculated weighted level difference (Dw).

One-third Octave Frequency (Hz)	Calculated level difference (D)	Reference Curve Dw32	Unfavorable Deviation
100	7.2	13	5.8
125	17.1	16	0
160	16.5	19	2.5
200	20.6	22	1.4
250	22.4	25	2.6
315	28.5	28	0
400	29.2	31	1.8
500	30.9	32	1.1
630	32.1	33	0.9
800	33.0	34	1

One-third Octave Frequency (Hz)	Calculated level difference (D)	Reference Curve Dw32	Unfavorable Deviation
1000	32.5	35	2.5
1250	32.7	36	3.3
1600	31.5	36	4.5
2000	33.9	36	2.1
2500	37.0	36	0
3150	39.9	36	0
Total deficiency (100Hz-3150Hz)			29.5

2.3 Result

Table 3 presents the sound insulation performance of the phone booth based on the both the American and Australian Standards. The main difference between the two rating methods is a small difference in the frequency range over which the performance is rated, as shown in the table below.

Table 3: Summary of acoustic performance

Metric	Rating
American ASTM E596-96 / ASTM E413 – 04 (100Hz-5000Hz)	Noise Isolation Class NIC 32
Australian/European AS ISO 140.4-2006 / AS ISO 717.1-2020 (100Hz-3150Hz)	Weighted Level Difference Dw 32

3. Discussion/Conclusion

An acoustic assessment has been conducted to obtain the weighted level difference (Dw) sound insulation performance of the Inapod Phone Booth in accordance with ISO 140.4-2016 and AS ISO 717.1-2020. The assessment is based on the measurement data provided by Inapod (Test Report No 7191201823-MEC19-EMK_CR1 by PSB Singapore).

Based on the information presented in this report, the weighted level difference (D_w) for the Inapod phone booths is **D_w32**. This is comparable to the previously rated performance of NIC 32.

The current and most appropriate test standard for furniture pods such as the Inapod S-Pod phone booth is:

- ISO 23351-1:2020. Acoustics – Measurements of speech level reduction of furniture ensembles and enclosures – Part 1: Laboratory method.

This standard produces a method and rating for a parameter known as Speech Level Reduction ($D_{S,A}$) instead of D_w. It was not possible to use the existing result to discern this parameter and further acoustic measurements would be required. Nevertheless, the D_w parameter is a useful sound isolation performance descriptor and is suitable for use in Australia.

Yours sincerely

Stantec Australia Pty Ltd

Jonathan Salim

Senior Acoustic Engineer

Appendix A Test Results

Stantec

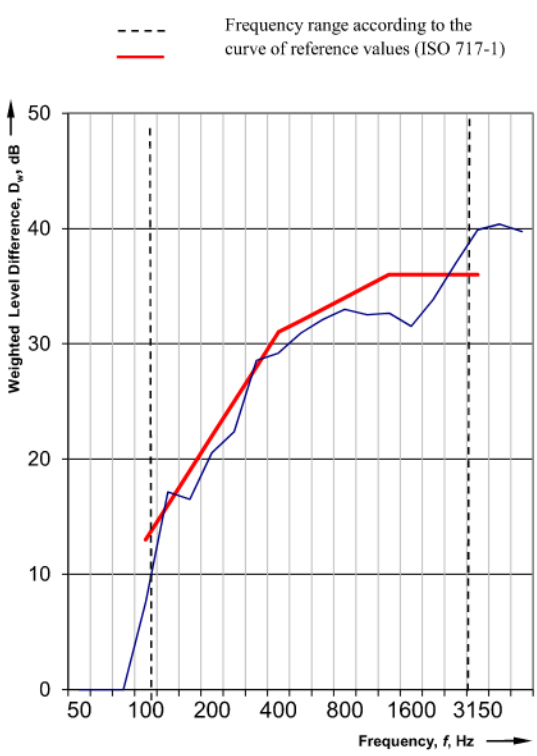
Standardized level difference according to ISO 140-4
Field Measurements of airbourne sound insulation between rooms

Client: Inapod **Date of test:** 21/02/2023

Description and identification of the building construction and test arrangement, direction of measurement:

Phone Booth Performance Test Between Outside and Inside of Booth(Dw)

f (Hz)	*Dw* (dB)
50	S/N
63	S/N
80	S/N
100	7.7
125	17.1
160	16.5
200	20.6
250	22.4
315	28.5
400	29.2
500	30.9
630	32.1
800	33.0
1000	32.5
1250	32.7
1600	31.5
2000	33.9
2500	37.0
3150	39.9
4000	40.4
5000	39.7



