

Percentage of Loss of Articulation for a Worship Place

By: Ir. Chuah Chin Hoon, P.Eng., MIEM

INTRODUCTION

In Acoustics, percentage of loss of articulation (%ALcons) in a hall plays a very important role in determining the speech clarity reproduced by a sound reinforcement system installed inside the hall. In the USA, the permissible values for %ALcons at octave bands in a hall or auditorium will not be allowed to exceed 15% for good speech intelligibility. However, I am more stringent and normally select this value to be less than 10% in my projects.

It is not denying that the preaching of pastors in a church is very imperative so as to ensure that the sermon must be able to be heard loud and clear by each audience inside the church hall, irrespective of where he or she sits.

In view of this, early this year, when we were invited to undertake the AV system designs for a church in a town in Malaysia, we had taken steps to carefully design good acoustic treatment and to select suitable loudspeakers for its church hall in order to make sure that the %ALcons at octave bands inside the hall will not exceed 10%.

This paper briefly describes the calculation of percentage of loss of articulation (%ALcons) for this new church hall.

2. APPROXIMATE HALL DIMENSIONS

- (a) Approximate Volume = 765.906 m³, and
- (b) Approximate Surface Areas = 545.582 m²

3. OPTIMUM REVERBERATION TIME (RT60) SELECTED AT 500 HZ = 0.56 SECOND

4. NUMBER OF AUDIENCE:

- (a) Half Full = 35 people and
- (b) Full Hall = 100 people

5. APPROXIMATE SOUND ABSORPTION INSIDE THE HALL

- (a) Air absorption from 1,000 Hz and above for a volume of 765.906 m³
- (b) Building structural absorption = 299.485 m²
- (c) Thin carpet = 147.79 m²
- (d) Wooden paneling over air space (stage wall) = 336.595 m², see Figure 1.
- (e) Curtain = 18 m², see Figure 2
- (f) Light upholstered seats = 45.174 m², see Figure 3
- (g) 50 mm rock wool wrapped with acoustic transparent fabric = 17.846 m²

Note : This rock wool was laid and hidden in the empty space above the Entrance. When I said "hidden" is because they cannot be seen from outside, but can be reached by sounds



Figure 1



Figure 2



Figure 3



Figure 4

inside the hall. Figure 4 is the photo showing the rock wool was kept behind the clock.

