CAVANAUGH TOCCI ASSOCIATES, INCORPORATED

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November 10, 2010

Ms. Eleanor Tillinghast
Green Berkshires Incorporated
292 Main Street
Great Barrington, MA 01230

Subject: Ambient Environmental Sound Measurements – Ridge Hill Area, Ashfield, MA

Dear Ms. Tillinghast,

Cavanaugh Tocci Associates, Inc. (CTA) has been retained by Green Berkshires Inc. to measure and report existing ambient environmental sound levels and frequency characteristics in the vicinity of Ridge Hill, Ashfield, MA.

Purpose

The purpose of the measurements is to document the existing acoustical environment in the vicinity of Ridge Hill, in accordance with the acoustical criteria for wind turbine evaluations promulgated by the Massachusetts Department of Environmental Protection (MassDEP).

Attachments

Tables 1 and 2 summarize ninetieth percentile background sound levels (L_{90}) measured in the vicinity of Ridge Hill in accordance with the MassDEP sound level policy, as further discussed herein.

Figure 1 is an area map, annotated to show sound measurement locations used for the Ridge Hill area ambient environmental sound survey.

Appendix A contains a glossary of acoustical terminology and the MassDEP acoustical criteria.

Appendix B contains A-weighted and C-weighted sound levels measured in 10-minute time intervals for a period of one week in the vicinity of Ridge Hill using unattended sound monitors.

Appendix C contains octave and one-third octave band sound level data measured by CTA staff using an integrating sound level meter/spectrum analyzer. Attended sound measurements are helpful in relating audible sound with measured frequency characteristics, and are used to augment long-term sound monitoring data collected by unattended sound monitors.

In addition to data presented in this letter report, all measured sound level data collected for this project have been retained in electronic file format, and are available for our further analysis if required.

Acoustical Terminology and Criteria

The MassDEP requires that environmental sound produced on a property and transmitted to the property line and/or to nearest dwelling(s) must not increase the broadband sound level by more than 10 dBA above the pre-existing ambient (dBA is the abbreviation for "decibels, A-weighted", the most commonly used descriptor for quantifying sound level as perceived by human hearing. The ambient is defined by MassDEP in terms of the 90th percentile sound level, symbolized L_{90}.)

In addition, the MDEP prohibits a "pure-tone" condition, and defines a pure-tone to exist when the sound level in any one octave band exceeds the sound levels in both adjacent octave bands by 3 decibels (dB) or more.

(See Appendix A for further explanation of terminology and criteria.)

Ashfield Sound Survey Measurements

The ambient sound survey in the Ridge Hill area of Ashfield, MA has included two separate, yet related types of measurements:

1. The first type of measurement was conducted by installing battery-powered, unattended sound monitors at five (5) residential neighborhood locations in the vicinity of and generally surrounding Ridge Hill. The sound monitors were programmed to report A-weighted (dBA) sound levels in sequential 10-minute time intervals, for a sound monitoring time period of one week.

   As requested by our client, at one of the sound monitoring locations (Graves Road) generally centered within the sound monitoring area) an additional sound monitor was installed to report C-weighted (dBC) sound levels, thereby providing simultaneous A-weighted and C-weighted sound level monitoring at a central location within the sound monitoring area.

   All the sound monitors were time-synchronized and sound-level-calibrated together at the beginning of the week-long sound monitoring time period; time-synchronization and calibration were confirmed at the end of the monitoring time period.

2. The second type of measurement was conducted using an integrating sound level meter/ frequency spectrum analyzer, with a CTA staff member present simultaneously observing and listening to the environment, and measuring sound levels and frequency characteristics during selected 10-minute time intervals over two sequential days within the week-long monitoring time period.

   The measurement data collected with the spectrum analyzer include A-weighted sound levels (dBA), C-weighted sound levels (dBC), and un-weighted octave and 1/3 octave band sound levels extending throughout the full range of human hearing (approximately 20 Hz to 20,000 Hz), and extending below the range of human hearing into the range of infrasound.

   The measurements with the spectrum analyzer were conducted by a CTA staff person roving between long-term sound monitoring locations; conducting visual observations, listening evaluations, and measurements with the spectrum analyzer over 10-minute time intervals. The CTA staff person conducted three sets of roving measurements over a 24-hour period, i.e. during afternoon/evening, late at night/early in the morning, and again during morning daylight hours.

Following the measurements, data were downloaded from stationary monitors and the sound level analyzer for processing and presentation.

Data Presentation

Measured data most relevant to characterizing the ambient sound in the vicinity of Ridge Hill as required by the MassDEP community sound level policy are presented in Appendices B and C attached to this letter. These data include:

- A-weighted 90th percentile sound levels (L_{90}) defined as the "ambient sound level" in the MassDEP policy and also referred to as the "background sound level" or the "residual sound level."
- Un-weighted octave and 1/3 octave band L_{90} sound levels.

Appendix B also reports both A-weight and C-weight sound levels measured at Graves Road and the arithmetic difference between C-weighted and A-weighted sound levels. It is interesting to note that the differences between C-weighted and A-weighted sound levels tend to be 10 dB or less.

A defective monitor keypad prevented data collection at the 56 South Street sound monitoring location. However, attended measurements of sound level and spectral characteristics at 56 South Street were completed to document the existing background sound level environment in the downtown Main Street area of Ashfield.

Review of Data Collected

The most important data for this sound survey are the:

- Ninetieth percentile (L_{90}) sound levels as the MassDEP policy on community sound uses the L_{90} sound level descriptor
- Octave band sound level spectra as the MassDEP policy evaluates the presence of tonal sound using octave band spectra.

The long-term sound monitoring data shown in Appendix B have been used to derive summary tables that list the daily lowest L_{90} sound levels measured at each monitoring location. It is important to note that a significant rain/windstorm occurred mid-week during the sound monitoring time period, causing a significant and unusual increase in background sound levels during the storm. As can be observed in the Appendix B sound monitoring data, the elevated sound levels associated with the storm commenced late-morning on Thursday September 30 and extended to early-afternoon Friday, November 1.

Weather conditions during the storm on Friday, October 1 are atypical of the area. High winds and rain resulted in unrepresentatively high sound levels during that day. Lowest measured L_{90} sound levels for all days monitored, including October 1, are reported in Table 1. In Table 2, the anomalous October 1 data are not included. Table 2 also reports the averages of lowest background sound levels measured over the one-week period, but without the anomalous October 1 sound level data. In addition, both tables include the lowest-measured L_{90} sound levels data collected at the Dobson residence (56 South Street) on two separate days with the sound level meter spectrum analyzer attended and operated by a CTA staff person.

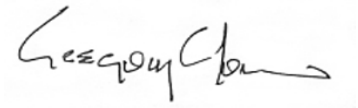
Evaluation

In general summary, the long-term sound monitoring data (augmented with attended sound level meter spectrum analyzer data) demonstrate that average lowest background L_{90} sound levels in the vicinity of Ridge Hill range between 24 and 30 dBA and occur late at night during calm, dry weather conditions.

If we can provide any further information, please do not hesitate to contact us. Thank you.

Sincerely,

Cavanaugh Tocci Associates, Inc.



Brion G. Koning, *Senior Consultant* Gregory C. Tocci, PE, *President*

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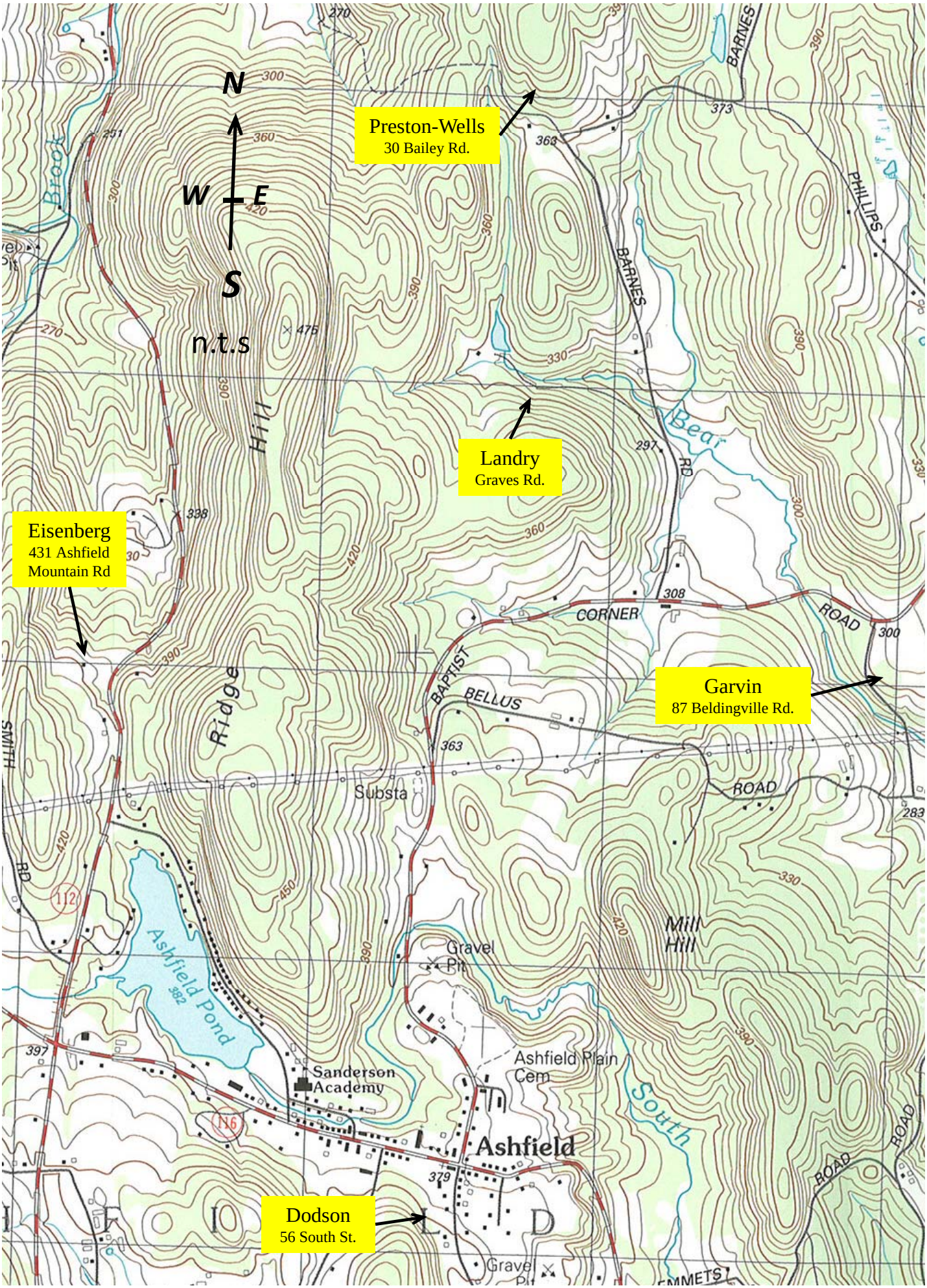
Table 1. Summary of Lowest Measured Background A-weighted (dBA) ninetieth percentile (L_{90}) Sound Levels Around Ridge Hill Area (Includes Sound Levels Measured During Rain/Windstorm)

	Tuesday 28-Sep-2010	Wednesday 29-Sep-2010	Thursday 30-Sep-2010	Friday 1-Oct-2010	Saturday 2-Oct-2010	Sunday 3-Oct-2010	Monday 4-Oct-2010
Measurement Location	**Daily Lowest L_{90} Background Sound Levels**						
Eisenberg residence 431 Ashfield Mountain Road (RT. 112)	**30**	**24**	**19**	**34**	**21**	**21**	**28**
Wells residence 30 Bailey Road	**33**	**26**	**27**	**33**	**20**	**19**	**21**
Landry residence Graves Road	**29**	**25**	**27**	**42**	**31**	**29**	**30**
Garvin residence 87 Beldingville Road	**32**	**28**	**32**	**33**	**28**	**28**	**29**
Dodson residence 56 South Street						**28**	**29**

Table 2. Summary of Lowest Measured Background A-weighted (dBA) ninetieth percentile (L_{90}) Sound Levels Around Ridge Hill Area

(Excludes Sound Levels Measured During Rain/Windstorm)

	Tuesday 28-Sep-2010	Wednesday 29-Sep-2010	Thursday 30-Sep-2010	Friday 1-Oct-2010	Saturday 2-Oct-2010	Sunday 3-Oct-2010	Monday 4-Oct-2010	
Measurement Location								**Average Lowest L_{90}**
Eisenberg residence 431 Ashfield Mountain Road (RT. 112)	**30**	**24**	**19**		**21**	**21**	**28**	**24**
Wells residence 30 Bailey Road	**33**	**26**	**27**		**20**	**19**	**21**	**24**
Landry residence Graves Road	**29**	**25**	**27**		**31**	**29**	**30**	**29**
Garvin residence 87 Beldingville Road	**32**	**28**	**32**		**28**	**28**	**29**	**30**
Dodson residence 56 South Street						**28**	**29**	**29**


N
W
E
S
n.t.s
Preston-Wells
30 Bailey Rd.
Landry
Graves Rd.
Eisenberg
431 Ashfield
Mountain Rd
Garvin
87 Beldingville Rd.
Dodson
56 South St.
Ashfield
Ashfield Pond
Sanderson
Academy
Ashfield Plain
Cem
Gravel
Pit
Substa
Mill
Hill
Ridge
Hill
Bear
BARNES
PHILLIPS
CORNER
ROAD
BAPTIST
BELLUS
SMITH
RD
South
ROAD

APPENDIX A

Glossary of Pertinent Acoustical Terminology and MDEP Community Sound Levels Criteria

Basic Principles of Acoustics

A-weighting

Generally, the sensitivity of human hearing is restricted to the frequency range of 20 Hz to 20,000 Hz. The human ear, however, is most sensitive to sound in the 500 to 8,000 Hz frequency range. Above and below this range, the ear becomes progressively less sensitive. To account for this feature of human hearing, sound level meters incorporate a filtering of acoustic signals according to frequency. This filtering is devised to correspond to the varying sensitivity of the human ear to sound over the audible frequency range. This filtering is called **A-weighting**. Sound pressure level values obtained using this weighting are referred to as A-weighted sound pressure levels and are signified by the identifier **dBA**. To provide some perspective, Figure 2.1 gives typical A-weighted sound pressure levels of various common sounds.

