Acoustics in a small control room

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Abstract

Acoustics in small rooms is allways a problem, particularly at the low frequency range, because of their size and the fact that there is very limited space to install all the acoustic materials needed in order to obtain the desired acoustic response, but when an electroacoustic system has to be employed as it is the case in a small Control Room for a small recording studio, matters become even worse. First of all, the space is further reduced in order to accomodate the required sound system, and with the presence of hard to control low resonant frecuencies, which can be excited at any moment during any recording session, it can be produced highly different sound presure levels at those frequencies, changing the timbre of sounds. Some measurement results are presented.

1 Introduction

Small recording studios are very common within the broadcast industry in Mexico, with even smaller control rooms, with rare exemptions where plenty of electronic equipment have to be installed inside, many of them without any acoustic treatment or design.

From the onset of the broadcast industry in Mexico, many recording and transmision studios have been built, but very few have been acosutically designed or conditioned, although fortunatelly, in increasing numbers nowadays. Sizes range from 6 to 20 square meters of floor area, (i.e. 13 to 50 cubic meters), with the average closer to the smaller size, where no less than a mixer, few recorders plus related equipment, one table, one equipment bench, two or three chairs for the involved personel, and often times with a couple of ⅓ to ½ cubic meter baffles plus a couple of so-called near field speakers for monitoring purposes, leaving only a few cubic meters for the sound to develope from the sources.

For many years, broadcasters requested from engineers some acoustical treatment for the studio, and completely excluding the control room conditioning, or even saying that the control room was only for the installation of the electronic equipment, while the studio had to be an acoustical room, because there were to be located the sound sources (voices, music), and the microphones to pick them up, so that the control room need not any acoustical treatment at all.

Some of those control rooms acoustically designed and treated have seen their walls originally covered with predesigned and costly diffusers and absroptive materials, with a second variable thikness layer of diffusing materials such as hundreds of tapes and CDs, docens of handbooks, and many other materials, in a somewhat random fashion, drastically altering the room simetry and the absorption balance stablished in the original design, and further reducing inner volume.

2 Development

This paper prersents some of the sound measurements made in a recording studio, incluging the control room, which was designed and built for a broadcast station (actually it was a set of recording studios, but only one is herewith presented), in order to allow them to record short clips, news, interviews and comercials, so one or two speakers could be accomodated inside the studio for voice recording and interviews, or a small round table for up to five people discussing an specific topic. The total available space for each studio consited of 28 square meters (4 x 7 mts.), with almost 3 mts. In height. Studio area of 4 x 4.5 mts was allocated, and control room area of 4 x 2.25 mts was considered apropriate by the owner. Fig. 1 shows a simplified floor plan of this studio and it's control room. Measurements results emphasize the Control Room acoustical conditions, but there are some of the Studio as well.

Rooms were made out of several layers consisting of two rocksheet plates with 5 cm. of compact fiberglass inside, alternated with layers of air space with some loose fiberglass in between, for a total wall thikness of almost 40 cm. which allowed to obtain acceptable sound insulation with low weight materials.

The observation window separating the studio and control room, in the size of 2.5 square meters, and consisting of three different layers of glass, and separated 7 to 15 cm. from each other (central glass vertical, and outer glasses non-parallel to the central one, nor to the front wall), also produced sufficient sound insulation for the main purpose of the recording studio, namely speech recording, with reazonable sound levels for the monitoring activitie within the control room.

Between the control room and the corridor, a large double glassed window with vertical glasses, floor to plafond was installed, allowing other employers and visitors to the broadcast station to have a detailed view of the action taking place in the studio during recording sessions. Insulation values obtained by this window were lower than those for the studio-control room window, but higher than those for the doors.

Access doors are on the right hand side of the complex, meaning that equipment and personel have to be located off center, to the left hand side of the control room, producing a non symetrical acoustics environment for the monitors, plus the operation and production people. Doors are double glassed mounted in an aluminum frame and with rubber seals all around the door (upper, lower and lateral sides). Insulation values shown in Table I reflect measurements made before and after each door and perimetral sealling was adjusted.

Table I sumarizes average sound insulation values obtained by measurements following the procedure outlined in ISO 140 standard for in situ evaluations [1]. In the cases of both doors and the wall marked with 7 (the one between two control rooms), the results presented were measured before and after the doors were adjusted and the wall was properly finished. This table also shows end values of the reverberation time results as an average of two different measurment points, made with an impulsive signal, for studio and control room.