Rating according to ISO 717-1:

Dw (C;Ctr) = 32 (-2 ; -7) **dB** $C_{50\text{-}3150}$ = - dB; $C_{50\text{-}5000}$ = - dB; $C_{100\text{-}5000}$ = - dB

Evaluation based on field measurment results obtained by an engineering method $C_{tr,50\text{-}3150}$ = - dB; $C_{tr,50\text{-}5000}$ = - dB; $C_{tr,100\text{-}5000}$ = - dB

N° of test report: 46245-SYD-AC-T002 **Name of test institute:** Stantec Australia

Date: 21/02/2023 **Engineer:** Hadie Artiel

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Test Report No. 7191201823-MEC19-EMK_CR1
dated 16 Jan 2019

PSB Singapore

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SUBJECT:

Laboratory measurement of noise reduction of enclosure submitted by Exsto Asia Pte Ltd on 11 Jan 2019.

TESTED FOR:

INAPOD

DATE OF TEST:

14 Jan 2019

DESCRIPTION OF SAMPLES:

The following enclosure was installed in the reverberation room.

Model	:	Acoustic Booth
Product Name	:	Phone Booth
External Dimension	:	1000mm (width) x 1000mm (depth) x 2170mm (height)
Internal Dimension	:	800mm (width) x 920mm (depth) x 2000mm (height)

The technical drawing of the phone booth submitted by the company was shown in Appendices.

Amendments (31 Jan 2019): Page 1 (SUBJECT and DESCRIPTION OF SAMPLES)

TÜV SÜD PSB

Laboratory:
TÜV SÜD PSB Pte. Ltd.
No.1 Science Park Drive
Singapore 118221

Phone : +65-6885 1333
Fax : +65-6776 8670
E-mail: testing@tuv-sud-psb.sg
www.tuv-sud-psb.sg
Co. Reg : 199002667R

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
1 Science Park Drive, #02-01
Singapore 118223

METHOD OF TEST:

The test was conducted in accordance with the following test standards.

a) ASTM E596-96 (Reapproved 2009) "Standard test method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures"

b) ASTM E413 - 04 "Classification for Rating Sound Insulation"

TEST EQUIPMENT:

The following instruments were used for the test.

1) LAN-XI Data Acquisition Unit (B & K Type 3160-A-042) with Pulse Labshop (v.16)

2) 1 units of 4-channel sound & vibration analyser (SVAN 958).

3) One units of loudspeaker (JBL MPro MP415)

4) 5 sets of ½" free-field microphone (B & K Type 4943) and pre-amplifer (B & K Type 2669)

5) A sound pressure level calibrator (Norsonic Type 1251)

6) A sound source amplifier (Crown model CE 1000)

TEST PROCEDURES:

1) The enclosure and test equipment were set up inside a reverberation room as shown in Figure 2.

2) Measurement system was calibrated.

3) Sound pressure level inside the phone booth was measured at 4 different microphone locations.

4) Sound pressure level outside the phone booth was measured at 8 different microphone locations.

5) A loudspeaker was placed at 2 separate different locations outside the phone booth to generate white noise for the measurement.

6) Noise reduction (NR) values was determined for each 1/3 octave frequency band from 100Hz to 5kHz based on the mean values of 2 different loudspeaker positions.

7) Noise Isolation Class (NIC) was determined at 500Hz frequency of the shifted reference curve according to ASTM E413.

TEST RESULTS:

The test results were tabulated in the following tables.

a) Table 1 shows the background noise level inside the phone booth

b) Table 2 shows the noise reduction level (NR) of the phone booth

c) Table 3 shows the measured noise reduction, NR and values of the shifted reference curve.

Table 1: Background Noise Level inside Phone Booth

1/3 Octave Frequency (Hz)	Background Noise Level (dBL)	
	1/3 Octave Band	1/1 Octave Band
100	46.0	43
125	42.9	
160	41.7	
200	36.3	29
250	36.2	
315	25.0	
400	29.5	17
500	18.5	
630	13.8	
800	10.6	9
1000	8.4	
1250	8.9	
1600	8.9	9
2000	8.2	
2500	8.8	
3150	9.0	10
4000	10.0	
5000	11.0	

RESULTS: (Con't)