An important feature of the human perception of continuous sound is that an increase or decrease in sound pressure level by 3 dB or less is barely perceptible; an increase or decrease of 5 dB is clearly perceptible; and an increase or decrease of 10 dB is perceived as a doubling or halving of noise level.

Figure 2.1

Loudness ratio and decibel scale (dBA) for common sounds.

Octave Band Sound Pressure Level

For general environmental sounds, inside and outside of buildings, acoustic analysis usually involves determining the sound pressure level in groups or bands of frequencies. It is customary to divide the audible frequency range into octave frequency bands. Figure 2.2 provides a list of octave band frequencies which have been defined in ANSI Standard S1.6–1984 Preferred Reference Quantities for Acoustical Measurements [10]. The ANSI standard does not define octave band numbers. These have been given in Figure 2.2 as they are commonly used in technical literature, particularly information pertinent to buildings.

Octave Band No.	Low Frequency Limit (Hz)	Center Frequency* (Hz)	High Frequency Limit (Hz)
	22.4	31.5	44.7
1	44.7	63.0	89.1
2	89.1	125.0	178.0
3	178.0	250.0	355.0
4	355.0	500.0	708.0
5	708.0	1,000.0	1,413.0
6	1,413.0	2,000.0	2,818.0
7	2,818.0	4,000.0	5,623.0
8	5,623.0	8,000.0	11,200.0
9	11,220.0	16,000.0	22,387.0

*Nominal Values

Figure 2.2

Preferred octave band frequencies.

Sound level meters often are outfitted with octave band measurement capabilities. This allows the instrument user to directly measure the sound pressure level in each octave band. Although this data can be listed in tabular form, it is more useful to graph octave band values on a chart, as shown in Figure 2.3. This allows the user to more easily identify specific features of background noise which might be of concern. Data presented in this fashion are referred to as an **octave band spectrum**. Also shown in Figure 2.3 is an octave band spectrum of noise produced by an aircraft taking-off at a distance of 1,000 feet.

Under certain circumstances, more frequency resolution in acoustical data is needed so that one-third octave band sound level spectra are used. For example, the 1,000 Hz octave band is divided into one-third octave bands with center frequencies at 800 Hz, 1,000 Hz and 1,250 Hz. In Section 3 of this guide, sound transmission loss (TL) for various glass configurations is reported in one-third octave band frequencies as required by applicable standards.

Figure 2.3

Octave band sound pressure level spectrum for typical commercial jet aircraft take-off.

Environmental Noise Descriptors

Besides frequency and level, environmental sounds exhibit a time-varying or temporal characteristic. The temporal character of noise level can be illustrated by considering noise levels that occur near a highway. During the day, noise levels are generally high, increasing to higher peaks when a noisy truck passes and decreasing to a lower level between vehicle platoons. At night, when traffic volumes are lower, the same variation occurs, but is centered around a lower level.

Noise descriptors are quantifications of noise that combine, into a single value, the three chief features of environmental noise: level, frequency and temporal characteristics. The use of A-weighted sound pressure level combines the first two characteristics — level and frequency — into a single number. Then, by averaging A-weighted sound pressure levels over time in various fashions, noise descriptors that combine all three features can be developed.

A commonly used descriptor is **percentile A-weighted sound levels**, A-weighted sound pressure levels exceeded for specific percentages of time within a noise monitoring period. For example, the one-hour 50 percentile A-weighted noise level, symbolized as the L_{50} (1 hour), is the A-weighted noise level exceeded a total of 30 minutes out of a continuous 60-minute period. Likewise, the L_{10} (20 minutes) is the A-weighted noise level exceeded a total of two minutes out of a continuous 20-minute period.

Percentile A-weighted noise levels most often are used to assess the time-varying character of noise. The **residual noise level** (defined as the nearly constant, low level of noise produced by distant motor vehicle traffic or industrial activity) is indicative of the lowest level in a monitoring period. Residual noise level is commonly defined as the L_{90}, i.e., the A-weighted sound level exceeded 90% of a monitoring time period. Intrusive noise is characterized as a high noise level that endures for only a short period and is produced by such events as aircraft flyovers and truck passbys.

Intrusive noise level is often defined as the L_{10}, i.e., the A-weighted sound level exceeded 10% of a monitoring time period. Although the L_{10} is useful for understanding environmental noise, it is no longer used by any federal agency in setting standards. Instead, the equivalent sound level has become commonly adopted as discussed below.

Equivalent Sound Level

For several years, the U.S. Environmental Protection Agency (EPA) has encouraged the use of the **equivalent sound level**: a descriptor that uses the average A-weighted energy and differs significantly from 50th percentile, or median, sound pressure level. Unlike the 50th percentile sound level which is not influenced by peak noise levels of short duration, the equivalent sound level is. Therefore, the A-weighted equivalent sound level combines level, frequency and temporal character into a single-valued descriptor. Equivalent sound level, symbolized as **Leq**, is always higher than the L_{50}, as it is influenced by noise contributions of high level and short duration such as aircraft flyovers or noisy truck passbys.

Massachusetts Department of ENVIRONMENTAL PROTECTION

f a c t s h e e t

Noise

Background

Noise is a type of air pollution that results from sounds that cause a nuisance, are or could injure public health, or unreasonably interfere with the comfortable enjoyment of life, property, or the conduct of business. Types of sounds that may cause noise include:

- "Loud" continuous sounds from industrial or commercial activity, demolition, or highly amplified music;
- Sounds in narrow frequency ranges such as "squealing" fans or other rotary equipment; and
- Intermittent or "impact" sounds such as those from pile drivers, jackhammers, slamming truck tailgates, public address systems, etc.

Policy

A noise source will be considered to be violating the Department's noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient, or
2. Produce a "pure tone" condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. "Ambient" is defined as the background A-weighted sound level that is exceeded 90% of the time, measured during equipment operating hours. "Ambient" may also be established by other means with consent of the Department.

For more information:
For complaints about specific noise sources, call the Board of Health for the municipality in which the noise source is located.

To learn more about responding to noise, odor and dust complaints or to request state assistance or support, please contact the service center in the nearest DEP regional office.

- Central Region, Worcester: (508) 792-7683
- Northeast Region, Wilmington: (978) 661-7677
- Southeast Region, Lakeville: (508) 946-2714
- Western Region, Springfield: (413) 755-2214

This Policy was originally adopted by the MA Department of Public Health in the early 1970's. It was reaffirmed by DEP's Division of Air Quality Control on February 1, 1990, and has remained in effect.

Massachusetts Department of
Environmental Protection
One Winter Street
Boston, MA 02108-4746

Commonwealth of
Massachusetts
Mitt Romney, Governor

Executive Office of
Environmental Affairs
Ellen Roy Herzfelder, Secretary

Department of
Environmental Protection
Edward P. Kunce,
Acting Commissioner

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February 2003.
Printed on recycled paper.

This information is available in alternate format by calling our ADA Coordinator at (617) 574-6872.

APPENDIX B

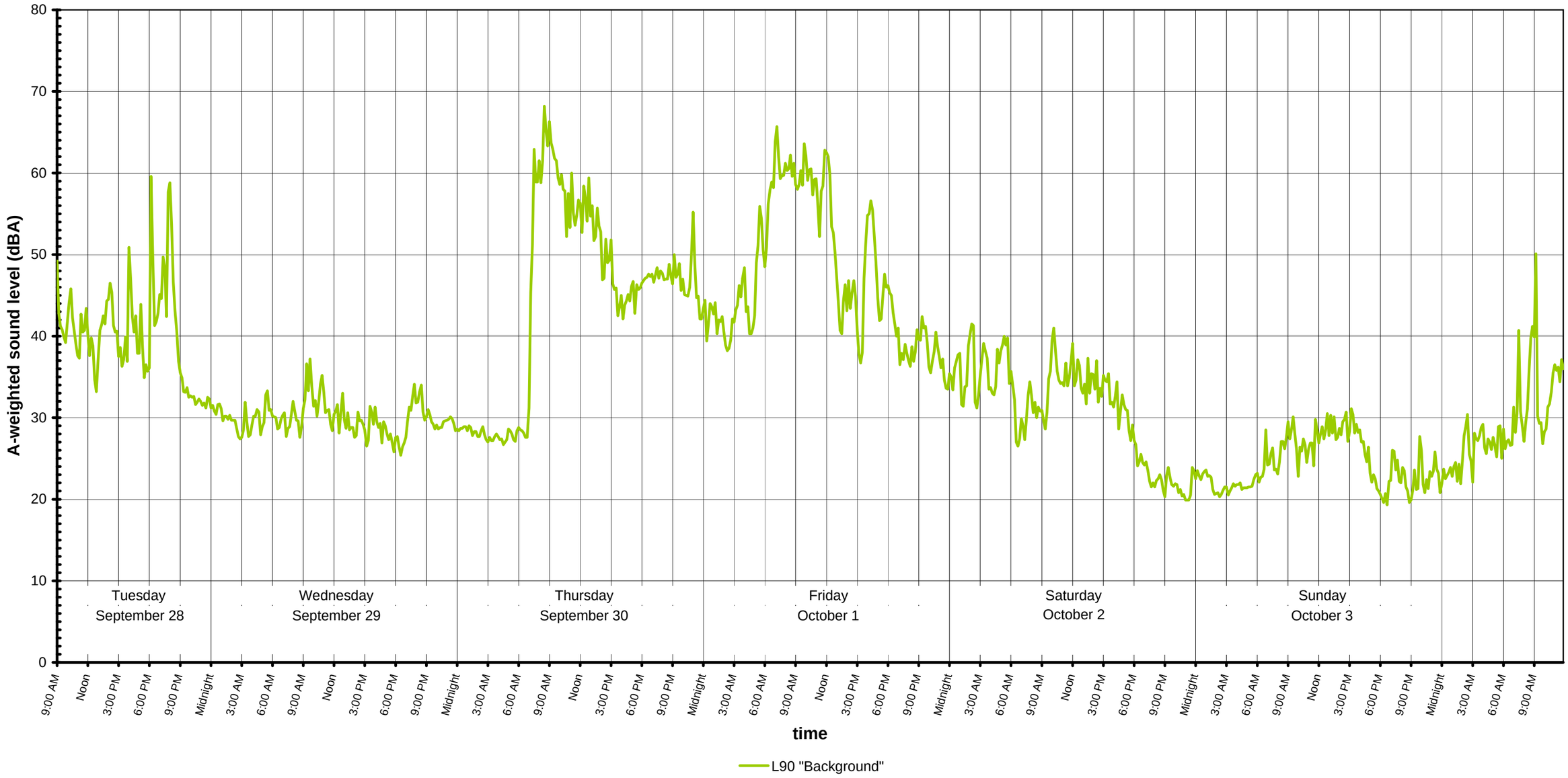
A-weighted and C-weighted
Sound Levels Monitoring Data

A-weight sound levels measured at 431 Ashfield Mountain Road (R4)

September 27, 2010 - October 4, 2010

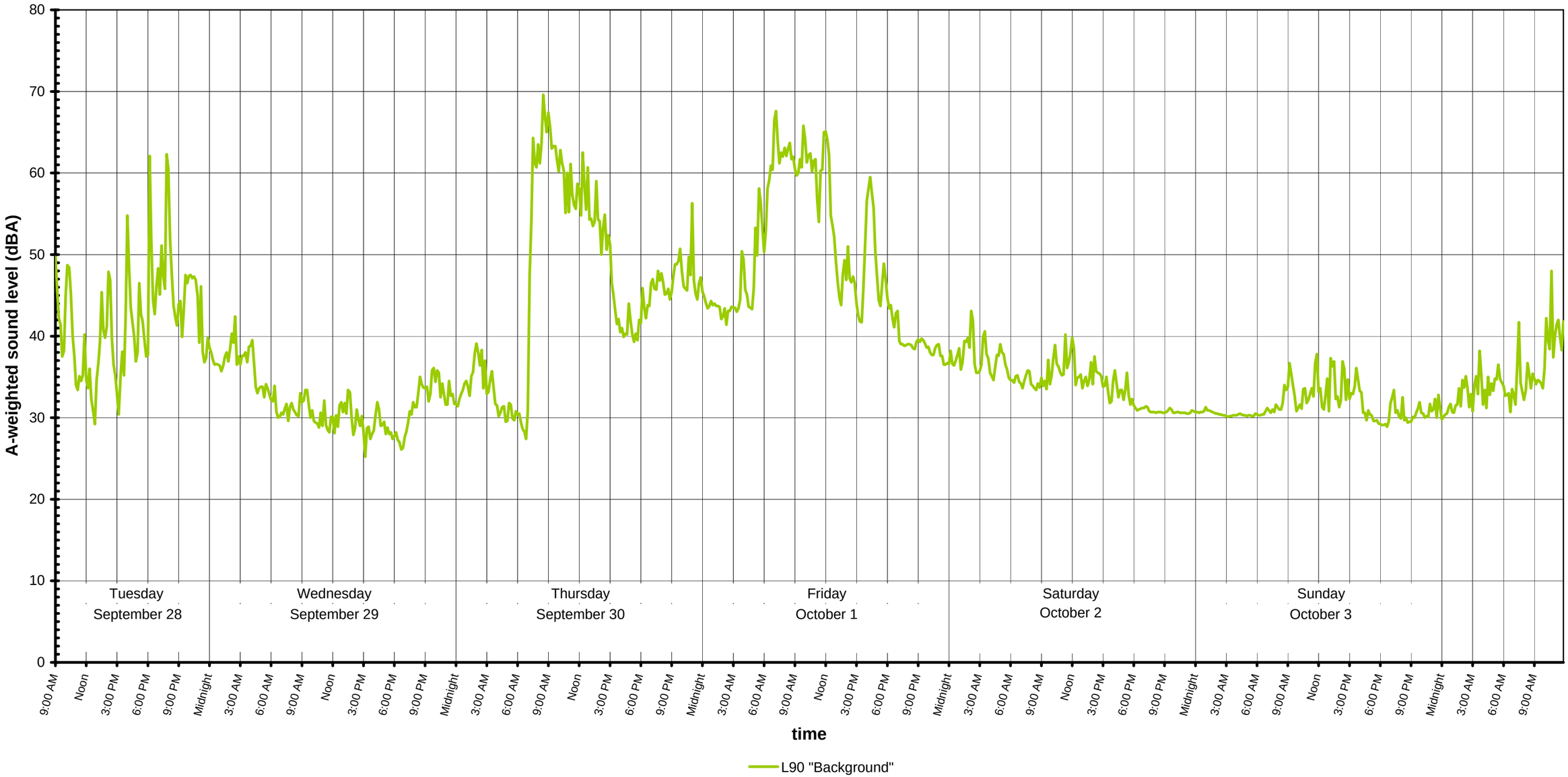
A-weight sound levels measured at 30 Bailey Road (R6)