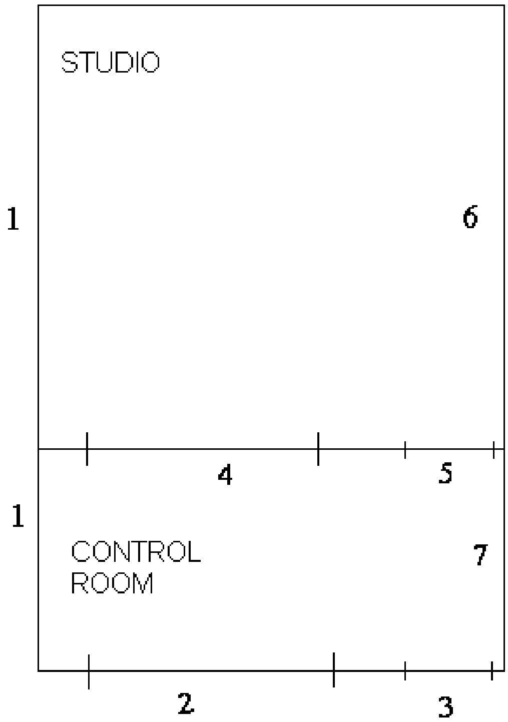

Fig. 1. This drawing shows a small recording studio for a broadcast station, where relative sizes for studio and control room can be apreciated. Total floor area is 7 x 4 mts. Control room floor area is 2.25 x 4 mts. = 9 mts2. Total volume = 22 mts3.

Numbers 1 through 7 define all the walls and partitions evaluated for noise insulation, where 1, 6 and 7 are blind walls made out of several rocksheet insulation layers; 2 (double glassed), and 4 (three non-paralell glasses), are observation windows; 3 and 5 are double glassed access doors.

Table I bellow shows measured transmission loss and reverberation times for both rooms, it can be seen short reverberation times in both rooms, but better balanced times in the control room.

STUDIO						
	Attenuations in dB					
Frequency Hz	125	250	500	1k	2k	4k
1 Wall to corridor	40.5	42	51	53.5	54.5	55
4 Window to Control Room	25	27	30.5	32.5	32.5	41
5 Door to Control Room	5	4	7	8	9	20
	14	16	20	16	16	28
6 Wall to Other Studio	41	45.5	61.5	59	56	51.5
	Reverberation Time in sec.					
Rev. Time	0.36	0.4	0.29	0.17	0.12	0.11

CONTROL ROOM						
	Attenuations in dB					
Frequency Hz	125	250	500	1k	2k	4k
2 Window to corridor	18	21.5	19.5	24	27	34
3 Door to corridor	12	7	7	9	12	19
	19	13	15	16	19	26
7 Wall to Other Control Room	10	19	26	33	38	46
	30	33	33	37	40	45
	Reverberation Time in sec.					
Rev. Time	0.36	0.37	0.33	0.33	0.31	0.34

TABLE I Sound attenuations and reverberation times of Studio and Control Room

Wall marked with number 7, separating two control rooms, although made out with the same layers as the others walls, showed very little attenuation in the first evaluation due to the fact that the construction personel did not finish it properly, in the original construction, with all the sound insulation layers running all the way to the corridor facade as expected, with proper seals among them, and adecuate support for both access doors to the control rooms (left and right), herewith located side by side, the second line shows results after the modification, showing improvement particularlly in the low frequencies, as can be seen in the second measurement.

Resonance modes were evaluated within both rooms, by means of the retro-reverberation method, and found out that there were strong resonances at several frequencies, as can be seen in Figure 2 bellow. Sound level differences were in excess of 5 dB between the maximum and minimum (aprox. 10 cm. away), at the 1848 resonant frquency shown, and were reduced to 2 dB after treatment. Absorption and diffusion was added to the room.

