CLASSROOM ACOUSTICS DOCUMENTATION PROTOCOL

Date__________________  Audiologist/Evaluator_____________________

School__________________ Room______________  Teacher_____________________

Student__________________  Grade_____  

If used, indicate FM/Classroom Amplification System ____________________________

CLASSROOM SCHEMATIC DIAGRAM - on back (or attach) with locations identified

TEACHER-LISTENER DISTANCE:  Nearest _____ Ft  Farthest _____ Ft

NOISE ANALYSIS

<table>
<thead>
<tr>
<th>Location</th>
<th>Condition: U=unoccupied; O=occupied; Hon=HVAC on; Hoff=HVAC off</th>
<th>Unamplified Level</th>
<th>Unamplified S/N ratio</th>
<th>Amplified Level</th>
<th>Amplified S/N ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
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<tr>
<td>B</td>
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<td>E</td>
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<td>F</td>
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<tr>
<td>Average:</td>
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</tbody>
</table>

* Target Student

REVERBERATION TIME ANALYSIS

Room Volume (V) = ____________________ cubic feet

Area Floor  ______ X ABS. Coef. ______ = A Floor  ____________

Area Ceiling ______ X ABS. Coef. ______ = A Ceiling  ____________

Area Side Wall 1 ______ X ABS. Coef. ______ = A Wall 1  ____________

Area Side Wall 2 ______ X ABS. Coef. ______ = A Wall 2  ____________

Area End Wall 1 ______ X ABS. Coef. ______ = A End 1  ____________

Area End Wall 2 ______ X ABS. Coef. ______ = A End 2  ____________

Total A________________

RT of classroom = .05X___________ (V)/ _______(A) = _______ seconds

NOTE: ANSI S12.60-2002 Standard = 35dBA and .6 second reverberation time for rooms up to 10,000 cubic feet.

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Part I. Noise Analysis

Equipment needed: sound level meter (SLM), 20 ft measuring tape, standard reading passage.

1. Draw a schematic of the classroom on the back of the form (or graph paper) and mark the locations of the measurements (A-G). Generally measurements should be taken from student desks at the four corners, the middle and the middle back of the room. If there is a target student, use location A to mark that student's position and eliminate the middle back of room position. Additional positions can be added if necessary.

2. Record the minimum and maximum teacher-listener distances (the closest the teacher will be to the student during instruction, usually about 2-3 feet, and the farthest the teacher will be).

3. Turn on the SLM; be sure it is set on the A-weighted scale and on slow response. If you can set the range of the meter, set it to accommodate 40-60 dBSPL to begin.

4. Ambient Noise Levels:
   a. Ambient noise levels should be measured in an empty classroom at several locations (marked A-G on the form) as levels may vary according to distance from noise sources. Indicate condition: (U = unoccupied, O=occupied, Hon=HVAC on, Hoff=HVAC off; example U/Hon = unoccupied with HVAC on). (NOTE: HVAC is the hearing, ventilation and air conditioning system).
   b. Measure the ambient noise level at the selected student locations and record it on the classroom documentation form. If the noise level fluctuates, take three measurements at 1-minute intervals and average the readings and record those on the form. These measurements will provide an estimate of the ambient noise level during an instructional period. If measurements can only be taken when students are not in the classroom you may convert the unoccupied noise levels to occupied by adding 10 dB to each unoccupied measurement. This conversion is roughly equal to the known difference in noise level between average unoccupied and occupied classrooms.
   c. Calculate and record the average ambient noise level for each condition measured.

5. Teacher Voice Levels- Unamplified:
   a. Position the teacher in the typical instructional position in the classroom. The students should be seated in their normal seats for instruction. It is important that the measurements are made in the time period when instruction occurs so that the acoustic conditions are representative of actual instructional environments.
   b. Orient the SLM to approximate the center of each selected student’s head while he/she is seated at his/her desks. Point the SLM microphone upwards in the direction of the teacher’s position, taking care to avoid placing your body in the sound path between teacher and student, which can produce inaccurate measurements.
   c. Ask the teacher to begin reading the standard passage, and record the teacher signal levels on the form at the various locations using the same procedures outlined in 4b. These measurements provide an estimate of the signal level during an instructional period.
   d. Determine signal-to-noise (S/N) ratio of the classroom by subtracting the ambient noise level from the teacher voice level at the selected student locations. For example, a student location with a teacher voice level of 60dBA and an ambient noise level of 50dBA would have a S/N ratio of +10dB. One with a teacher level of 60dBA and a noise level of 70dBA would have a S/N of -10dB.
   e. Averaging all teacher voice levels and subtracting from the average ambient level for the various conditions will calculate an average S/N level.