September 27, 2010 - October 4, 2010



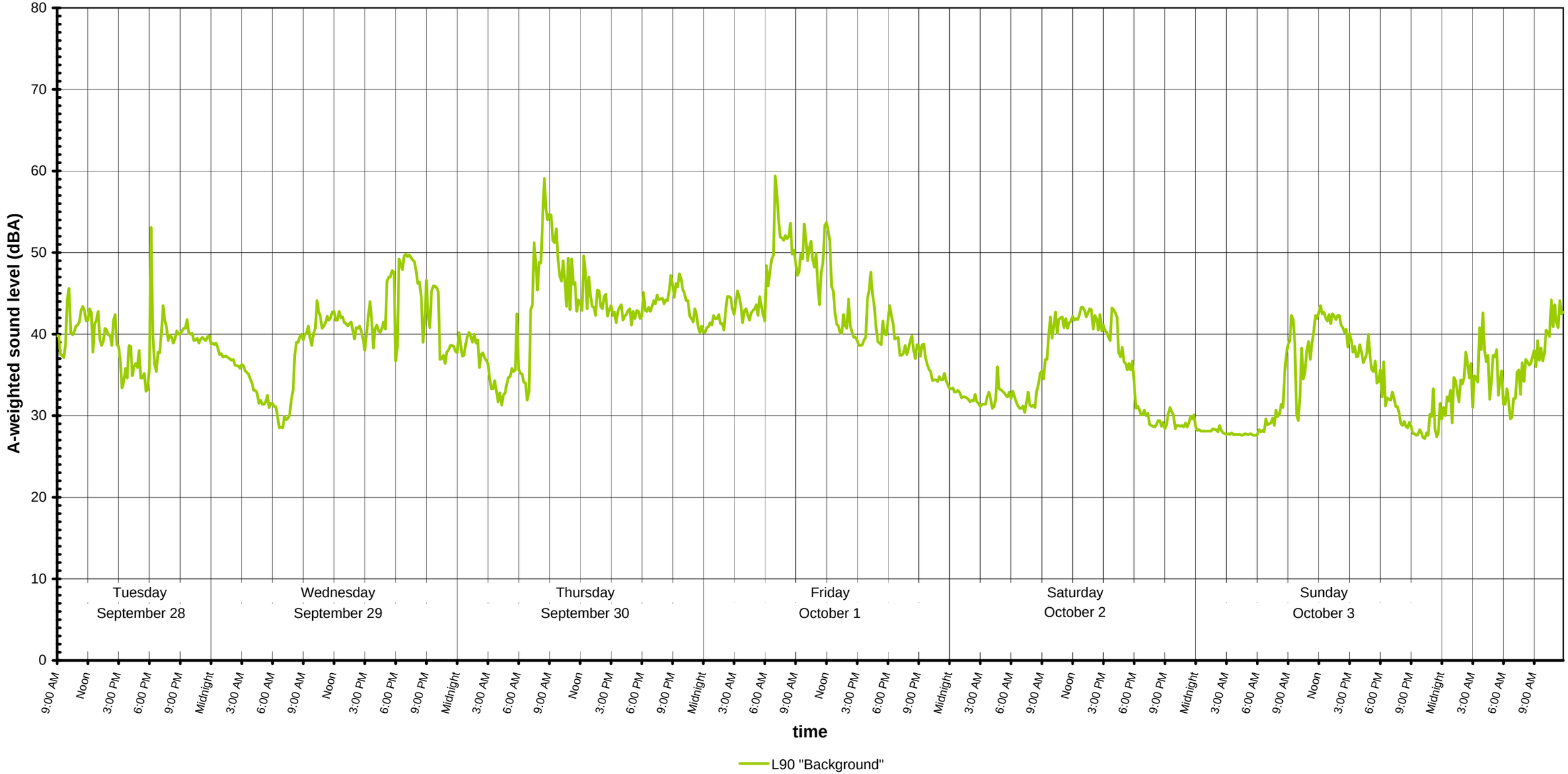
A-weight sound levels measured at Graves Road (R7)

September 27, 2010 - October 4, 2010



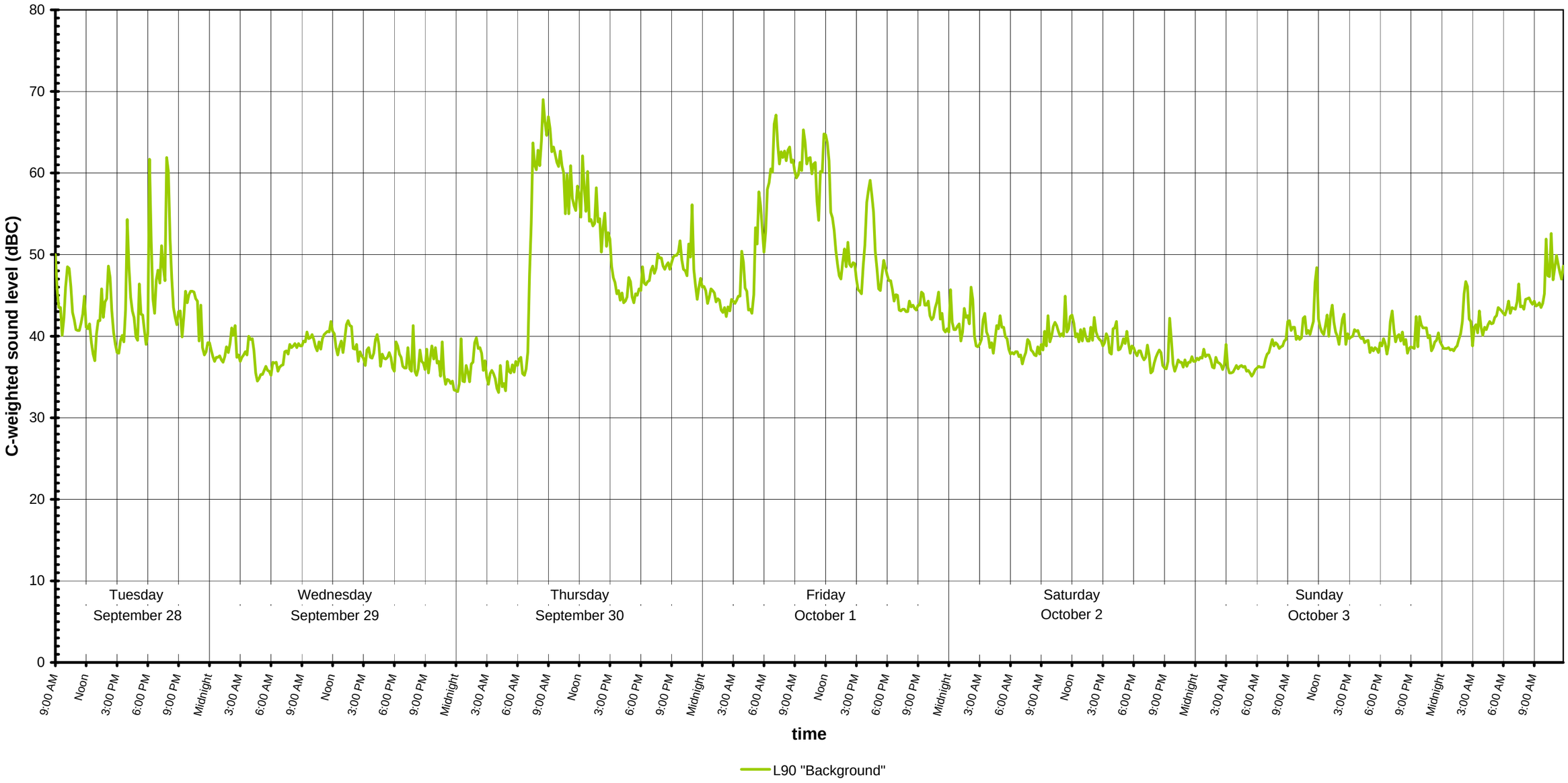
A-weight sound levels measured at 87 Beldingville Road (R8)

September 27, 2010 - October 4, 2010



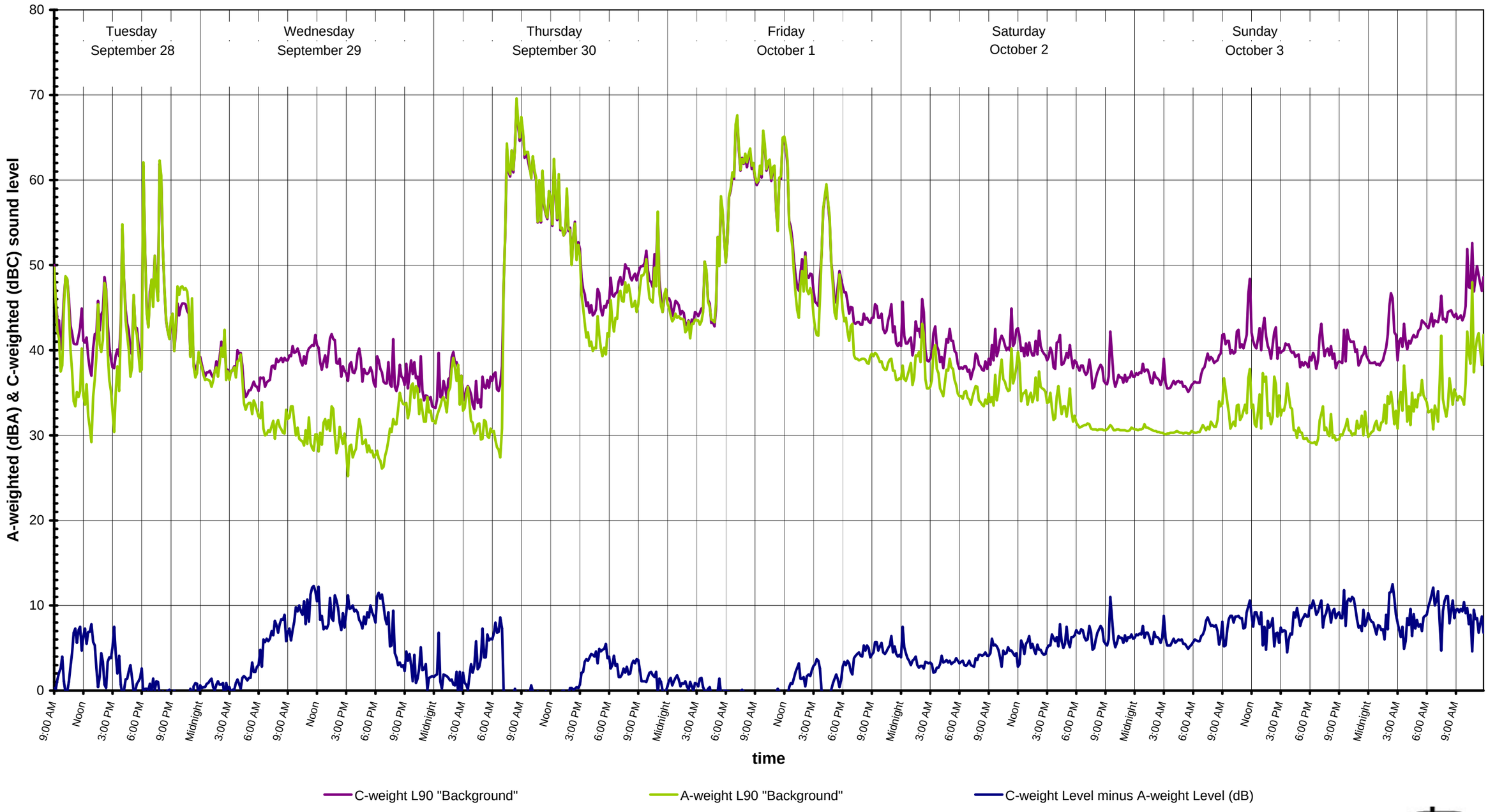
C-weight sound levels measured at Graves Road (R14)

September 27, 2010 - October 4, 2010



A-weight and C-weight L90 sound levels measured at Graves Road (R14)