- (h) Audience :
- (i) Half Full = 35 people, and
- (ii) Full Hall = 100 people

6. CALCULATED REVERBERATION TIMES (RT60) AT OCTAVE BANDS, SEE FIGURE 5

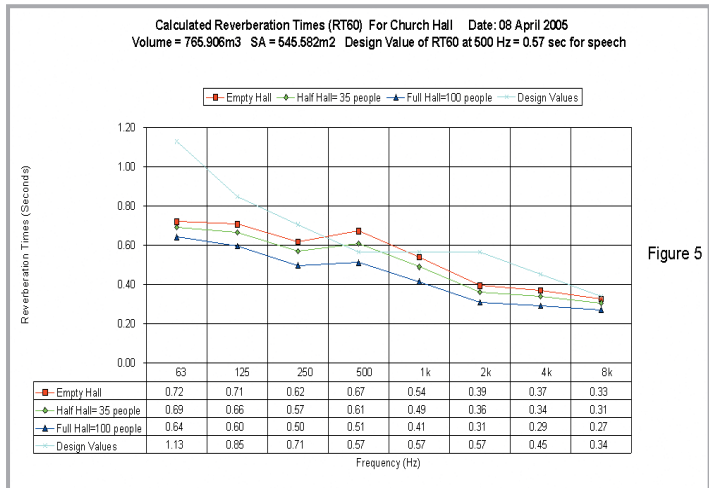


Figure 5

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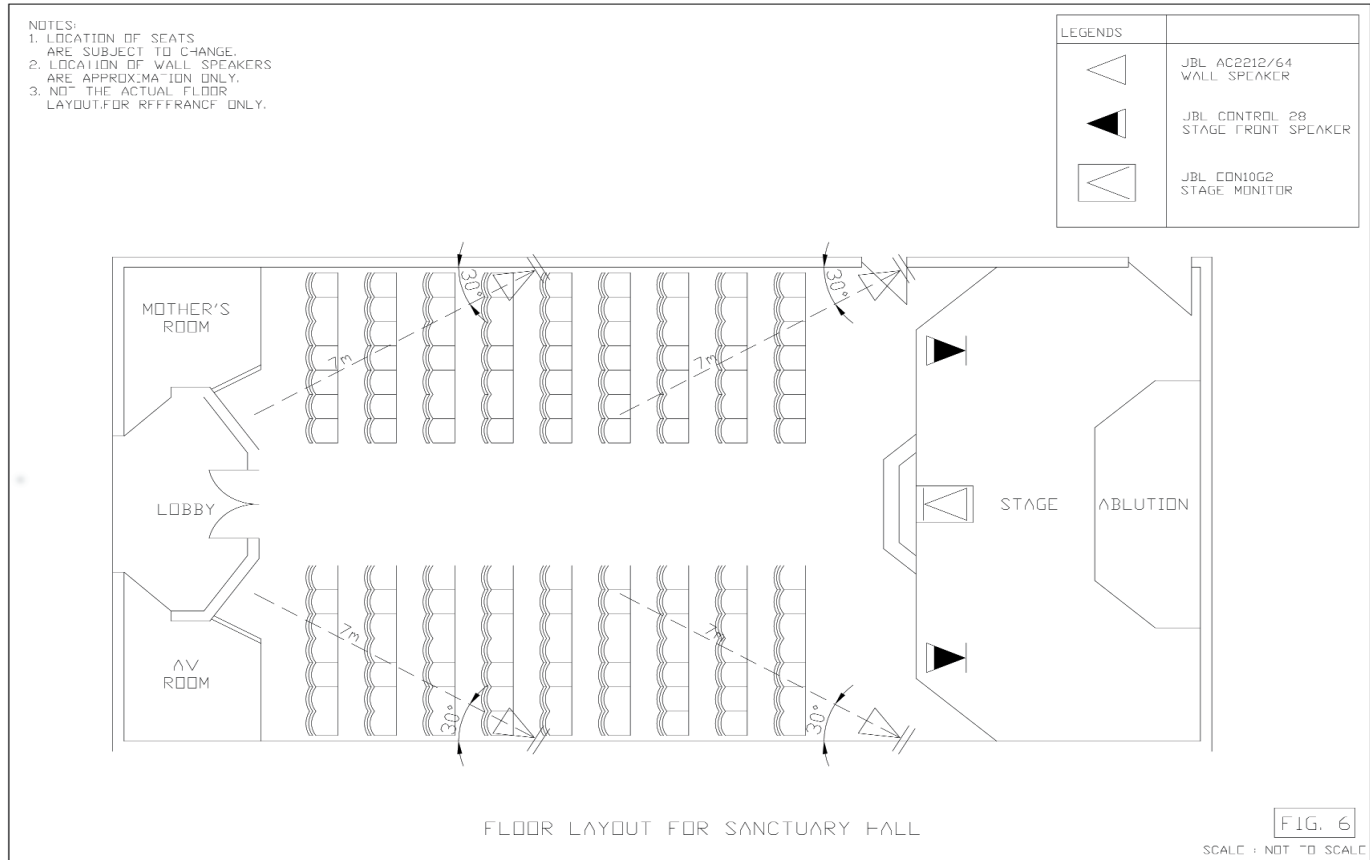


Figure 6

The calculated reverberation times (RT 60) at octave bands in empty hall using Eyring formula are shown in Figure 5 and tabulated below:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Q	0.72	0.71	0.62	0.67	0.54	0.39	0.37	0.33

Please note that they are all well below the designed values, except at 500 Hz.

7. LOUDSPEAKERS

(a) Wall speakers

(a) Four 2 way wall speakers type JBL 2212/64, are installed on the side walls, as shown in Figure 6, at a height of about 7.5 feet above the floor and inclined at an angle of about 25 degrees downward and about 30 degrees from the wall surface so as to ensure all listeners are in the sound coverage. Figure 7 shows the photo of these wall speakers installed.

(b) These speakers have the following dispersion angles:

- (i) Horizontal : 60 degrees
- (ii) Vertical : 40 degrees

They are high “Q” speakers with the following values:

Frequency (Hz)	125	250	500	1k	2k	4k	8k
Q	2	2.5	4	9	13.5	16	31

(c) These speakers have a maximum Sound Pressure Level (SPL) of 120 dB at 1m at rated power at low frequency.

