



Improved rehearsing conditions in Norway after ISO 23591

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ABSTRACT

In Norway, music organizations have been working together with leading acousticians since the end of the 1980s. We have seen many small steps in the process of improving rehearsing and performance acoustics. By far the most important and successful has been the acoustic standards, first the Norwegian NS 8178 *Acoustic criteria for rooms and spaces for music rehearsal and performance*, replaced in 2021 by ISO 23591 *Acoustic quality criteria for music rehearsal rooms*.

Nine years after the NS 8178:2014 – we experience improved rehearsing conditions for music ensembles. The reason for this is a combination of many factors. Improved acoustics, witness reports from musicians and acousticians, statistics and measurements, National Standards, cooperation between music organizations, acousticians and politicians work together towards better rehearsing and concert facilities. Guldberg Academic Male Choir, now rehearsing in the assembly hall at Ruseløkka school, built according to the NS 8178, is a typical example.

It is no doubt that the standards have resulted in improved rehearsing conditions. Enough volume, area and suitable room dimensions, suitable reverberation time and other criteria has proven to be the main factors.

Keywords: *music, rehearsal, room acoustics,*

1. INTRODUCTION

The ISO 23591:2021 “Acoustic quality criteria for music rehearsal rooms and spaces” was published in September 2021, and published as a Norwegian Standard, NS-Iso 23591 in December 2021. Almost two years after publication, experience from this standard is limited. The ISO 23591 is based on the former Norwegian Standard NS: 8178:2014, and we have positive experience of the effect this standard has for the development of good acoustical rehearsal rooms for music. Compared with the Norwegian NS 8178 the ISO 23591 is more precise, is completed with international acoustic knowledge, has incorporated the experiences from the NS 8178:2014 and is adjusted according to the use of the NS 8178:2014.

2. BACKGROUND – WHY THE ISO 23591?

The development of ISO 23591:2021, starting with NS 8178:2014, is based on the need for suitable and well-equipped rehearsal rooms for music.

From a musician’s point of view, the rehearsal room is the most important room. This is where they spend most of their time. For a choir or an orchestra, the rehearsal room is their “home ground”, where they learn to play or sing together with the other musicians. The musicians adapt their musical practice and skills to the acoustical situation in the rehearsal room, and if this is not adequate, we learn to play in an unbalanced way, or to develop poor sound quality and timbre.

The concert rooms are where the ensemble «shows off». That’s when we want to present ourselves at our best, for the audience and the local community. In many ways, our concerts are also our pay-back to society. That’s a part of our way of making the local community a better place to live. The concerts are also a recruitment arena for our music ensembles. If a music group sounds well, people will want to join and to be a member of that group.

We know from statistics that in Norway, more than 10.000 rooms are used for music purposes every week. This is

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based on our member lists, our knowledge from music practice in Norway and data from Statistics Norway [1]. The situation is not unique for Norway. International surveys also show that many rooms are in use for musical practice. Figures from European Choral Association (https://europeanchoralassociation.org/wp-content/uploads/2019/01/singingeurope_report.pdf) [2] show that there are 37 million people singing in choirs in Europe. 4,5% of the European population takes part in collective singing, in more than 1 million vocal ensembles. Knowing that most rooms are used by one ensemble, this indicates that there are close to 1 million choir rehearsal rooms in Europe.

At the “Choir Acoustic” session at the “World Symposium on Choral Music” in Istanbul 29th April 2023 [3] there was a panel discussion about acoustics in choir rehearsal rooms, clearly showing that the focus on suitable rehearsal rooms is a world-wide issue, and comments from the participants showed that the ISO 23591 is very welcome. This was expressed as well from the musicians as from the acousticians at the Symposium.

The development of ISO 23591 was also built on “the Norwegian Experience”, showing that developing a formal acoustic standard was a very important step in the Norwegian process of more suitable music rehearsal rooms. The council for Music Organizations in Norway started to cooperate with Norwegian acousticians at the end of the 1980s. We have built awareness in the music society about the importance of suitable rehearsal rooms, and little by little we see positive results: The music rehearsal situation is gradually getting better, and the effects of suitable rehearsal rooms are slowly getting realized.