September 27, 2010 - October 4, 2010



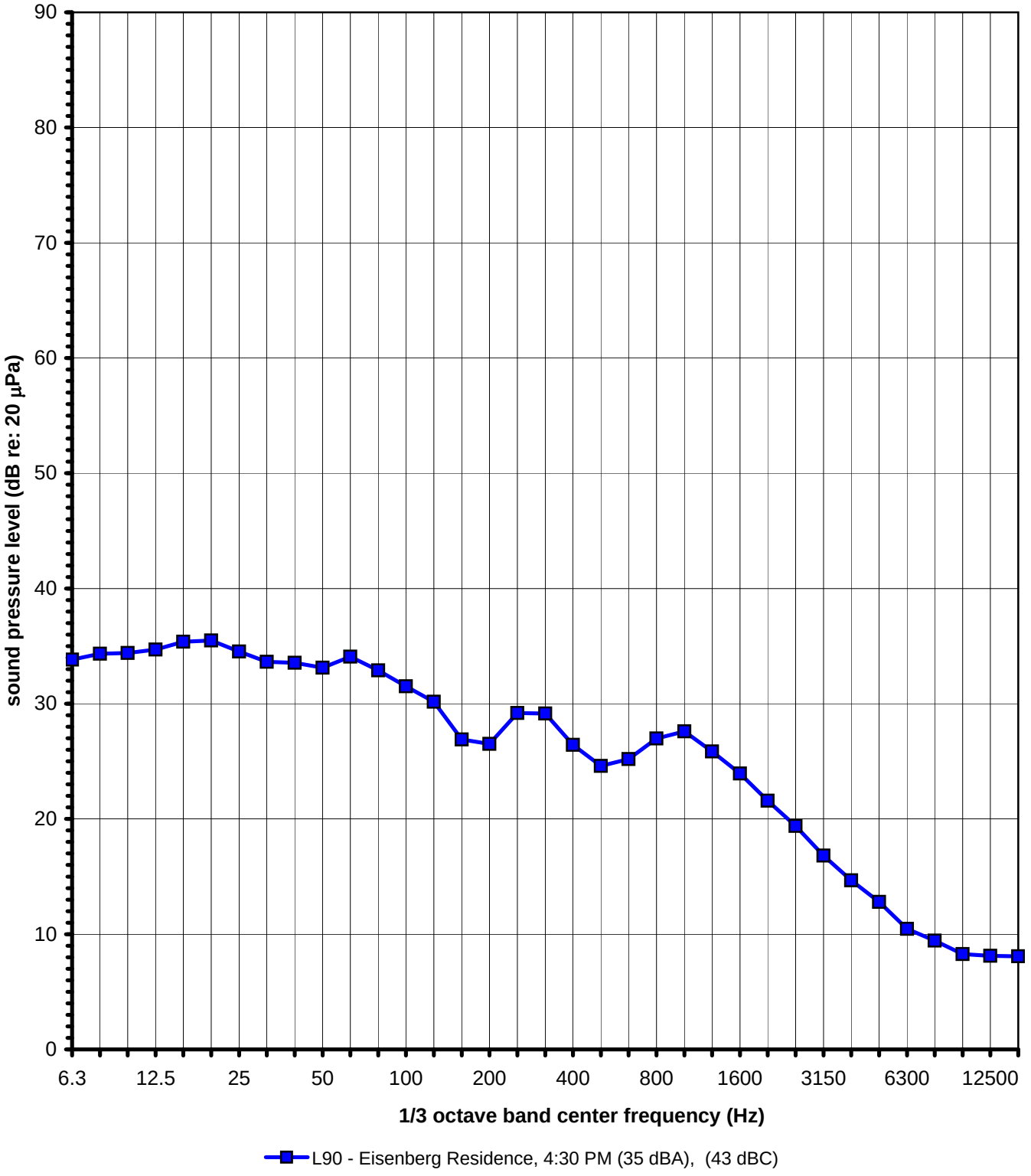
APPENDIX C

1/3 Octave and 1/1 Octave

Sound Level/Frequency Spectra

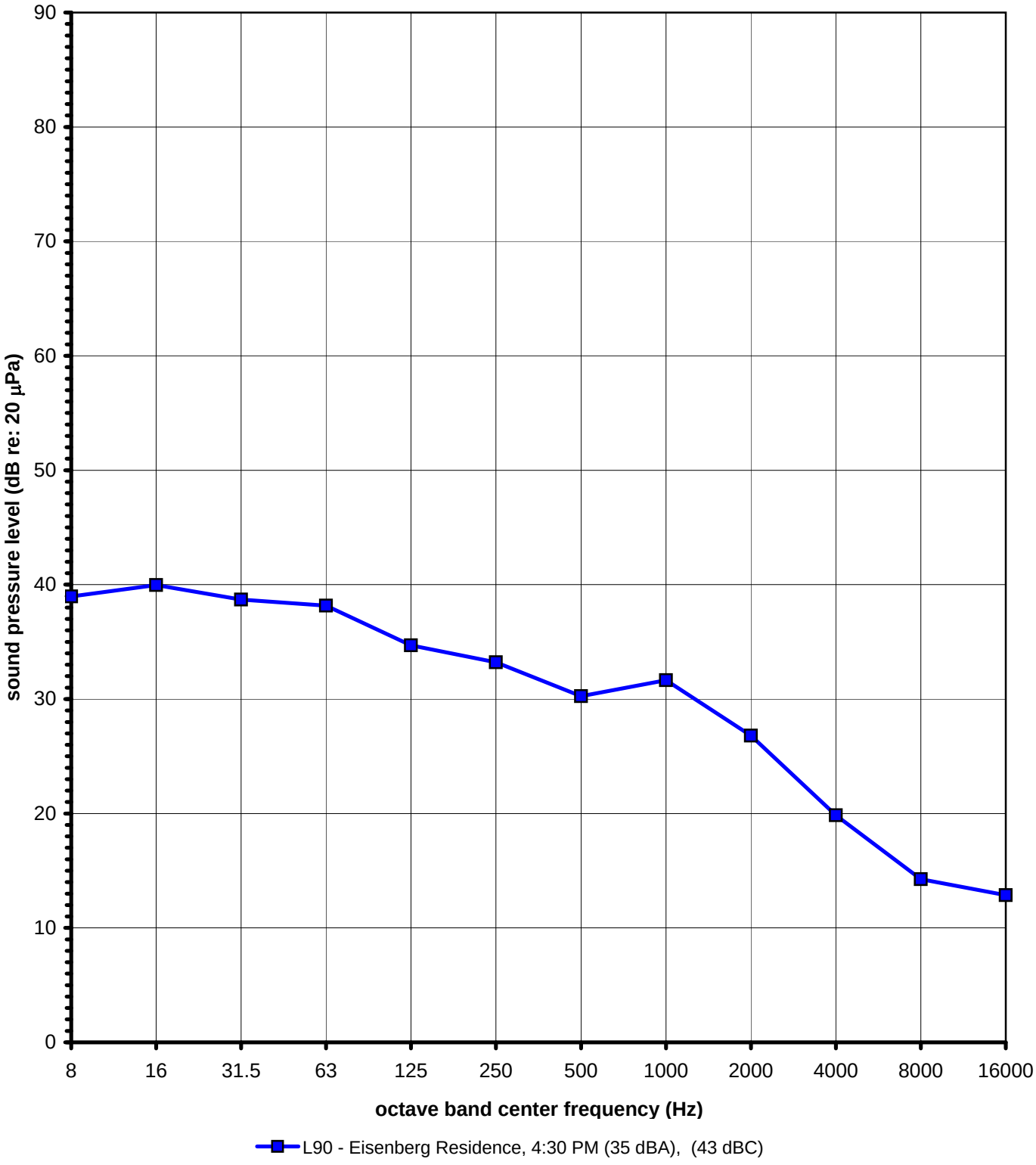
Eisenberg Residence - One Third Octave Band Sound Levels

Sunday, October 3, 2010



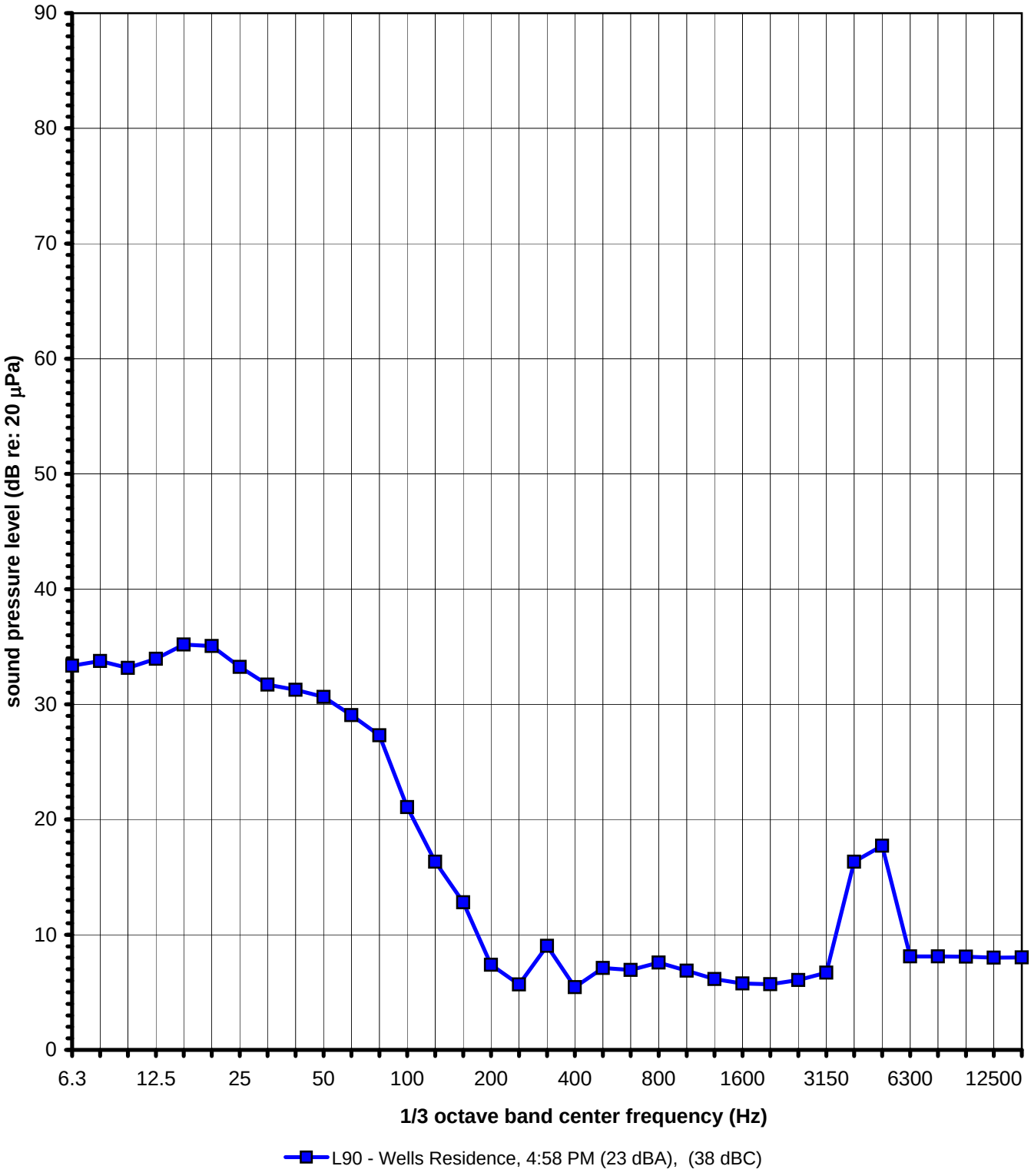
Eisenberg Residence - Octave Band Sound Levels

Sunday, October 3, 2010



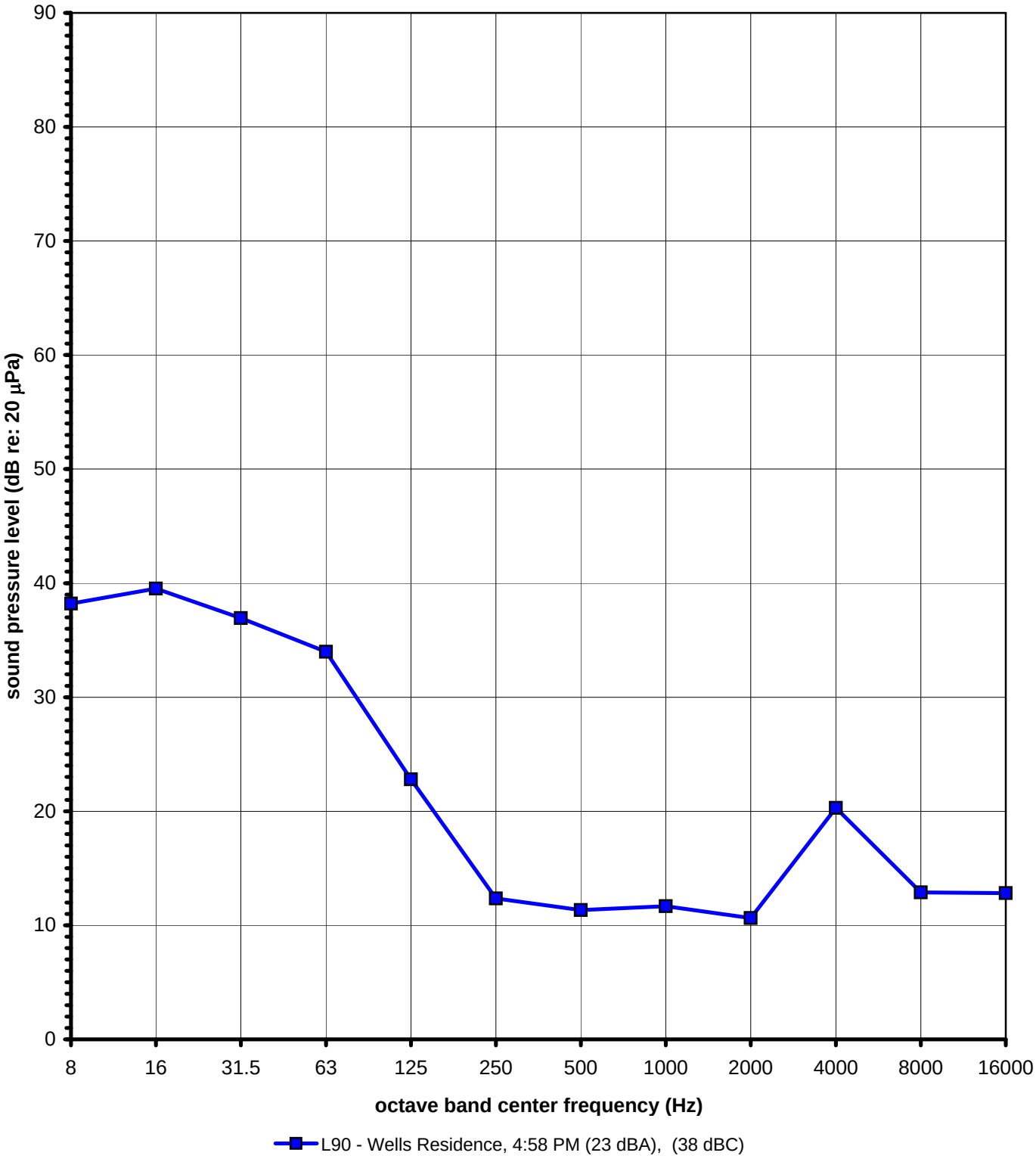
Wells Residence - One Third Octave Band Sound Levels