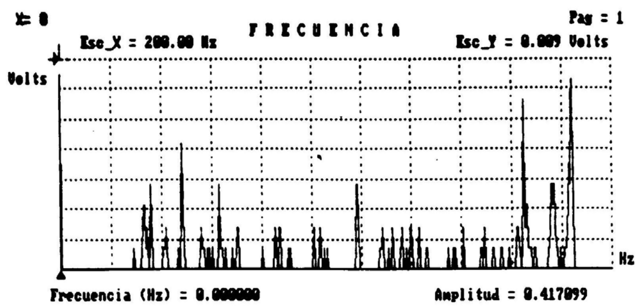

Fig. 2. Resonant frequencies by the retro-reverberation method (1848 Hz, 2nd peak)

Reverberation time measured at some resonance frequencies proved to be longer than expected for the given octave band. After some adjustment in the general absorption in both rooms, new reverberation time measurements were made, final values shown in Table I. Figure 3 shows the result of the 1848 Hz reverberation time in the studio, where the value now falls within the 1 kHz and 2 kHz impulsive signal reverberation time measurements from Table I.

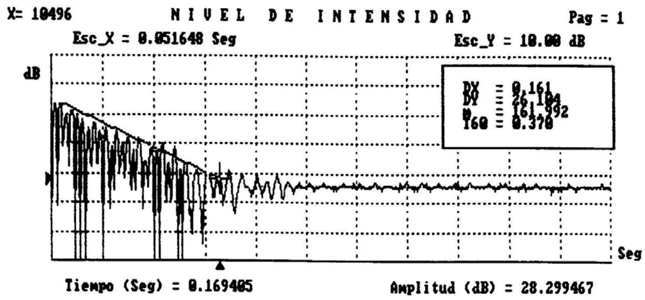

Fig. 3. Reverberation time result at 1848 Hz (one of the very strong resonances within the studio), after absorption adjustment.

Employing a TEF system, measurements were carried out do determine the Speech Intelligibility score and the reverberation time inside both rooms, the studio and the Control Room, by the Speech Transmision Index STI method. The score results confirmed the expected conditions of very good speech intelligibility due to the short reverberation times in the frequency range of interest for speech quality and a low background noise due to the reazonably good sound insulation values obtained.

TEF SPEECH INTELLIGIBILITY TEST — TEF 20

FREQUENCY	STI	EARLY RT60	S/N RATIO
125 Hz	0.80	0.37	9.1 dB
250 Hz	0.83	0.29	9.9 dB
500 Hz	0.77	0.42	8.2 dB
1000 Hz	0.81	0.34	9.4 dB
2000 Hz	0.77	0.43	8.0 dB
4000 Hz	0.75	0.47	7.4 dB
8000 Hz	0.91	0.20	12.2 dB

-- OVERALL --
STI = 0.78
Equivalent S/N Ratio = 9.2 dB
Equivalent Early RT60 = 0.36 s

-- SUBJECTIVE EVALUATION --
EXCELLENT

File: XEW-C1.STI — Noise source = Measure

Fig. 4. TEF system window showing STI, Early decay TR60 and equivalent S/N Ratio.

The reverberation times (Early decay), evaluated by this system at the same time of the STI measurement, and determined at seven different octave bands proved to be similar to those obtained by the measurments with an impulsive signal (see Table I). Results obtained for the empty (only equipment and furniture in place), control room are shown in Figure 4, together with the ‘sujective’ instrument’s exclamation ‘Exellent’.

3 Comments

Some practical measurements were performed in this control room in order to verify it’s compliance with the original design goal, and some corrections had to be made based in the measurements results for insullation and conditioning in order to obtain a closer to the designed response of the rooms.

As normally expected, the acoustical response of the control room is not fully uniform, but not so different either, although general conditions are good and the subjective impresion of the trained people involved in the production of audio material in this studio was in accordance to the ‘subjective’ evaluation of the TEF system.

Design could have addressed the simetry problem mentioned, but the architectural design based on the owner needs and preferences determined this layout. High absorption located behind the loudspeakers improved this condition

Monitoring in this control room is made by a set of normal stereo monitoring baffles with three speakers each, located at the side of the observation window, and a set of ‘near field’ baffles, with two units each, located on top of the console.

4 Conclusion

Control room proved to have some sound level variations at some given frequencies, other that expected by source distance.

Reverberation time was not fully as expected, but close enough to work with little influence from the room.

After modification, sound levels were more uniform and the reverberation times at the resonant frequencies were similar to the reverberation times of the adjacent frequencies, reducing coloration of the sound within the control room.

References

[1] INTERNATIONAL STANDARD ISO 140-4 (Acoustics — Measurement of sound insulation in buildings and of building elements — Part 4: Field measurements of airborne sound insulation between rooms). 2nd. Ed. ISO, 1998.