3. FROM THE MUSICIANS’ POINT OF VIEW

The musicians spend most of their playing or singing time in the rehearsal room, either in individual practice rooms, in small ensemble rooms, in rooms for small or larger ensembles or rehearsing in a full orchestra, choir or wind band.

For the musician, the most important aspects of the rehearsal rooms are:

- The ability to hear oneself appropriate (not too loud and not too soft),
- The ability to hear the other musicians (not too loud and not too soft),
- And the appropriate balance between “myself” and “the others” (especially to hear “the musician next to my nearest colleague”)
- The sound level in the room shall not be too high

- The room responds to my own playing in a good manner (with volume and timbre that is according to my playing/singing, and not distorting my sound)
- It should be possible to hear the conductor’s instructions clearly (not too much background noise)
- Enough space to sit/stand freely, and with sufficient distance to reflective surfaces and other musicians.

In a rehearsal situation, the first three bullet points are often regarded as the most important.

For the music ensembles a suitable practice room improves the well-being of the musicians and the conductor. A room that is well suited improves the rehearsing quality. A good rehearsal room improves the music quality of any music ensemble.

4. CASE STUDIES

4.1 Case 1 – Guldberg Academic Male Choir

Guldberg Academic Male Choir is a good quality amateur choir of 40 male singers, located in Oslo, Norway (<https://www.guldbergs.no/>). After losing their former rehearsal room, the choir has been searching for a suitable rehearsal room in the Oslo area. In this search for a good rehearsal room, they have ordered acoustic reports from several possible rooms. The acoustic reports have been conducted and evaluated after the recommendations in ISO 23591.

One of the few rooms that almost fulfilled the ISO 23591 was the multipurpose room at Ruseløkka primary and secondary school in Oslo [4]. This room has a net volume of 1030 m³, and the dimensions are 20,6 m x 9,8 m x 5,1 m. The net area in the room is 202 m². The room is equipped with an aQflex system which gives the reverberation time of 0,9 seconds or 1,2 seconds.

According to ISO 23591

- The volume of the room, 1030 m³, is large enough for 40 singers,
- The net area of the room, 202 m², is large enough for this size of choir – minimum 50 m² + 0,5 m² per singer = 70 m²,
- The net room height, 5,1 m is according to the ISO 23591, min 5,0 m,
- The length-to-width room ratio is 2,1, which is above the recommendations of max 1,6,
- The T₃₀, of 1,2 seconds, is within the range for 1000 m³, 1,2-1,6 seconds, see figure 1,

- The relative frequency-dependent reverberation time is within the suited range, see figure 2.

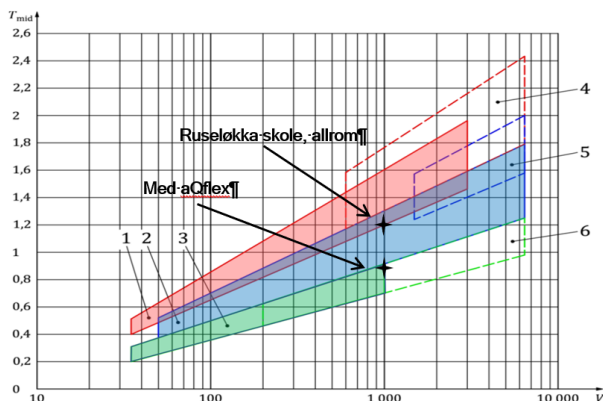


Figure 1. Reverberation time T_{30} , Ruseløkka school. The red area (1) is suited volume and T_{mid} for acoustic quiet music, the blue area (2) is suited area and T_{mid} for acoustic loud music according to ISO 23591.