Sunday, October 3, 2010



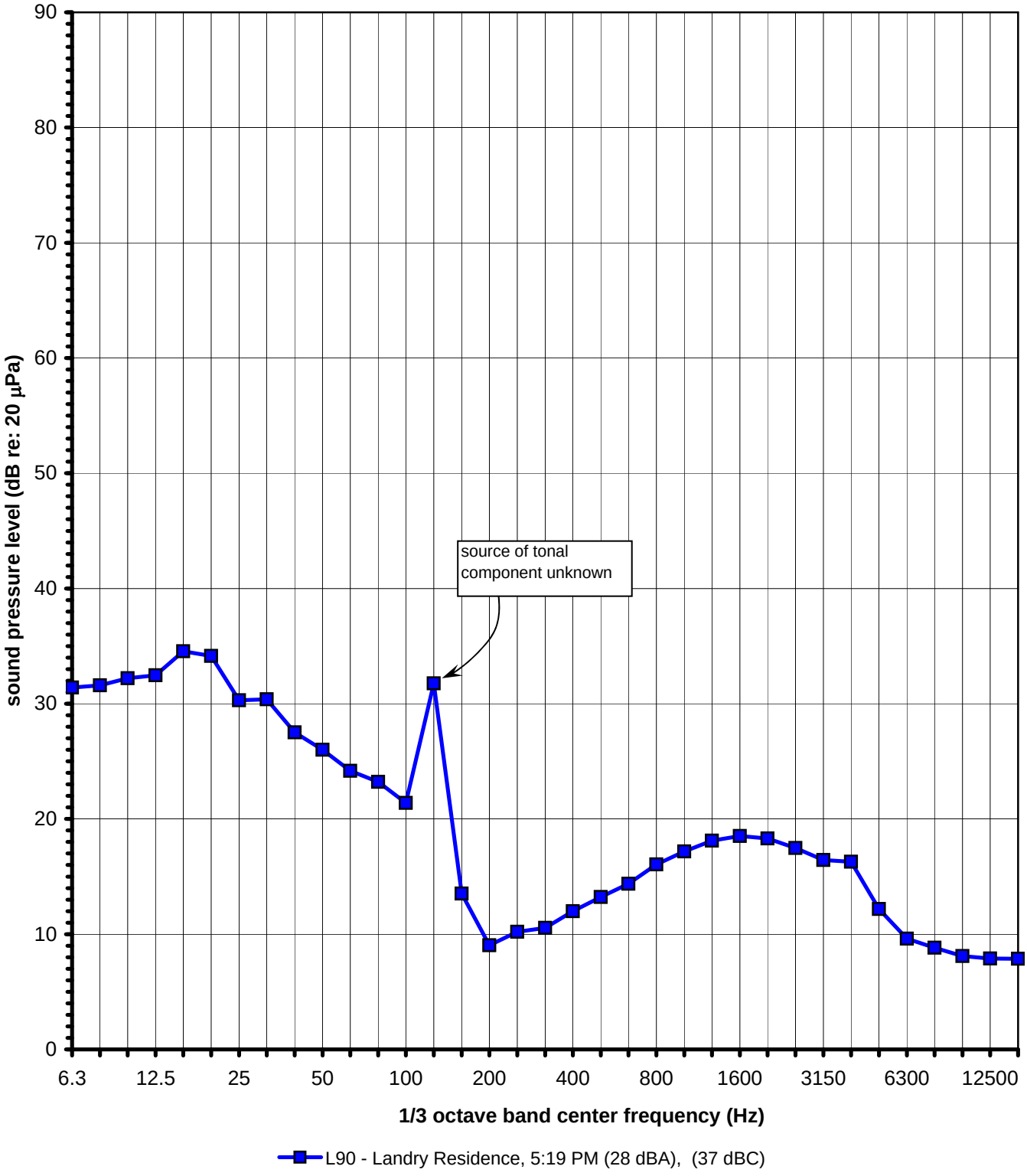
Wells Residence - Octave Band Sound Levels

Sunday, October 3, 2010



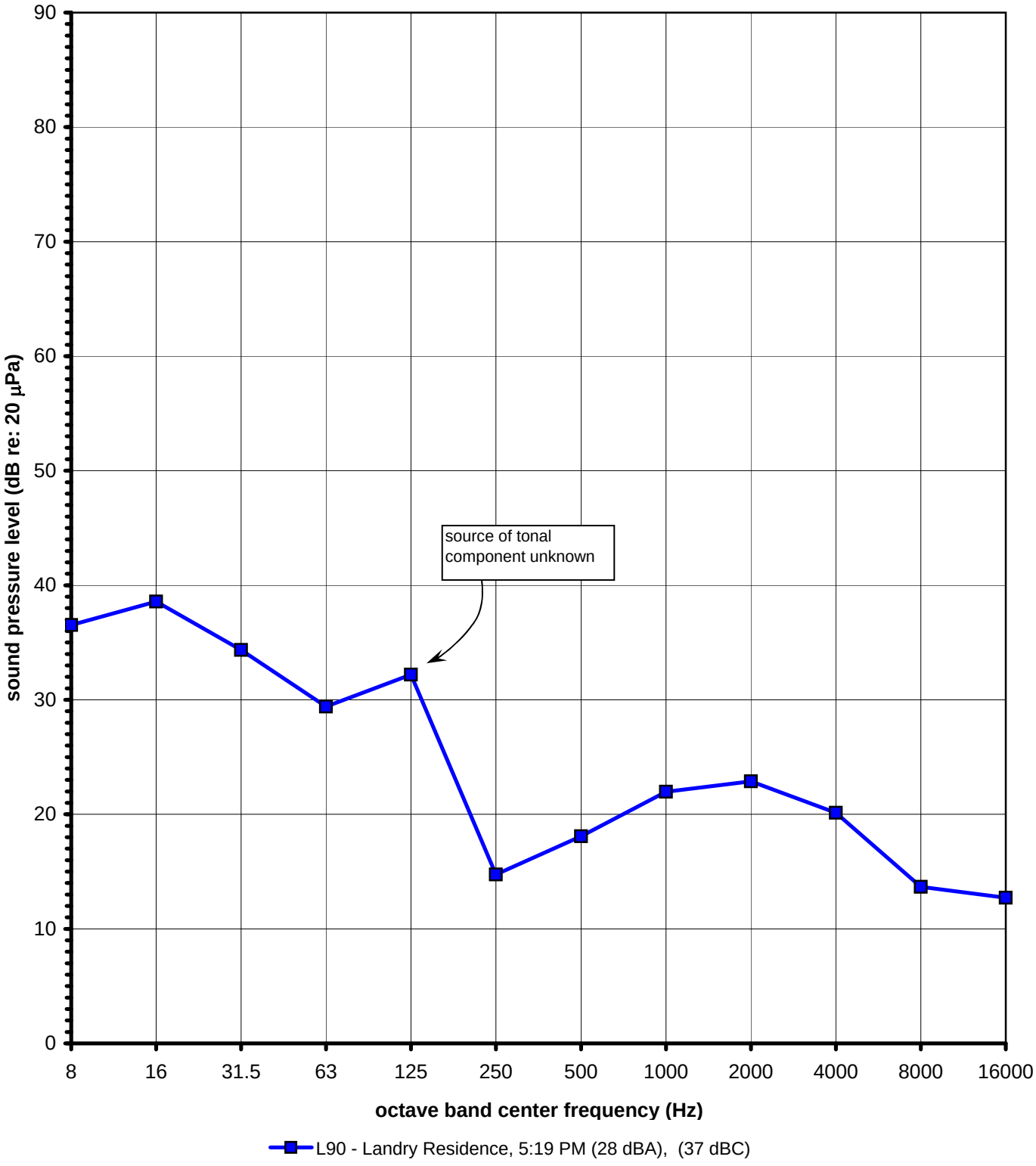
Landry Residence - One Third Octave Band Sound Levels

Sunday, October 3, 2010



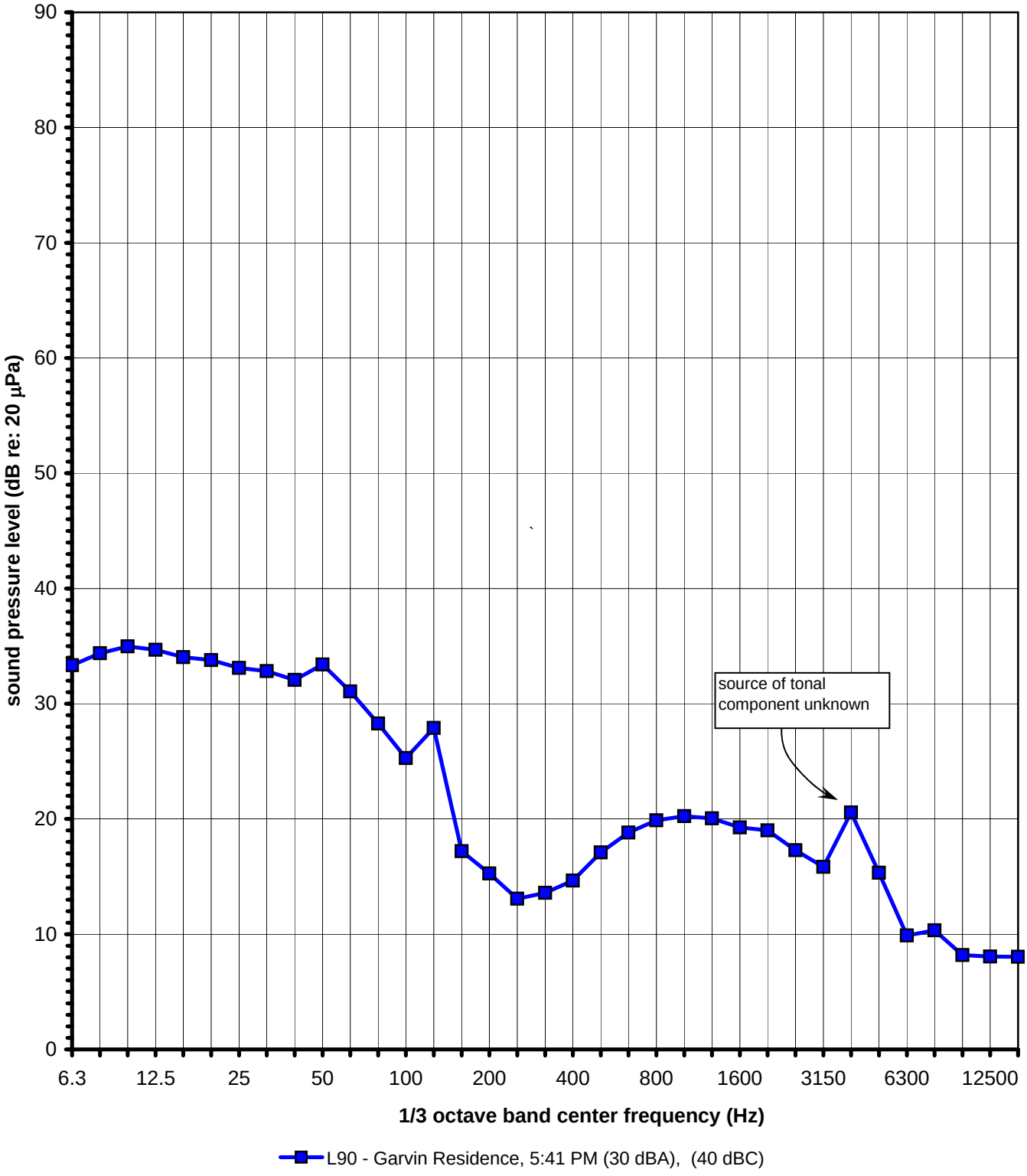
Landry Residence - Octave Band Sound Levels

Sunday, October 3, 2010



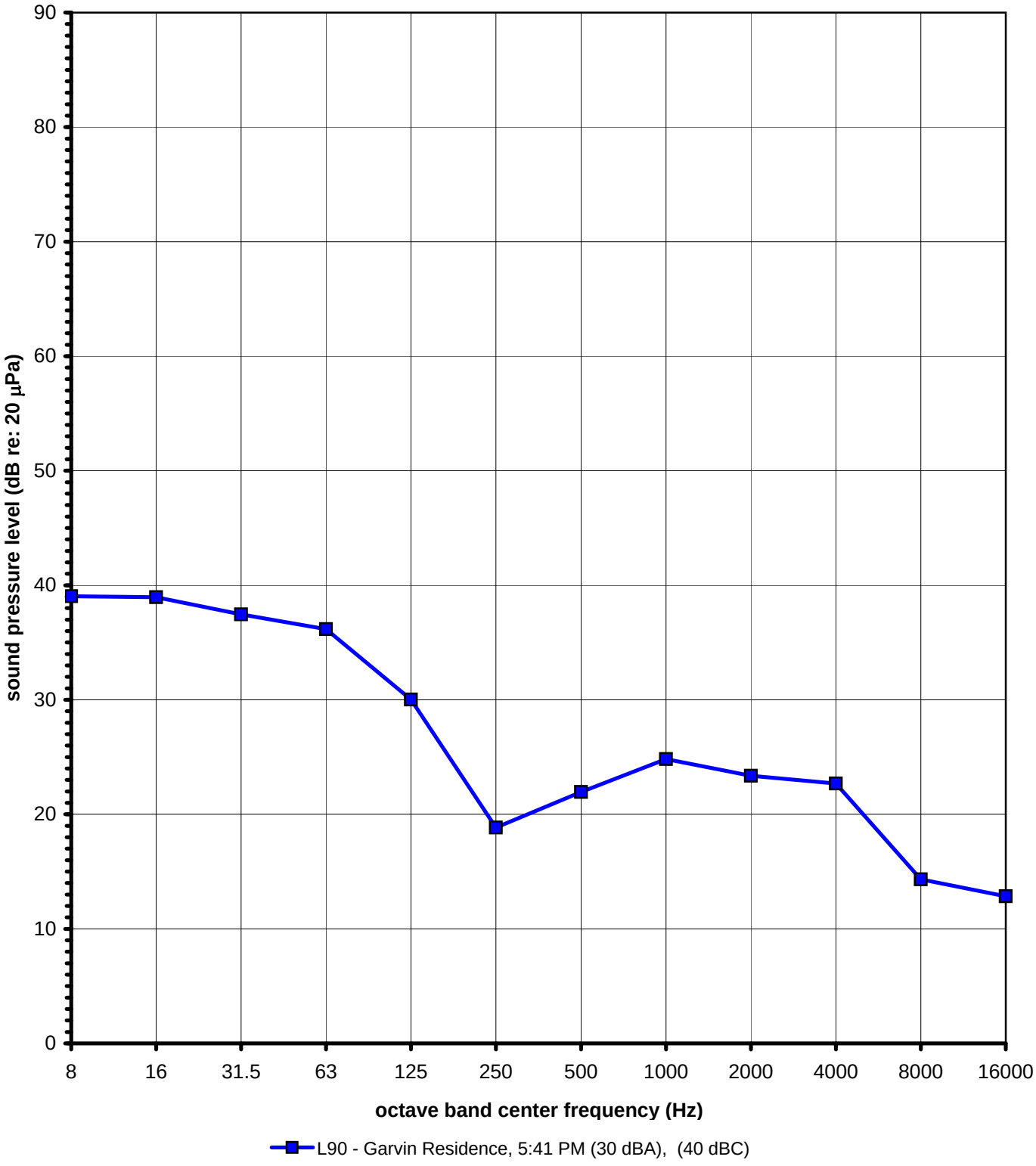
Garvin Residence - One Third Octave Band Sound Levels