Table 2 : Noise Reduction Level of Phone Booth

1/3 Octave Frequency (Hz)	Noise level (dBL)		Noise Reduction Level, NR (dBL)
	Outside Phone Booth	Inside Phone Booth	
100	80.65	73.46	7.2
125	83.31	66.17	17.1
160	84.23	67.73	16.5
200	85.15	64.59	20.6
250	85.40	63.01	22.4
315	83.52	54.98	28.5
400	81.94	52.75	29.2
500	82.87	51.94	30.9
630	84.45	52.35	32.1
800	84.30	51.30	33.0
1000	83.56	51.03	32.5
1250	81.79	49.13	32.7
1600	82.17	50.63	31.5
2000	84.15	50.29	33.9
2500	82.82	45.86	37.0
3150	85.18	45.29	39.9
4000	84.35	43.97	40.4
5000	83.43	43.70	39.7
Overall Linear (dBL)	**96.2**	**75.9**	**20.4**

RESULTS: (Con't)

Table 3 : Measured Noise Reduction, NR and values of the shifted reference curve for NIC= 32

1/3 Octave Band Frequency (Hz)	Measured Noise Reduction, NR, (dB)	Shifted Reference Curve NIC = 32 dB	Deficiency
100	7.2	13	5.8
125	17.1	16	0.0
160	16.5	19	2.5
200	20.6	22	1.4
250	22.4	25	2.6
315	28.5	28	0.0
400	29.2	31	1.8
500	30.9	**32**	1.1
630	32.1	33	0.9
800	33.0	34	1.0
1000	32.5	35	2.5
1250	32.7	36	3.3
1600	31.5	36	4.5
2000	33.9	36	2.1
2500	37.0	36	0.0
3150	39.9	36	0.0
4000	40.4	36	0.0
5000	39.7	36	0.0
Total deficiency (125Hz – 4000Hz)			**24**

The values in Table 1 were plotted as shown in Figure 1.

Remark:

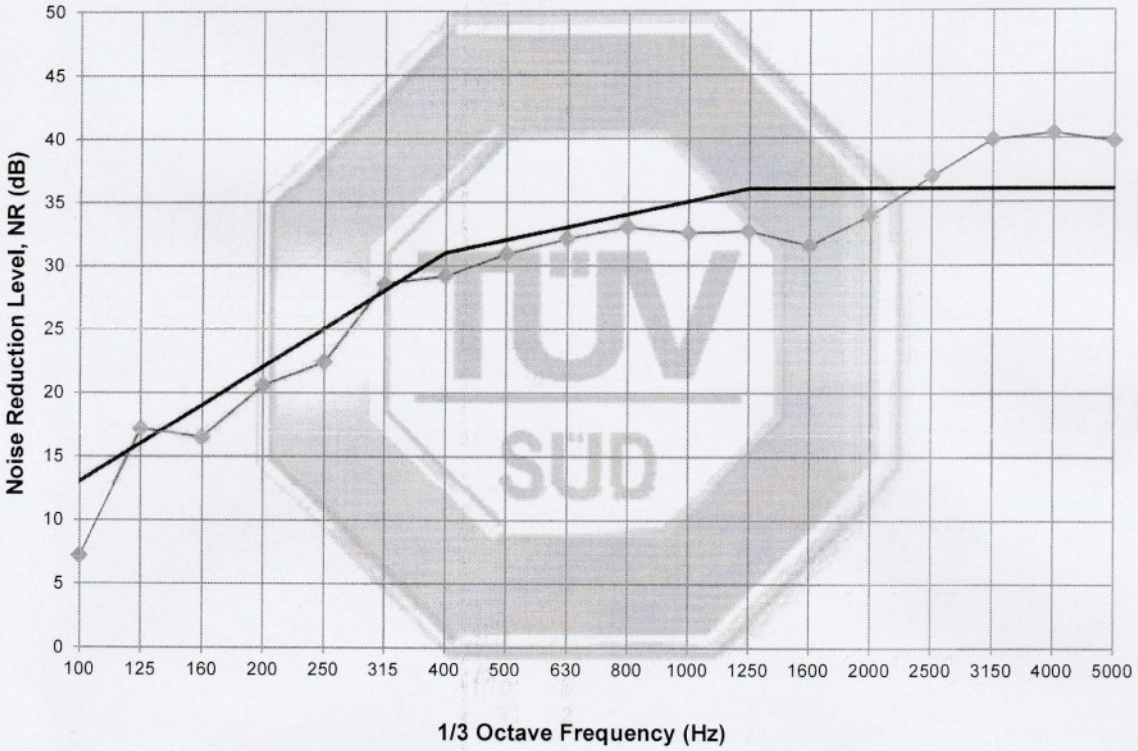
The tested Phone Booth achieved
a) Noise Reduction, NR = 20dB
b) Noise Isolation class, NIC = 32