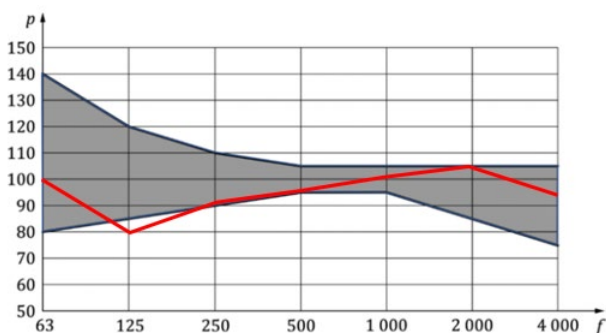


Figure 2. Frequency-dependent tolerance limits in percent relative to average value of mid-frequency reverberation time, T_{mid} , at the frequency bands 500 Hz and 1000 Hz in Ruseløkka school. The grey area is suited for acoustic music according to ISO 23591.

After trying many different rehearsal rooms, the Guldberg Academic Male Choir finds this room well suited. They prefer the room state without the aQflex inflated, this reduces the T_{mid} to 0,9 seconds – and outside of the criterion in ISO 23591. They would prefer the room length-to-width

ratio (of 2,1) to be lower, preferably not over 1,6 (as in the standard). The width of the room reduces the possibility to a very good placement of the choir, and does not give enough room behind the conductor. The conductor, Sigurd Engesnes says that “The best is of course that the singers can hear themselves and the other singers, this improves the inter-choral listening, the intonation, balance and music expression of the choir” [5]. He also says that “The instructions from the conductor become easier to understand when the singers hear themselves and how they can listen to the others. It provides more effective choir rehearsal and the joy of singing together becomes greater and better.”

The vice chairman in the choir says: “How can a choir develop musically when the singers cannot hear each other? It’s like playing football in darkness with blindfolds.”. An other singer explains: “And the room makes it possible for us to focus on the details, the small things that mean incredibly much for the timbre and the music expression of the choir”.

The aQflex that reduces the average reverberation time to 0,9 seconds means that the room also can be suited for acoustic loud music, for instance a wind band. Acoustic loud music ensembles need 50 m³ per musicians, which means that the room is big enough for up to 20 musicians. The room strength, G , is 15 dB, which is maximum for loud acoustic music.

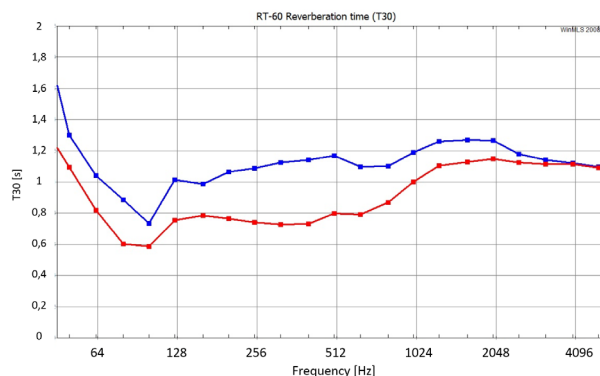


Figure 3. Reverberation time T_{30} , Ruseløkka school. The blue curve is without the aQflex inflated, the red curve with the aQflex inflated.

4.2 Case 2 – Music rehearsal rooms in Stavanger

At the annual meeting of Norsk sangerforum (one of the national Choir Federations in Norway) in Stavanger, 26th –

27th May 2022, there was a seminar on “Good rehearsal rooms for choir. Before the seminar, Rogaland music council had examined the acoustic conditions in four rooms which have been used for choir rehearsals and compared the rooms with the criteria in ISO 23591 [6]. During the seminar, the participating singers and conductors were singing in all four rooms.

One of the rooms was almost according to the criteria in ISO 23591, the other three had different issues and shortcomings. The rooms varied in size from “medium ensemble room” ca 200 m³ to “large ensemble room” of 780 m³. The first room (report 1103_08) was large enough and had good dimensions but was too dry. The second room (1103_09) had room height of only 3,2 m and size of 11,5 m x 5,8 m and beams in the ceiling. The third room (1103_06) was a room used by the Stavanger music school for choir teaching, had a net height of 2,9 m and reverberation time shorter than recommended for amplified music. Finally, the fourth room (1103_07) was close to fulfilling all the criteria in the ISO 23591.