Sunday, October 3, 2010



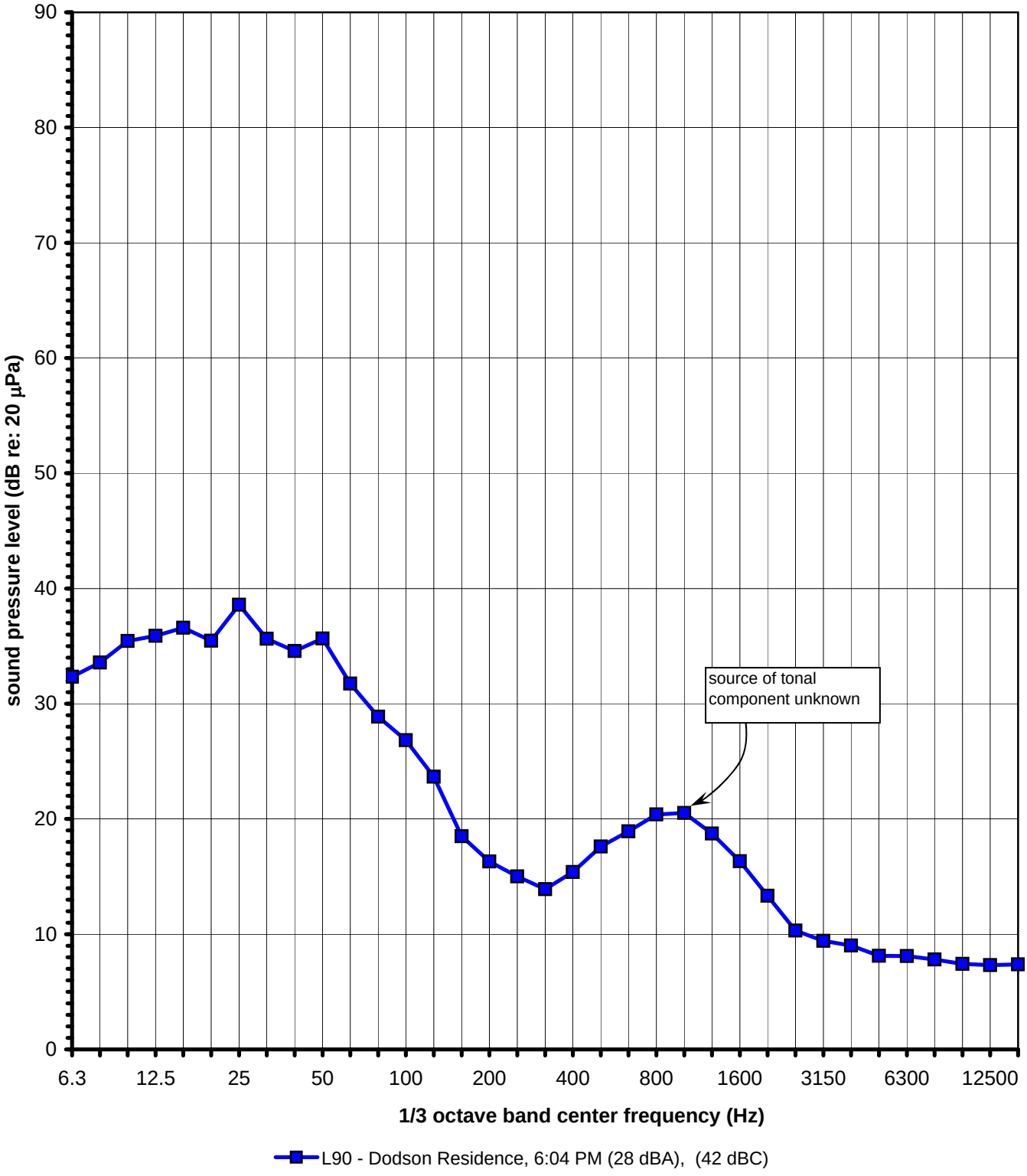
Garvin Residence - Octave Band Sound Levels

Sunday, October 3, 2010



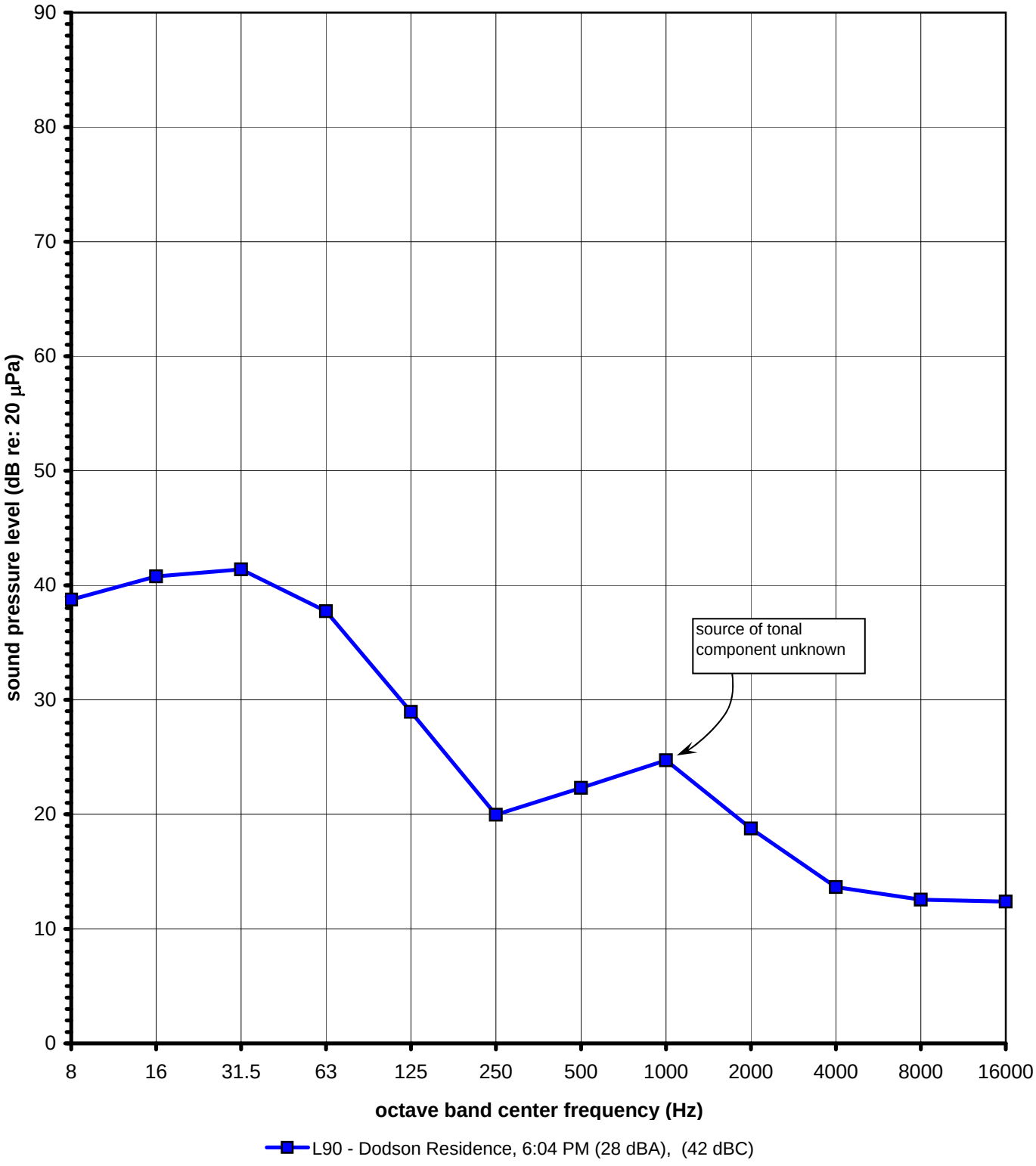
Dodson Residence - One Third Octave Band Sound Levels

Sunday, October 3, 2010



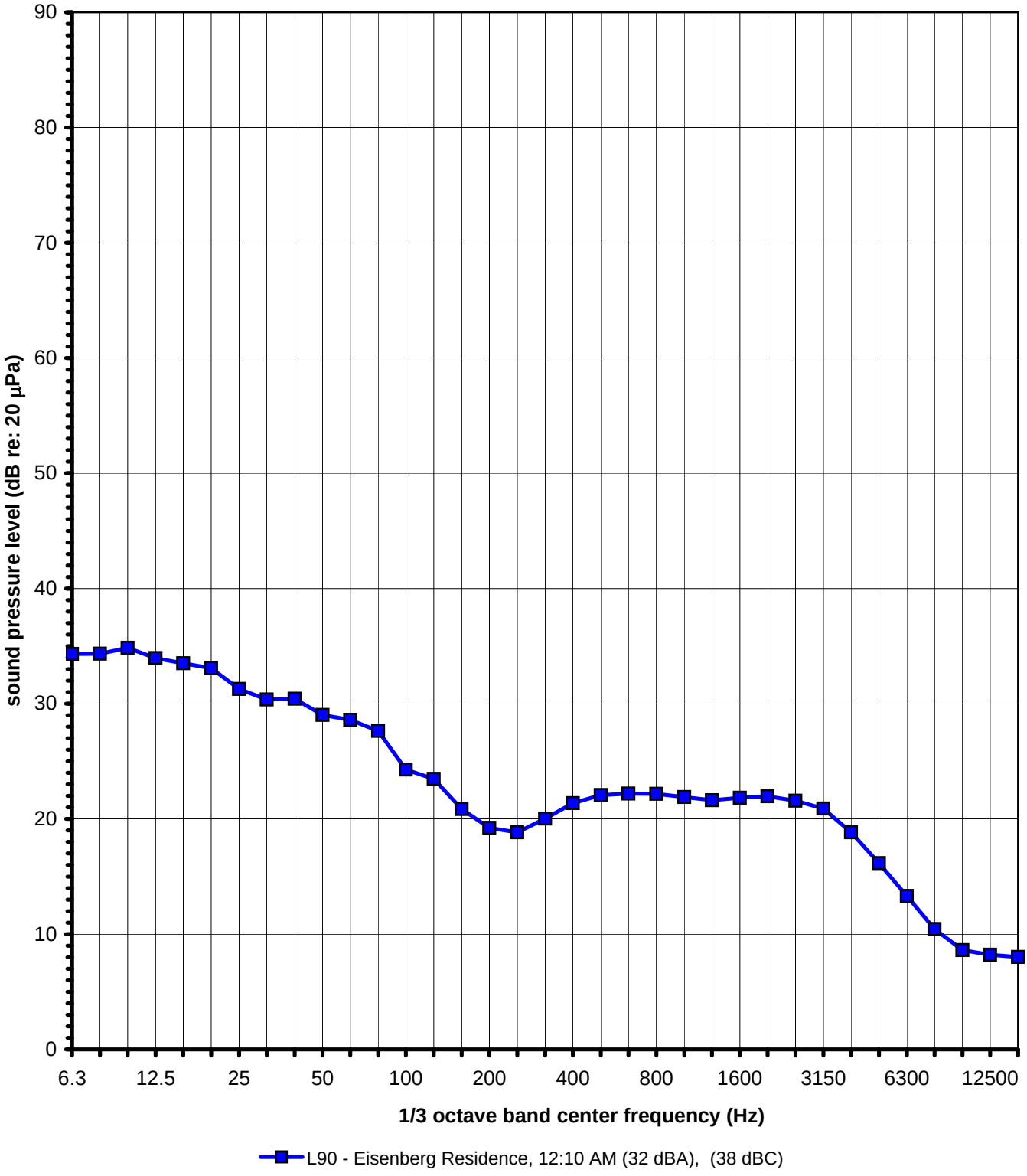
Dodson Residence - Octave Band Sound Levels

Sunday, October 3, 2010



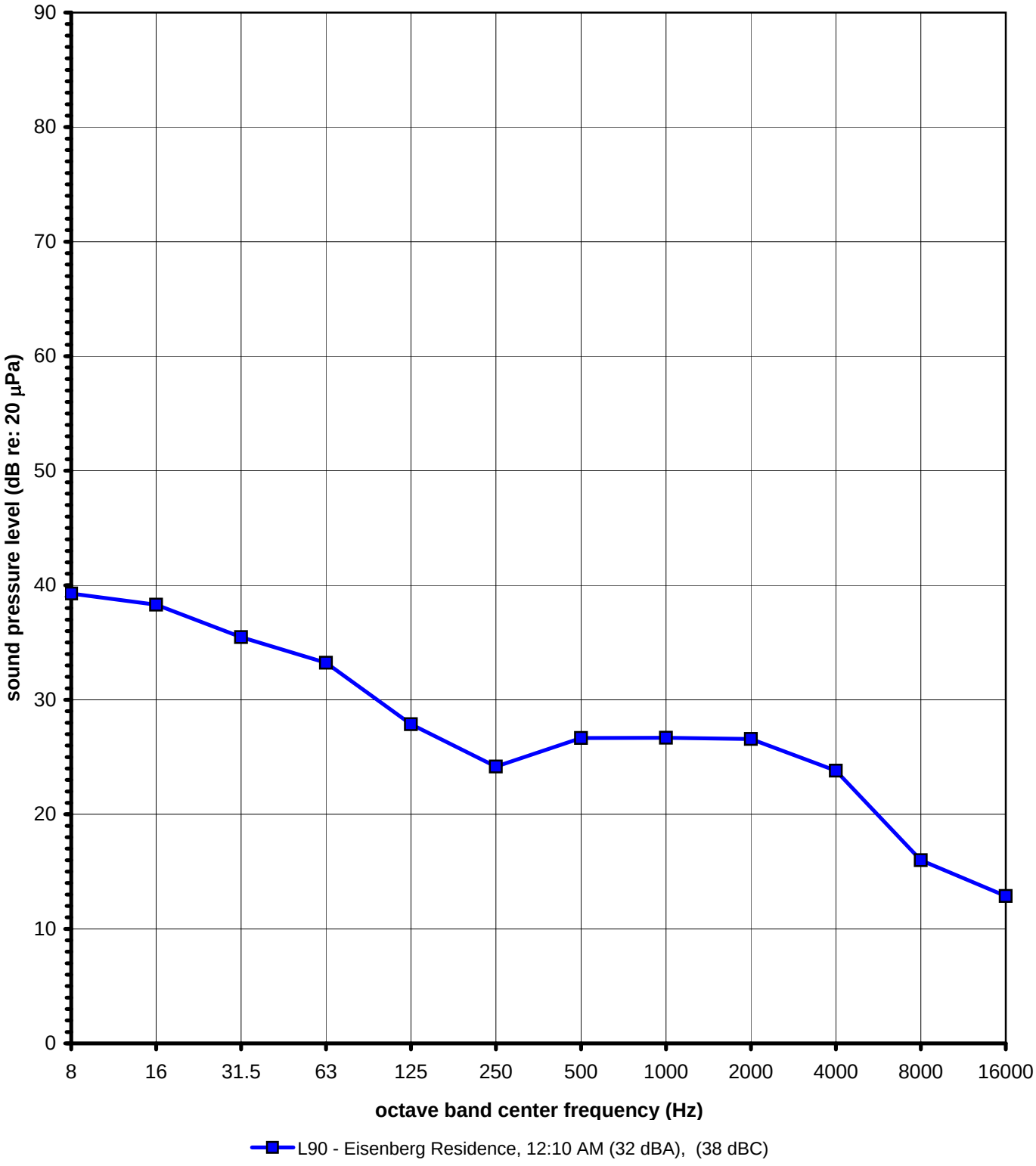
Eisenberg Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