6. Teacher Voice Levels - Amplified:
   a. Repeat the steps 5a-e above.
   b. Compare results to the unamplified condition to determine the benefits of the amplification system.

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Part II. Calculation of Reverberation Levels

Equipment needed: 20 ft measuring tape or ultrasonic distance estimator; calculator.

Formula to estimate classroom reverberation time: $RT = 0.05 \frac{V}{A}$ where $RT$ = reverberation time in seconds, $V$ = volume room, and $A$ = total absorption of the room surfaces in Sabins.

1. All of the reverberation estimates can be conducted in an unoccupied classroom. Because a formula is used, no improvement in accuracy is obtained with students and teacher present. During more detailed measurements, the presence of the room occupants would be desirable.

2. Calculate the volume of the classroom by measuring the length, width, and height of the classroom in feet (your diagram of the classroom will aid in recording these measurements) and multiplying them together (volume = length of room x width or room x height of room).

3. Record the resultant room volume in cubic feet on the classroom documentation form.

4. Multiply the volume of the room by the constant .05 to obtain the numerator for the $RT = 0.05 \frac{V}{A}$ equation. Record the results on the classroom form.

5. To obtain the denominator of the equation, the area of the walls, floor, and ceiling of the room must first be calculated in square feet. If the walls, ceiling, or floor are irregularly shaped, each section must be measured separately. The area of the floor and ceiling is determined by multiplying the length of the floor or ceiling times its width. The area of the walls can be obtained by multiplying the length of each wall by its height. Enter the values for the area of each on the classroom documentation form.

6. The absorption coefficient (Abs. Coef.) is a measure of the sound reflectiveness of different construction materials. The coefficient, expressed in Sabins, must be determined for the material composing the walls, ceiling, and floor. Average absorption coefficients are given in the table below for the most common construction materials. If a difference construction material is encountered and you use another absorption coefficient table, average the coefficients given in the other table for 500, 1000, and 2000 Hz for the purpose of these calculations. Enter the average absorption coefficient in the appropriate place on the documentation form.

7. Multiply the area of each floor, ceiling, and wall times the absorptive coefficient of the material composing the surface. Add up all of the resultants of the multiplications to obtain the $A$ (total absorption of the room in Sabins) in the $RT = 0.05 \frac{V}{A}$ formula for the room and record it on the form.

8. Take the numerator from Step 3 ($0.05 \times V$) and the denominator from Step 6 ($A$=total absorption in Sabins for the room) and divide them in order to determine the estimated reverberation time of the room in seconds ($RT = 0.05 \frac{V}{A}$). Enter the estimate on the documentation form. It should also be noted that the $RT$ of a room can be obtained using a reverberation meter.

SOUND ABSORPTION CO-EFFICIENTS FOR COMMON CLASSROOM MATERIALS

<table>
<thead>
<tr>
<th>Material</th>
<th>Ave. Absorp Coefficient</th>
<th>Material</th>
<th>Ave. Absorp Coefficient</th>
<th>Material</th>
<th>Ave. Absorp Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>WALLS:</td>
<td></td>
<td>FLOORS:</td>
<td></td>
<td>CEILINGS:</td>
<td></td>
</tr>
<tr>
<td>Brick</td>
<td>0.04</td>
<td>Wood parquet on concrete</td>
<td>0.06</td>
<td>Plaster, gypsum, or lime on lath</td>
<td>0.05</td>
</tr>
<tr>
<td>Painted concrete</td>
<td>0.07</td>
<td>Linoleum</td>
<td>0.03</td>
<td>Acoustic tiles (5/8&quot;)- suspended</td>
<td>0.68</td>
</tr>
<tr>
<td>Window glass</td>
<td>0.12</td>
<td>Carpet on concrete</td>
<td>0.37</td>
<td>Acoustic tiles (1/2&quot;)- suspended</td>
<td>0.66</td>
</tr>
<tr>
<td>Plaster on concrete</td>
<td>0.06</td>
<td>Carpet on foam padding</td>
<td>0.63</td>
<td>Acoustic tiles (1/2&quot;)- not suspended</td>
<td>0.67</td>
</tr>
<tr>
<td>Plywood</td>
<td>0.12</td>
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<td>High absorptive panels- suspended</td>
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<tr>
<td>Concrete block</td>
<td>0.33</td>
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</tbody>
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