This demonstration was very effective, and it was clear that the criteria in ISO 23591 was perceived as good. After the three rooms with issues, the reactions from the participants were unanimous. Instantly, the fourth room was simply a very good rehearsal room. They even had to sing an extra song to experience the good feeling in this room.

4.4 Case 3 – The panel discussion at the World Symposium of Choral Music 2023

The participants in the symposium were mainly choir conductors from all around the world. Kjetil Aamann from Norsk sangerforum presented the ISO 23591 as a basis for further discussion. In the panel were in addition to mr. Aamann were Türker Talayman (acoustician from Turkey) and Emre Orhon (acoustic engineer, composer and singer). They underlined the importance having standards in the process of developing well-suited rooms for music activities (teaching, rehearsal and performance). They expressed and appreciated that the ISO standard contained the most important criteria in the planning process for new rooms for music activities and found the figures and criteria to be very adequate. The panel discussed in detail several of the criteria, in particular the volume and the reverberation time. It was particularly expressed that singing in rooms that are not suitable for singing, can lead to damage to the vocal tract - this has been researched and emphasized by medical specialists. This was high-lighted as an argument for enough volume and adapted room acoustics, especially in teaching and rehearsal rooms.

Input from the audience showed clearly the need for this music rehearsal room standard. The volume defined in the standard was an eye-opener for many in the audience.

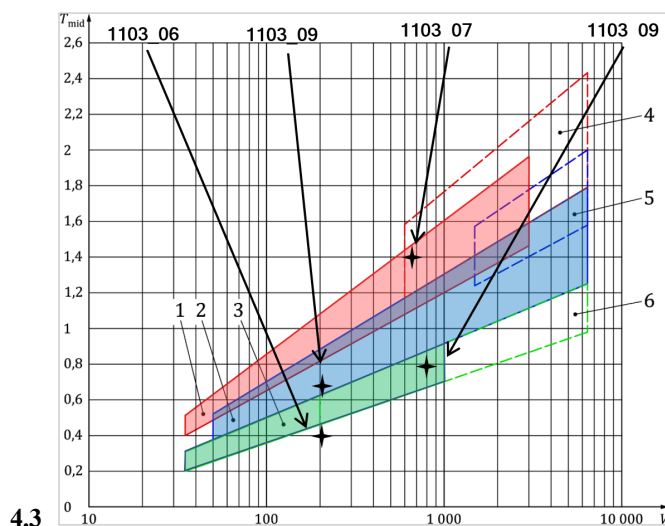


Figure 4. Net volume and corresponding reverberation time in four choir rehearsal rooms in Stavanger.

4.5 Case 4 – Lalm Community House

Lalm Community House was a typical local community house in the small village of Lalm in Vågå municipality in the middle of Norway. The room dimensions were 17,0 m x 10 m x 4,8 m, 840 m³ and the average T_{30} was 1,49 second. The T_{30} had a variation from 0,9 second at 125 Hz rising to over 1,6 seconds at 1.6 kHz. The room was used as a rehearsal room for the local wind band, of about 25 musicians. The band was rehearsing in a little stage in the end of the room.

After the acoustic report was given by Innlandet Music Council, the acousticians at COWI A/S proposed acoustic measures based on the criteria in NS 8178. The main focus was to reduce the T_{30} to a bit less than 1 second, add diffusion in the room and to equalize the reverberation curve as flat as possible. The brass band was advised to move from the stage to the main room for rehearsals.

The measures were carried out as planned, resulting in a reverberation in the lower part of the span in ISO 23591, and a flat curve from 125 Hz to 2 kHz.