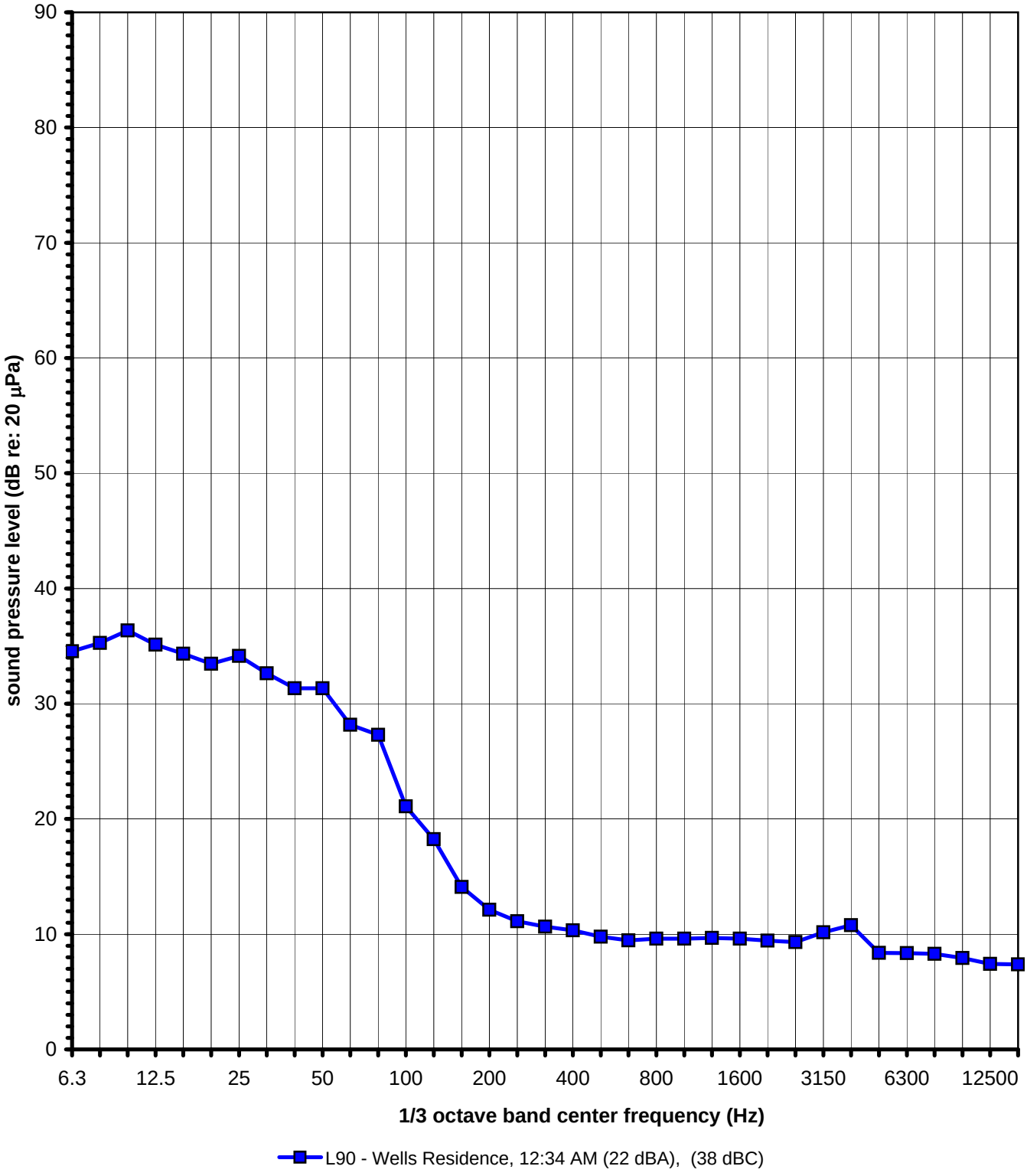
Eisenberg Residence - Octave Band Sound Levels

Monday, October 4, 2010



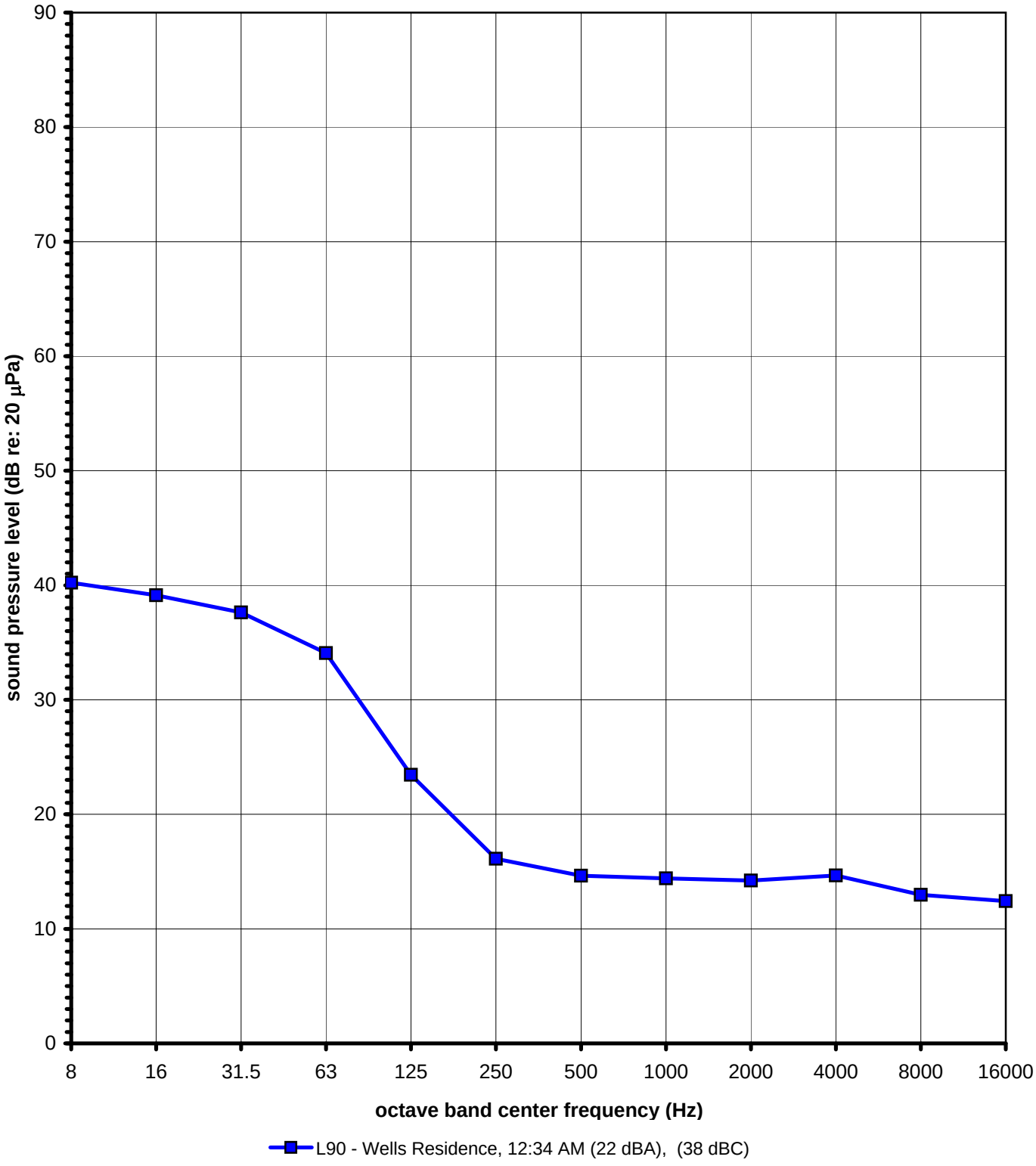
Wells Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



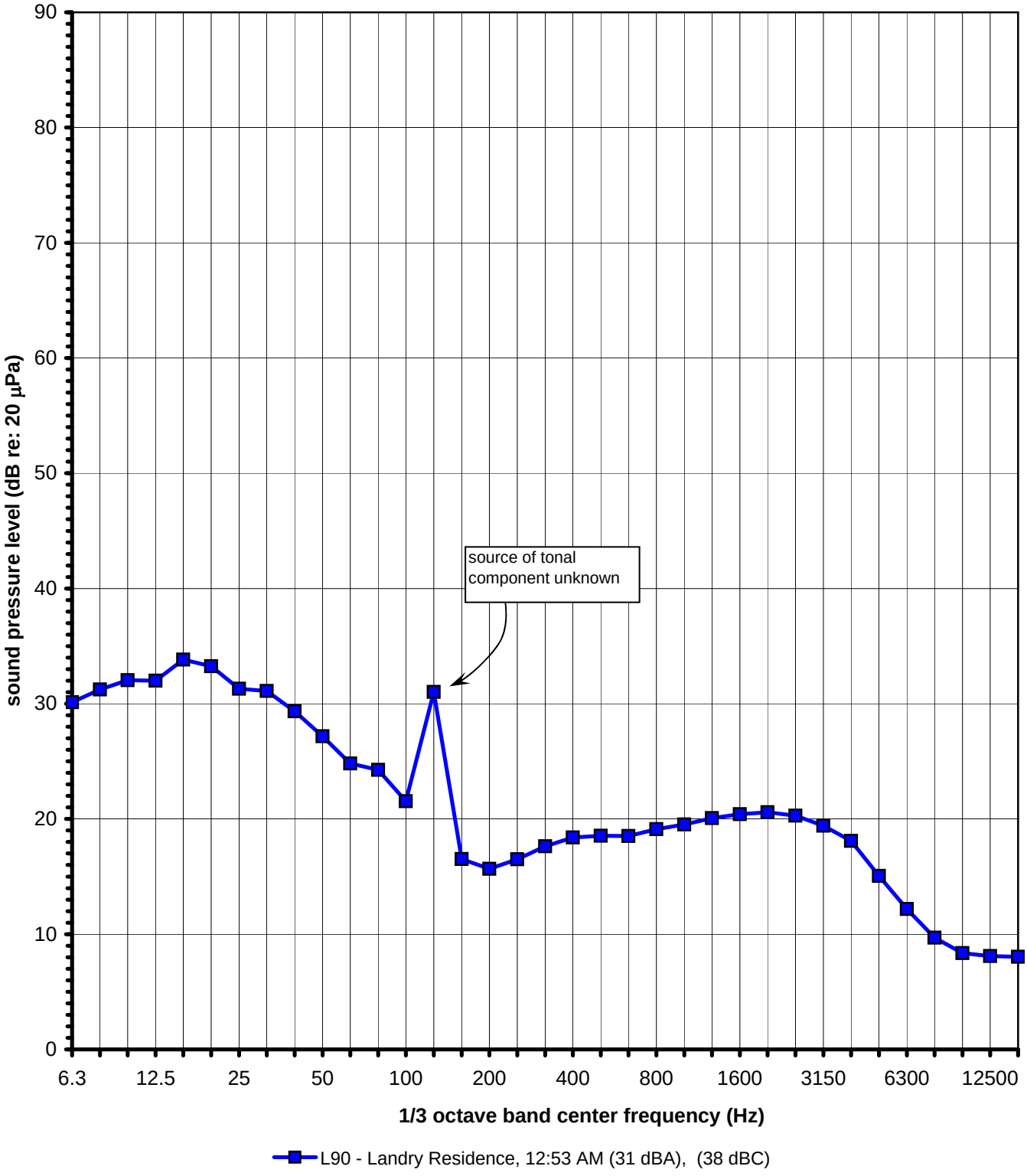
Wells Residence - Octave Band Sound Levels