Francis Ee Min Kuen
Testing Officer

Lem Chee Meng
Product Manager
Acoustics
Real Estate & Infrastructure - Mechanical

RESULTS: (cont'd)

Figure 1 : Noise Isolation Performance of Phone Booth (NIC 32)



PSB Singapore

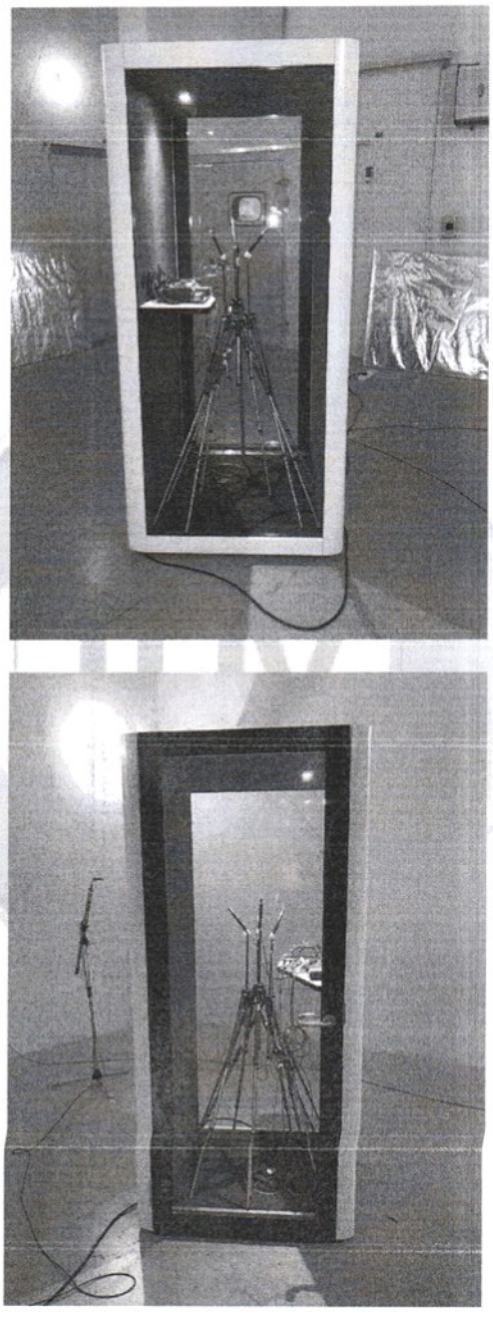
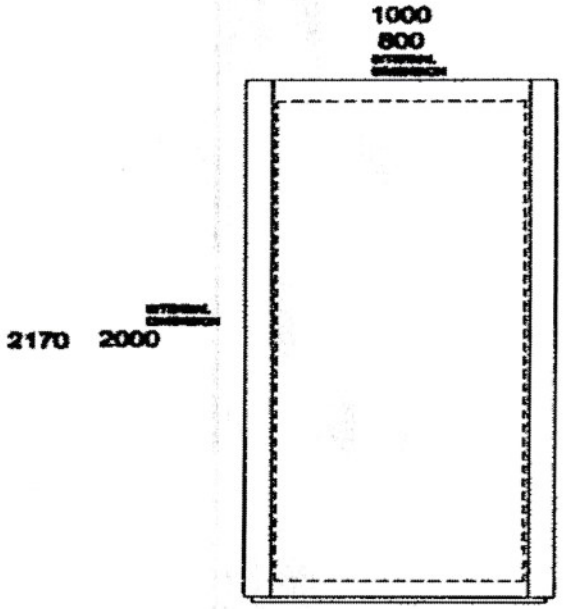
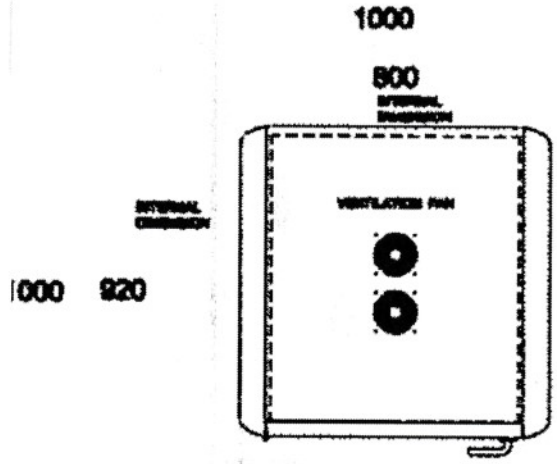