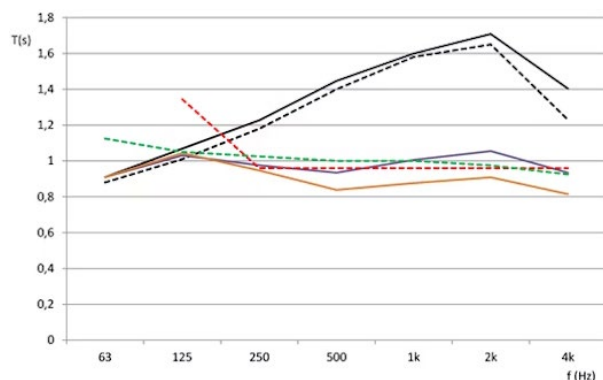


Figure 5. Lalm Community House, T_{30} . Top two curves show situation before measures, bottom four curves after measures.

The feedback from the musicians is that “the acoustic conditions are like night and day”. The conductor says:” I have been the conductor since we rehearse at stage, where trombones and tuba dominated the balance and the sound, and the sound from the rest of the band more or less disappeared. After moving to the main room this was a little better, but still there was a wall of sound coming towards me. After mounting the absorbers we are very happy. The main difference is that I now can hear the details in the music. The musicians are also satisfied, they say it’s much easier to hear each other. Now it’s easier to work with the dynamics and balance, and the sound of the wind band was much tighter.”

We receive similar comments from many rooms used for wind band rehearsals where the criteria from NS 8178/ISO 23591 have been the basis for changing the acoustic situation. They all are very satisfied, the rehearsal situations have changed from bad to good, the feedback are almost always the same as in Lalm Community House.

5. HOW TO CONDUCT A MUSIC ENSEMBLE IN A SUITABLE REHEARSAL ROOM

As a part of a development program in the The Adult Education Association of Music in Norway (Musikkens Studieforbund), conductors and musicians at the Norsk sangerforum has developed guidelines of “how to conduct rehearsals in a rehearsal room that is well suited for choir. Most of the content will also be applicable to other music ensembles, such as wind band, school bands and amateur orchestras.

First of all, there has been a discussion about “What is a suitable rehearsal room”. The criteria in ISO 23591 have been evaluated and discussed first of all from the conductor’s points of view, but also the singer’s and the musician’s point of view.

The main criteria have been evaluated, prioritized and commented, also related to the guidelines and recommendations from the Norwegian Music Council [7]. The criteria have mainly been evaluated from the non-professional’s point of view, but the conductors and quite a number of musicians also have experience also as professionals.

The evaluation process has been going on – and is still going on – at conferences, discussions and workshops for conductors and music conferences and talks with singers and musicians, in Norway and abroad (example World Symposium on Choral Music 2023 [3]). We have also carried out surveys to and interviews with conductors. We see comments in social media (Facebook, Twitter and Instagram) and receive informal comments from musicians and conductors.

5.1 Evaluation of the criteria

5.1.1 The volume criterion

The volume criterion has mainly been discussed for the quiet and loud acoustic genres. For the smaller rooms (small and medium ensemble rooms) the volume criterion per musician/singer is 25 m³ for quiet music ensembles and 50 m³ for loud music ensembles (60 m³ for extra loud music ensembles).

This criterion is perceived as good. Especially when combining this criterion with the net room height, the net area and the room ration criteria, the volume criterion is well accepted.

The crucial point is evaluated as the combination of the dimension criteria of the room AND the volume criterion.

Is the volume criterion too small? No, the conductors and musicians seem to mean that the volumes according to the standard are big enough. It is of course often an advantage if the room is bigger, but as a minimum the criterion is acceptable.

Is the volume criterion too big? No, there is really a need for this kind of volumes, for the sound to spread in the room, to have enough distance to reflecting surfaces, and to be able to sing or play at *forte* or *fortissimo*.

Conclusion: The volume criterion seems to be well accepted.

Table 1. Net volume and net height, acoustic music.