At the longest distance, i.e. 7 metres, required for sound coverage inside the Hall for each wall speaker, the maximum sound pressure level (SPL) on axis, is about 103 dB. However, this high SPL is reduced and the system will operate between 85 to 90 dB without feedback.

(b) Stage front speaker

(Two JBL Control 28 speakers, see Figure 8, were installed at and below the stage front to cover the first few rows of seats. Their nominal coverage is 90 degrees x 90 degrees with an SPL of 88 dB at 1m 1w.

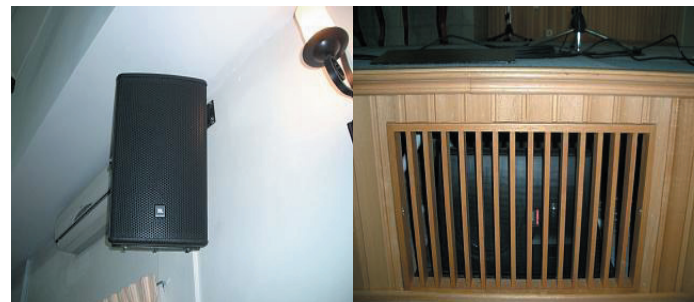


Figure 7

Figure 8

(c) Stage monitors

Owing to the fact that the stage is small, only one stage monitor model JBL EON 10 G2 speaker, see Figure 9, was provided on stage. This speaker has dispersion angles of 90 degrees (H) x 90

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degrees (V), with an SPL of 117 dB at 1m at rated power. Since it is an active speaker, it can be used, if necessary, as a standby unit, in case the main system fails.

(d) Wall monitoring speakers

Three units of JBL Control 1, were installed on walls in Control Room, Entrance, and Mother’s Care Room, see Figure 10, to provide certain amount of sound to these areas.



Figure 9



Figure 10

- (b) Dynamic microphone: Shure Beta 58, Shure SM 58 and Beyerdynamic M700TG
- (c) Wireless microphone: Shure UHF wireless microphone system EUT24BETA58 ,
- (d) Mixing Console: Soundcraft M12, see Figure 12
- (e) Power amplifier: Crown Xls 620
- (f) Graphic equaliser: Rane ME 60



Figure 11



Figure 12

8. SELECTION OF CONDENSER MICROPHONE FOR ALTAR

After completion of the installation, several condenser microphones with goose-neck were tested. Finally, the model Sennheiser MK 36 with super-cardioid directional characteristic was selected.

9. LIST OF OTHER EQUIPMENT

(a) Altar microphone: Sennheiser short-gun microphone type MK 36, see Figure 11,

10. CALCULATED PERCENTAGE OF LOSS OF ARTICULATION (%ALCONS)

Based on the values of “Q” of wall speakers JBL AC 2212/64 given by the manufacturer and the calculated RT 60 as stated in item 6 above, the percentage of loss of articulation (%ALcons) at octave bands for the wall speakers at distances of 7 and 10 metres respectively away from them were calculated as shown in Figure 13. They were further tabulated as follows:

Frequency (Hz)	125	250	500	1k	2k	4k	8k
%AL cons at 7m	6.4	3.88	2.89	0.82	0.29	0.217	0.087
%AL cons at 10m	13.07	7.937	5.89	1.68	0.60	0.443	0.179