Figure 2 : Test Setup of Phone Booth inside reverberation room

PSB Singapore



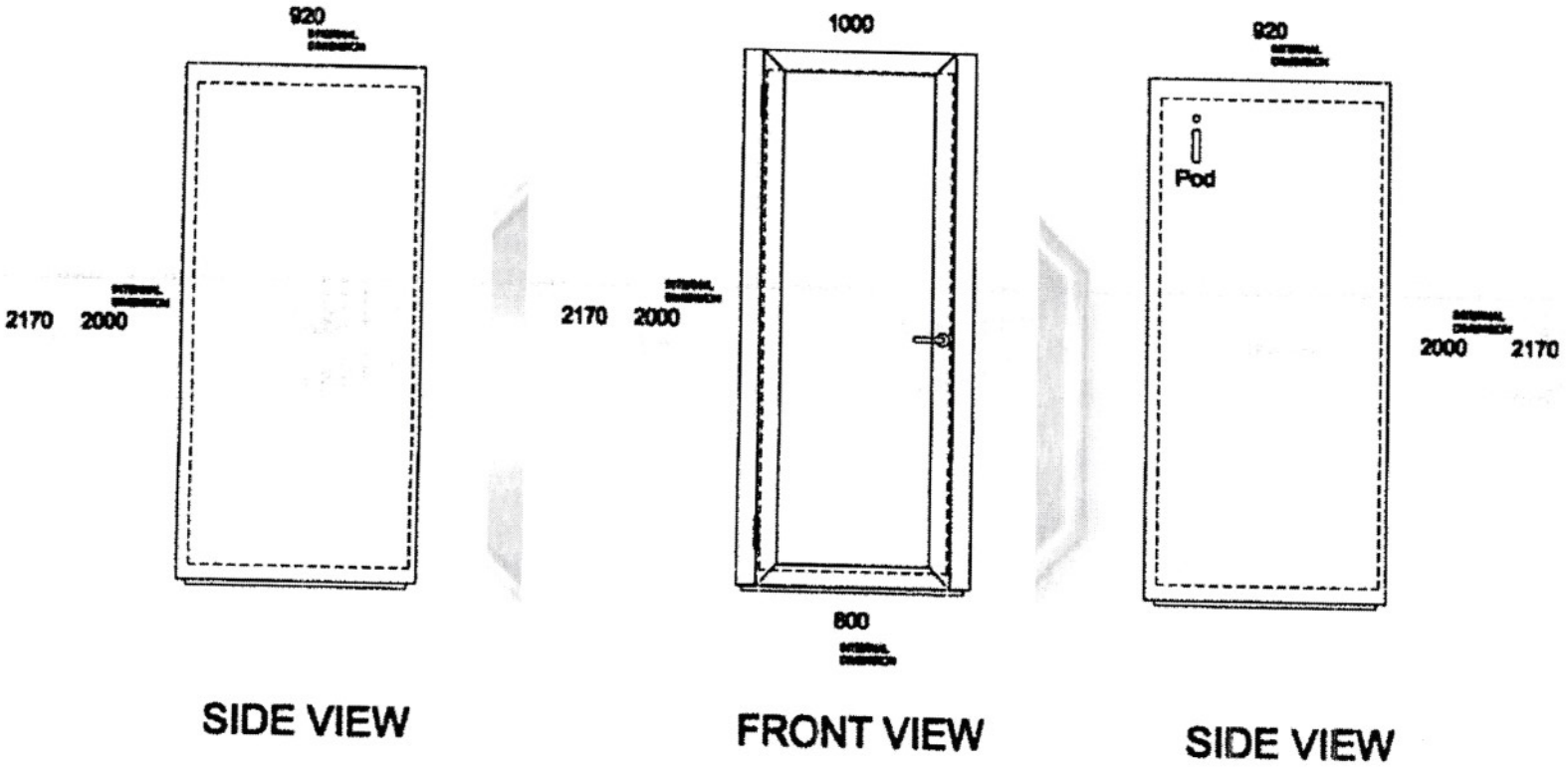
REAR VIEW



PLAN VIEW

Appendix 1 : Technical drawing of Phone Booth

PSB Singapore



Appendix 2 : Technical drawing of Phone Booth

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July 2011