	Practice	Small ens	Med ens	Large ens
Musicians (N)	1-2	3-12	12-ca 25	> Ca 25
Volume quiet	>35 m ³	>25 x N m ³	>25 x N m ³	>25 x N m ³
Volume loud Volume extra loud	>50 m ³	>30 x N m ³ >50 x N m ³	>30 x N m ³ >50 x N m ³	>50 x N m ³ >60 x N m ³
Room height quiet	>2,7 m	>3,5 m	>4,5 m	>5,0 m
Room height loud	>3,0 m	>3,5 m	>4,5 m	>5,0 m
nb: Adequate room dimension ratio	1:1,15 - 1:1,45	1:1,15 - 1:1,45	1:1,15 - 1:1,6	1:1,15 - 1:1,6

5.1.2 The room dimension criteria

The room dimension is a set of criteria, net room height, net area and width-to-length ratio. The musicians seem to prefer to have a certain distance to the nearest reflecting surface, often minimum 2 m, preferably up to 3 m. This to give space for the sound to propagate through the room and to have control of the timbre of the voice or instrument. This is especially important for the loud instruments (with sound power level higher than 95 dB at forte). This is not taken in account in the ISO 23591, but the combination of the net volume, net area, net room height and width-to-length ratio will in most cases make it possible to have enough distance to the nearest wall.

The net area seems to be important to many musicians. Especially in rooms with permanent rised seating there will quite often be too little area for the musicians, even if the volume and net room height criteria are fulfilled. In some cases, the minimum net area criterion for loud music ensembles (120 m² + 2 m² per musician) might be unnecessary large, if the percussion group is not extensive.

Conclusion: The dimensional criterion seems to be well received but might be used with common sense. The important criterion is really the combination of the net room height, the net area and the width-to-length ratio criteria – and also the volume criterion.

5.1.3 The reverberation criteria

The reverberation criteria are in reality several criteria:

- Mean reverberation time and
- The frequency-dependent tolerance limit

The difference in the reverberation situation in different positions in the room is not covered in the ISO 23591 standard. In some rooms this may be an extra issue, if the room can be described as having several acoustic rooms. In some multipurpose rooms the acoustic condition at the stage area differs from the audience area – this is perceived as a challenging situation. In some rooms, there is a

proscenium wall covering much of the opening between the stage and the audience (proscenium), and if the stage area is too small this might be very difficult.



Bryne wind band rehearsing in the auditorium in Vardheia secondary School in Time, Rogaland

When discussing the reverberation time, the main focus is to find the balance between “good sound” and “not too much reverberation”. The span in volume/reverberation time in the standard seem to be well accepted. Most of the conductors seem to prefer the lower half of the reverberation span. The musicians can accept longer reverberation time, as a result hearing the other musicians better and easier being able to intonate together with the others and facilitate the co-playing and the music interaction.

The combination of the volume and the reverberation time give as a consequence the room strength, G . If the volume is just big enough according to the number of musicians/singers, the tendency to prefer the lower part of the reverberation time is even more clear. In some cases, the conductors prefer a slightly lower reverberation time than the lower limit in the standard. If the volume is too small (and the reverberation time is quite long) this result is too loud sound in the room. Unfortunately, this is not uncommon in Norway, and has lead to some conductors opinion that the rehearsal room should be “as dry as possible”. But especially for amateur ensembles there is a need for adapted reverberation time, to maintain and develop the general sound quality of the ensemble. When having the experience of a well-adapted reverberation time, the musicians and singers prefer this (ref as an example case 1, Guldberg Academic Male Choir).

Conclusion: The reverberation spans given in the ISO 23591 is well received, especially when combining feedbacks from musicians and the conductors. The reverberation span normally makes it possible to hear “myself and the others in a balanced way and have a nice sound in the room”.

5.1.4 The background noise criteria

The background noise criteria are combined of at least two criteria:

- The average max dBA should not be too high,
- There should be no disturbing sound coloration or single-frequency background noise.

The background noise situation is not often reported as a problem. The ISO 23591 defines rather strict criterion for background noise. If the monitored level is just a little above the criterion this is normally not regarded as a major problem.

It's more common to have comments on background sound coloration (from the air ventilation) or single-frequency background noise (often from the lighting equipment).

In multi-purpose rooms, often in schools, there are quite often disturbing sound from refrigerators, coolers, freezer or similar kitchen equipment disturbing the sound situation in the rehearsal room.

Conclusion: The background noise criteria seem to be well received.