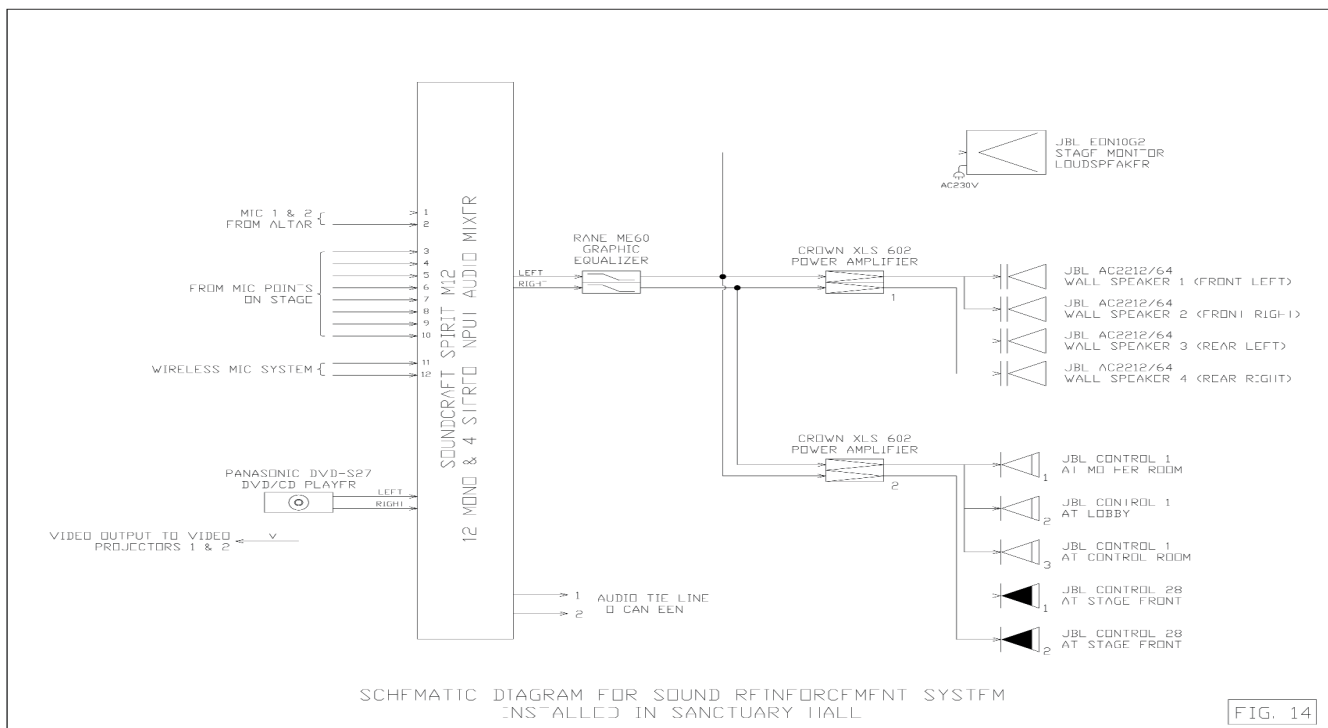


Figure 14

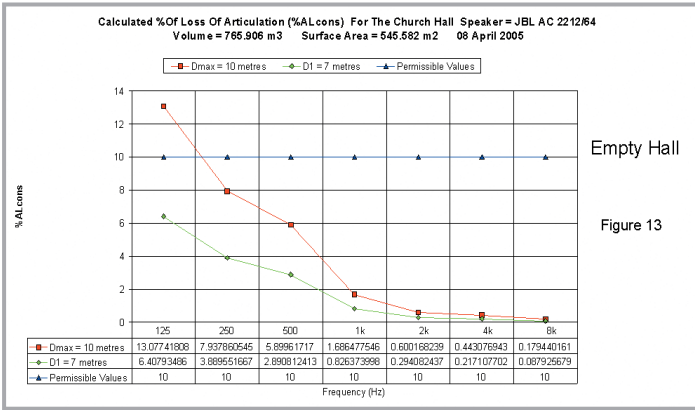


Figure 13

It is noted that they are all well below the permissible value of 10% and it, therefore, clearly shows that good speech intelligibility can be obtained inside the whole Hall.

11. SYSTEM EQUALISATION

After completion of the installation, the whole system was equalised to eliminate the acoustic howling and improve the tonal quality. Pink noise at 1/3 octave bands was sent into the hall and the Rane graphic equaliser ME 60 was adjusted based on AES Ideal Curves for speech, with the help of an Ivie Real Time Analyser.

12. SCHEMATIC DIAGRAM

The schematic diagram for the sound reinforcement system for the church hall is shown in Figure 14 (previous page).

13. AV CONTRACTOR

The AV systems were installed by Integrated Audio Visual Sdn Bhd of Kuala Lumpur, Malaysia.

14. CONCLUSION

The sound reinforcement system has been operational since April 2005 and it has been functional satisfactorily.

Just for information, two 8' x 8' motorised screens had been installed at both sides of the rear wall, see Figure 15, with two video projectors installed below the roof, see Figure 16.

The up and down of these two video screens could be controlled either at the front side wall or in the Control Room.

At the stage front, two computer points were also provided for connection to PC's for the video display on the screens, when the PC's are used on stage. However, similar connections are also provided in the Control Room, if the PC's will be used inside the Control Room.

One unit of DVD player model Panasonic DVD-S27 is also provided in the Control Room. ■



Figure 15



Figure 16