Aural Tests and Proofs

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Ward Guthrie, RPT, of the Appleton, WI Chapter, wrote an article in the September, 2009 *Piano Technicians Journal*, where he listed all the common aural tests. This chart is displayed at the end of this article.

HOW THESE TESTS ARE USED IN REAL LIFE

Interval Tested	**Test Beat Rates**	**Interval Type**	**Speed**
Unison	=	Unison	Pure
Fourth	M3<M6	4:3	Approx. 1 beat/sec
Fifth	M6>M10	3:2	Approx 3 beats/5sec
Octave	M3<M10, $4^{th}>5^{th}$	4:2+	Slightly wide
Double Octave	M3<M17	4:1+	Slightly wide
Octave	M10<M17	2:1+	Slightly wide
Octave	m3<M6, $12^{th}<5^{th}$	6:3+	Slightly wide
Octave	m6<M3, $11^{th}>4^{th}$	8:4+	Slightly wide
Octave	M6>m3, A4<d5	10:5+	Slightly wide

If the M3-M17 is the same, that's a 4:2 octave. If the M3 beats a little faster, that's a 4:2+ octave. The wider + octave provides a little more flexibility to fit all the other octaves in. If it gets too wide, the first place it will be heard will be at the 2:1 level. This is particularly noticeable in small pianos, which can't be stretched quite as wide as a Steinway, for example. The inharmonicity at the lower end of the temperament is tighter and less tolerant on spinets. Err slightly on the 4:2+ side. The determining factor is how clean the octaves sound. There should not be any noticeable beats. The difference between the 4:2 and the 4:1 intervals is going to be cleaner and purer on a big piano; there is room to be more flexible and have the intervals still sound good.

How do we move down from an A octave to tune an F temperament? Split the octave into contiguous major thirds. Starting with the A octave, an octave can then be tuned off the F. The major thirds should progress evenly, so that the major third in the middle is equally faster than the lower third as it is slower than the third above it. Because it is easier to create an error just with fourths and fifths, by spreading thirds out evenly there is a more accurate consistency.

WHERE AND HOW WARD USES THESE TESTS

Area Used	**Octave Type**	**Aural Test Used**
Midrange D3 to C6	4:2+	M3<M10, $4^{th}>5^{th}$
Midrange, treble A4 to A6	4:1+	M3<M17
Upper Treble C6 to top	2:1+	M10<M17, $5^{th} < 12^{th}$
Midrange Bass E3 to E1	6:3+	m3<M6
Bass G1 to bottom	8:4+	m6<M3

Stretching octaves at the top, we don't want the octave and the fifth to be wide. Check an octave and a fifth below; the upper note should not be wide from this. Instead it should be clean or slightly narrow. Classical music might be not stretched as much, and jazz might like more stretch. Consider, too, the acoustic in the room. A live room with an audience, like a cavernous auditorium, the wider you can get, the better, because the top note you want to sing out will get carried farther in that acoustical space. This is like the Doppler Effect. If the piano is tuned narrow, by the time the sound reaches the back of the room, it will sound flat. It sounds expansive and it carries and is not considered sharp; it sounds interesting and gives life to the instrument. In a recording studio, don't over-tune it or it will go wild.

For choral work or orchestras, keep the octave as flat and straight as possible. However, many instruments do play sharp, especially in the high notes: flutists, violinists, clarinetists, and vocalists. Instrumentalists might not notice if the piano is tuned a half step sharp in the treble, but they definitely would notice if it were flat. In the average home, the treble should be tuned fairly clean.

In the mid-range, have the 4:2 octave perfect and the 6:3 octave narrow. In the lower midrange, go for a perfect 6:3 octave. Going lower, the 6:3 widens slightly. Pay attention to the louder, more obvious relationships. As you go down in the piano, the louder overtones are more noticeable than in the middle of the piano. At the very bottom, a good test is an octave and a minor 7^{th}, which is an expanded interval. Two octaves and a major third is also a good check, but doesn't beat as fast and is a bit harder to hear.

After the 6:3 octave, the next octave type is the 8:4 octave, which is m6<M3 at the very bottom of the piano. In smaller pianos this may not help. Another technique is to try "ghosting": hold down the octave and strike the harmonic note above and listen for beats. Yet another test in the very lowest area is to listen for the harmonic of the fifth one or two octaves above the bottom note. In tuning the lower bass, by following the 6:3 down and letting it go wide, that's where the 8:4 octave will put it anyway. These tests are indicators of the pitch for keeping it even and give an idea of the relationship. Keep the width of the octaves progressing gradually without distorting the intervals.

If there is a mismatch in the interval, decided which should be closest. Sometimes one string will not fit with the other according to the machine. Use your ear choose the best compromise.

COMMON AURAL TESTS

Interval Tested	Test	Test Note	Range to Use	Interval Type	Comparing
Unison	M17-fork	M17 below A-440	Pitch transfer note	5:1	5:1 vs. 1:1
Fourth	M3-M6	M3 below lowest note of 4th	Midrange	4:3	5:4 vs. 5:3
Fifth	M6-M10	M6 below lowest note of 5th	Midrange	3:2	5:3 vs. 5:2
Octave	M3-M10	M3 below lowest note of 8va	Midrange, treble	4:2	5:4 vs. 5:2
Octave	4th-5th	4th above lowest note of 8va	Midrange, treble	4:2	4:3 vs. 3:2
Double Octave	M3-M17	M3 below lowest not of dbl 8va	Midrange, treble	4:1	5:4 vs. 5:1
Double Octave	4th-12th	4th above lowest note of dbl 8vz	Midrange, treble	4:1	4:3 vs. 3:1
Twelfth	M6-M17	N6 below lowest note of 12th	Treble	3:1	5:3 vs. 5:1
Octave	M10-M17	M10 below lowest note of 8va	Treble, high treble	2:1	5:2 vs. 5:1
Octave	5th-12th	5th below lowest note of 8va	Treble, high treble	2:1	3:2 vs. 3:1
Octave	m3-M6	M3 above lowest note of 8va	Upper bass	6:3	6:5 vs. 5:3
Octave	5th-4th	5th above lowest note of 8va	Upper bass	6:3	6:4 vs. 4:3
Octave	12th-5th	5th above upper note of 8va	Upper bass	6:3	6:2 vs. 3:2
Double Octave	m6-M10	M6 above lower not of double 8va	Upper bass	8:2	8:5 vs. 5:2
Double Octave	11th-5th	5th below upper note of double 8va	Upper bass	8:2	8:3 vs. 3:2
Octave	m6-M3	M3 below upper note of 8va	Bass	8:4	8:5 vs. 5:4
Octave	11th-4th	4th above upper note of 8va	Bass	8:4	8:3 vs. 4:3
Fifth	m3-M3	M3 above lower note of 5th	Bass	6:4	6:5 vs. 5:4
Twelfth	m3-M10	M3 above lower note of 12th	Bass	6:2	6:5 vs. 5:2
Octave	M6-m3	M6 above lower note of 8va	Low Bass	10:5	10:6 vs. 6:5
Octave	A4-d5	A4 above lower note of 8va	Low Bass	10:5	10:7 vs. 7:5
Octave	M24-M17	M17 above upper note of 8va	Low Bass	10:5	10:1 vs. 5:1
Octave	m10-m3	m3 above upper note of 8va	Low Bass, Large Piano	12:6	12:5 vs. 6:5
Octave	19th-12th	12th above upper note of 8va	Low Bass, Large Piano	12:6	12:2 vs. 6:2