5.2 Recommendations for conducting

From the conductor's point of view, it's important

- To hear the ensemble in a balanced way
 - Each group of instruments/voices
 - The entire ensemble
- To be able to easily give instructions to the ensemble
- To be able to work with balance, tuning and intonation, music phrasing, timbre and music expression
- That there is not too much background noise or other disturbances in the room
- And that the sound response in the room is adequate.

5.2.1 “The listening singer” - “The listening musician”

The purpose for the conductor is to develop the musicians to be “a listening singer or musician”, that means to listen to the other players and singers to interact musically in the ensemble. This development needs a well-suited room. The conductor must train the individual musician to listen to the other musicians, to guide how to listen and to interact musically. Then the singer or musician can adapt their own music making to the collective expression of the ensemble.

5.2.2 Warming up in a well-suited rehearsal room

The warm-up session is especially important for developing the awareness of the other singers/musicians and training to use the listening ear. For choir singers, the placement of the vowels is of great importance. It is necessary to be aware of their own vocal placement and listening to the other singers' placement - and to adapt to the others to fit into the overall sound of the choir.

The warm-up session is very useful for training the ear, in unison singing as well as harmonically. In the harmonies it's also necessary to be aware of the balance between the tones to achieve a perfect presentation of the chord.

Finally, the warm-up session is suited for developing an awareness of the use of body in singing, breathing and the sound quality – as well for the individual singer as for the choir as a whole.

5.2.3 Rehearsal phase one – to learn the melody line and intervals

The first step for a singer is to learn the melody line and intervals in their music part. For an amateur this might take some time, not all amateur singers can read notes. In many choirs this process takes much of the rehearsal time. It's experienced that when rehearsing in a well-suited room this phase is vastly reduced, leaving more rehearsal time to the musical interpretation.

Good use of the warm-up sessions helps to develop “the listening singer”, to follow the other singers and to adapt appropriately. In this phase, the singers who can sing the intervals correctly can act as guidance – but it is also important to prevent this effect to be too strong and find the good balance between the self-confidence of each singer and following the other singers.

The musical progression of the singers varies, the conductor can use the room acoustics to give adequate instruction to the individual singer. This is possible because the balance between each voice and the choir makes it possible for the

conductor to hear each singer (and each group of singers) well.

To reduce the “learn-intervals-and-melody-line”-phase of the rehearsals is one of the important effects of well-suited rehearsal rooms.

5.2.4 Rehearsal phase two – to sing together musically

In a well-suited room the conductor can work systematically with the musical elements – this is much more difficult if the room is not suited. The elements can be trained separately, further developing the concept of “the listening singer”. And they can be developed together to form the desired music expression in the choir and in each piece of music.

The elements to be trained are sound, precision, musical phrasing, dynamics, balance, homogeneity, intonation, articulation, placing of the vowels and more. Working with these elements requires that all singers know their own part and feels secure.

The room – dimensions, reverberation time, frequency stability and not too much background noise - is important to be able to work systematically. Each of the criteria in the ISO 23591 has proven to be useful.

6. CONCLUSIONS

The overall conclusions from the conductors and musicians who have experience from using rooms that comply with the ISO 23591 are that the standard is adequate and works well. The main criteria are well selected, and the size, figures, requirements and tables will result in well-suited rehearsal rooms.

Especially the focus on the volume and dimensions is an eye-opener for many musicians. The feedback is particularly positive to these criteria. The volume and dimensioning criteria also make it possible to have adequate reverberation time, the reverberation criterion in the standard is well received. Some conductors seem to prefer the reverberation time in the lower part of the variation given in the standard. It seems to be a tendency to accept, and to appreciate somewhat longer reverberation time, after spending rehearsal time in a little more reverberant rooms, maybe especially for amateurs.

We have received comments that the need for relevant net area can be difficult to achieve, mostly in multipurpose rooms with rising floor in the audience area. Some ensembles feel that the criterion for net area could have

been better discussed, this is also the case assessing the suitability if existing rooms.

7. ACKNOWLEDGMENTS

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