Monday, October 4, 2010



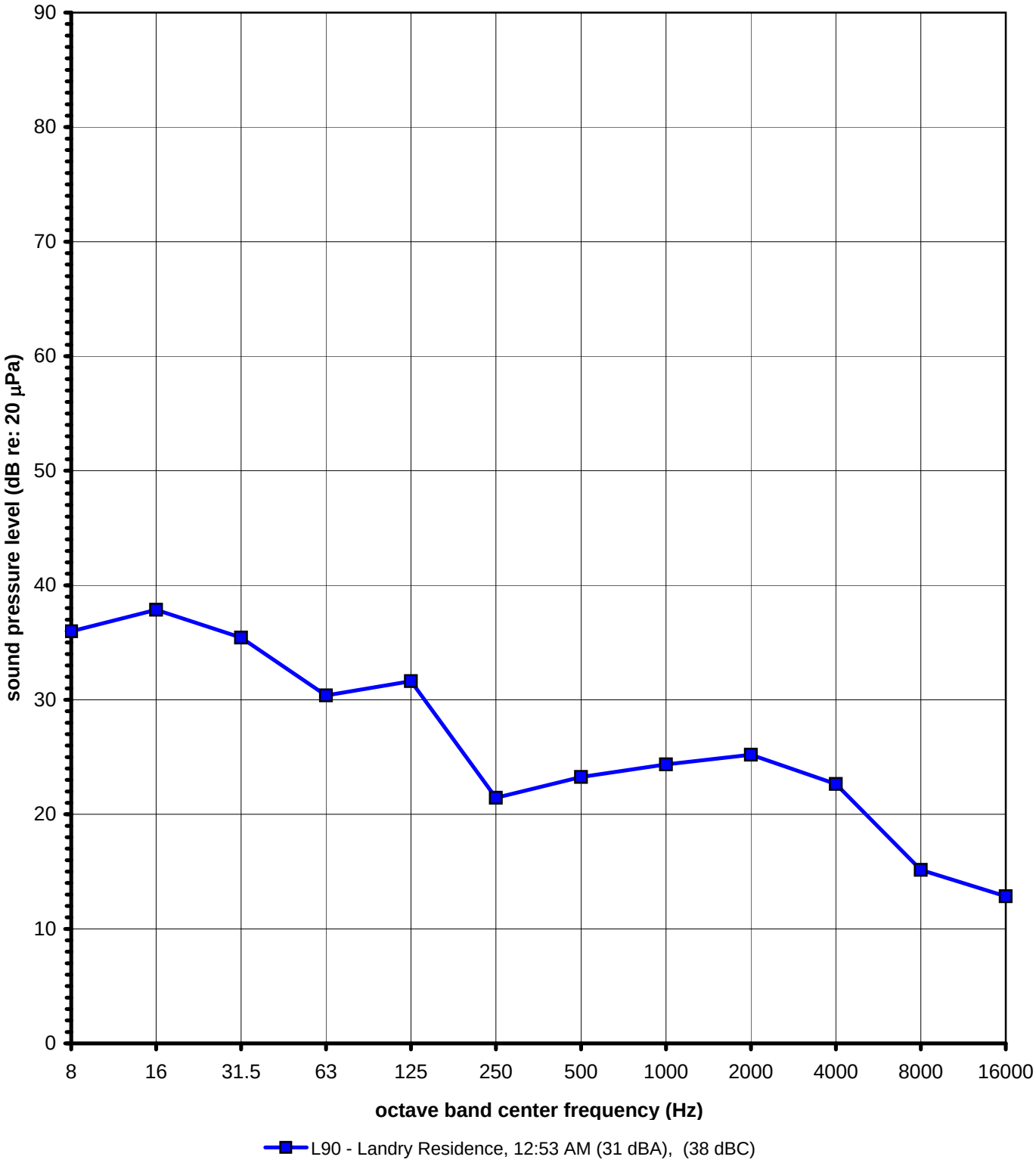
Landry Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



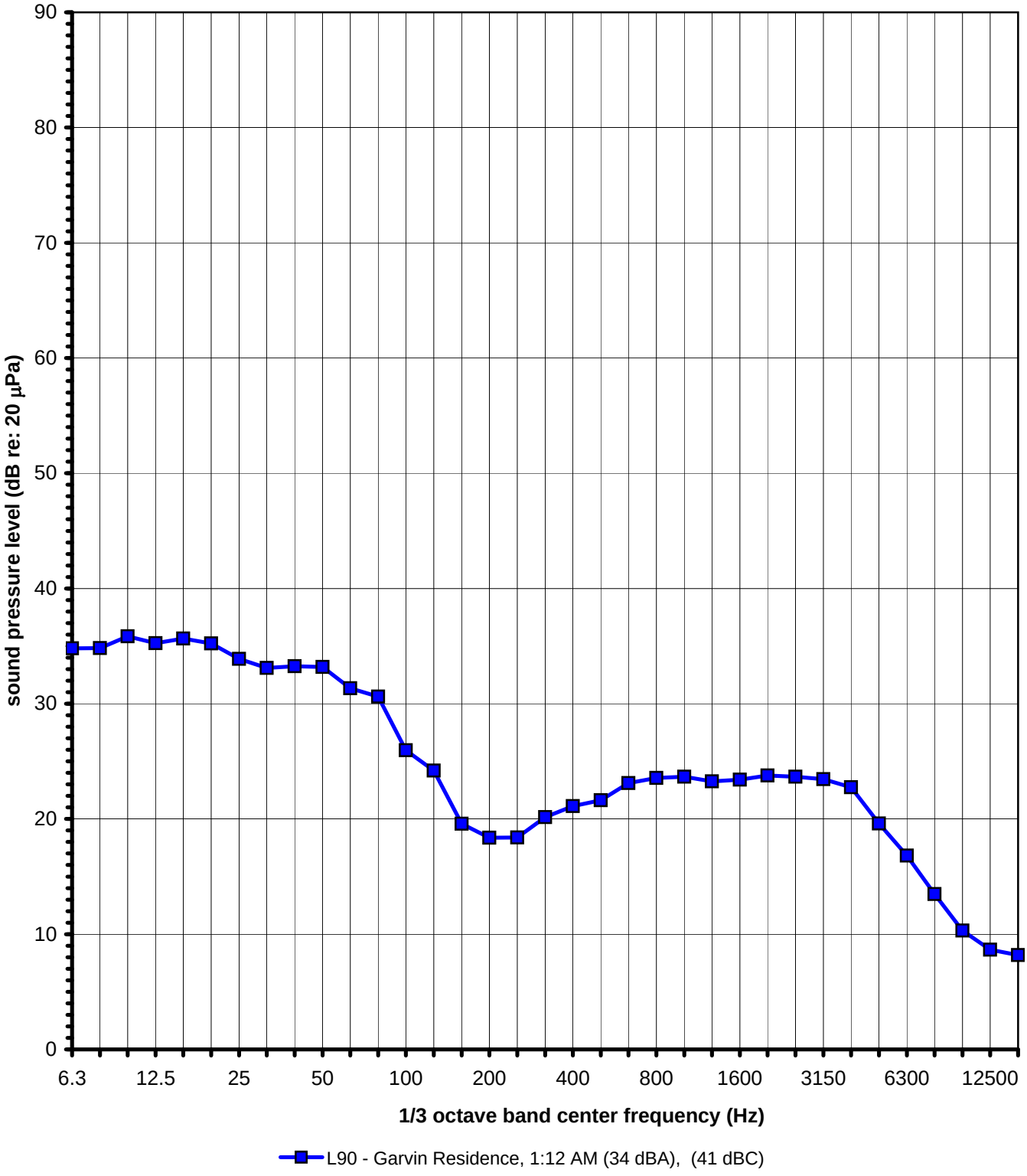
Landry Residence - Octave Band Sound Levels

Monday, October 4, 2010



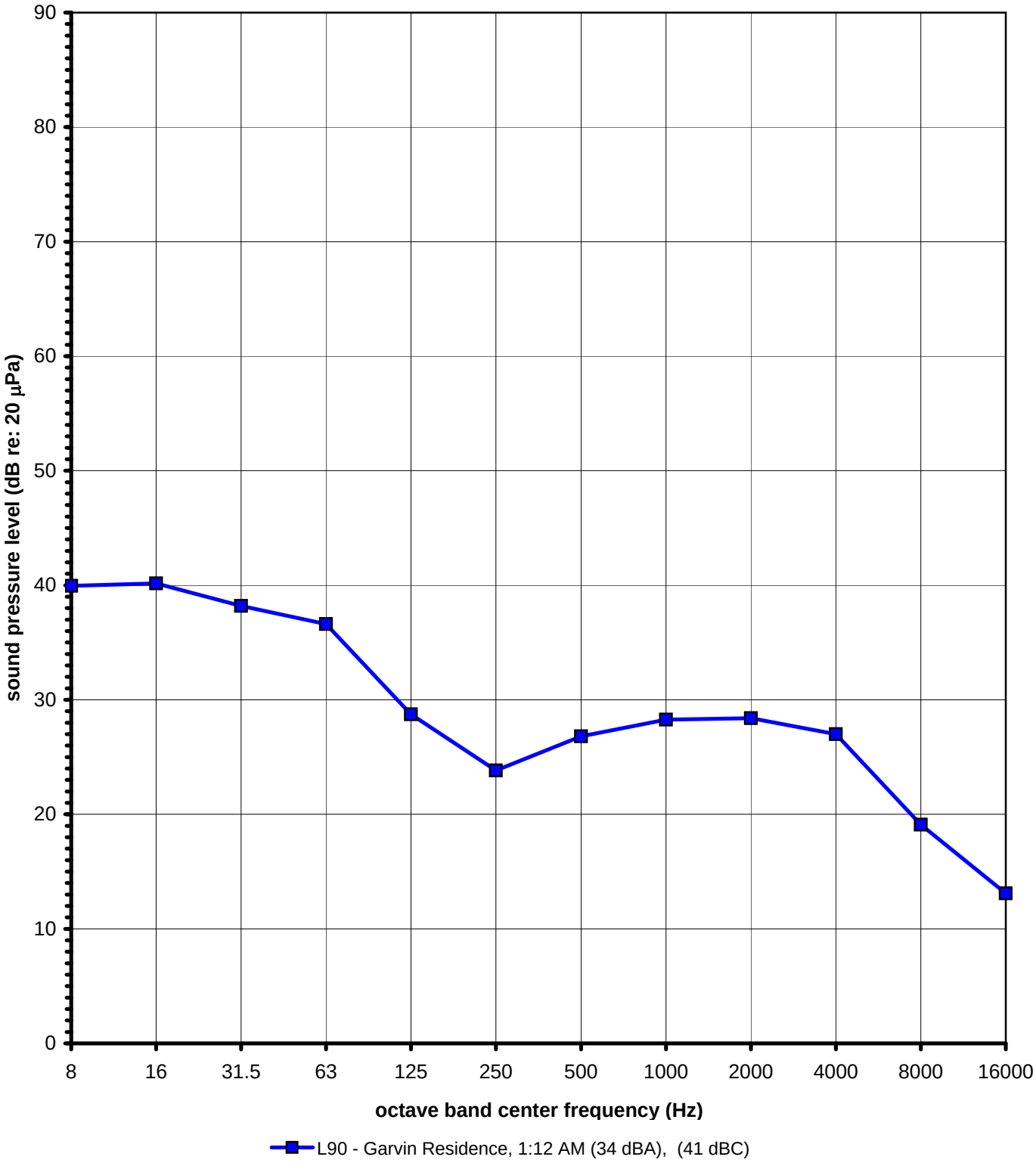
Garvin Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



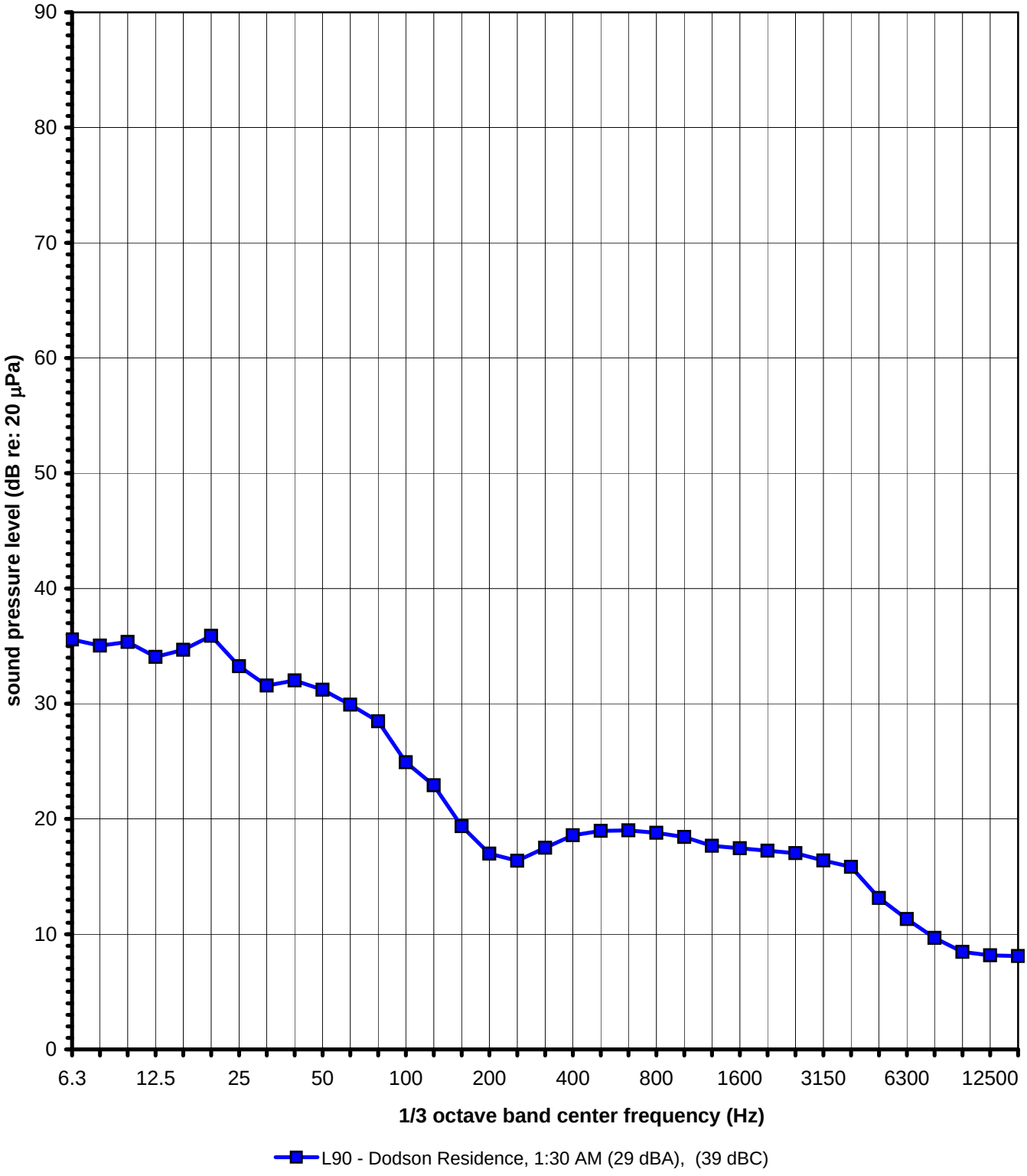
Garvin Residence - Octave Band Sound Levels

Monday, October 4, 2010



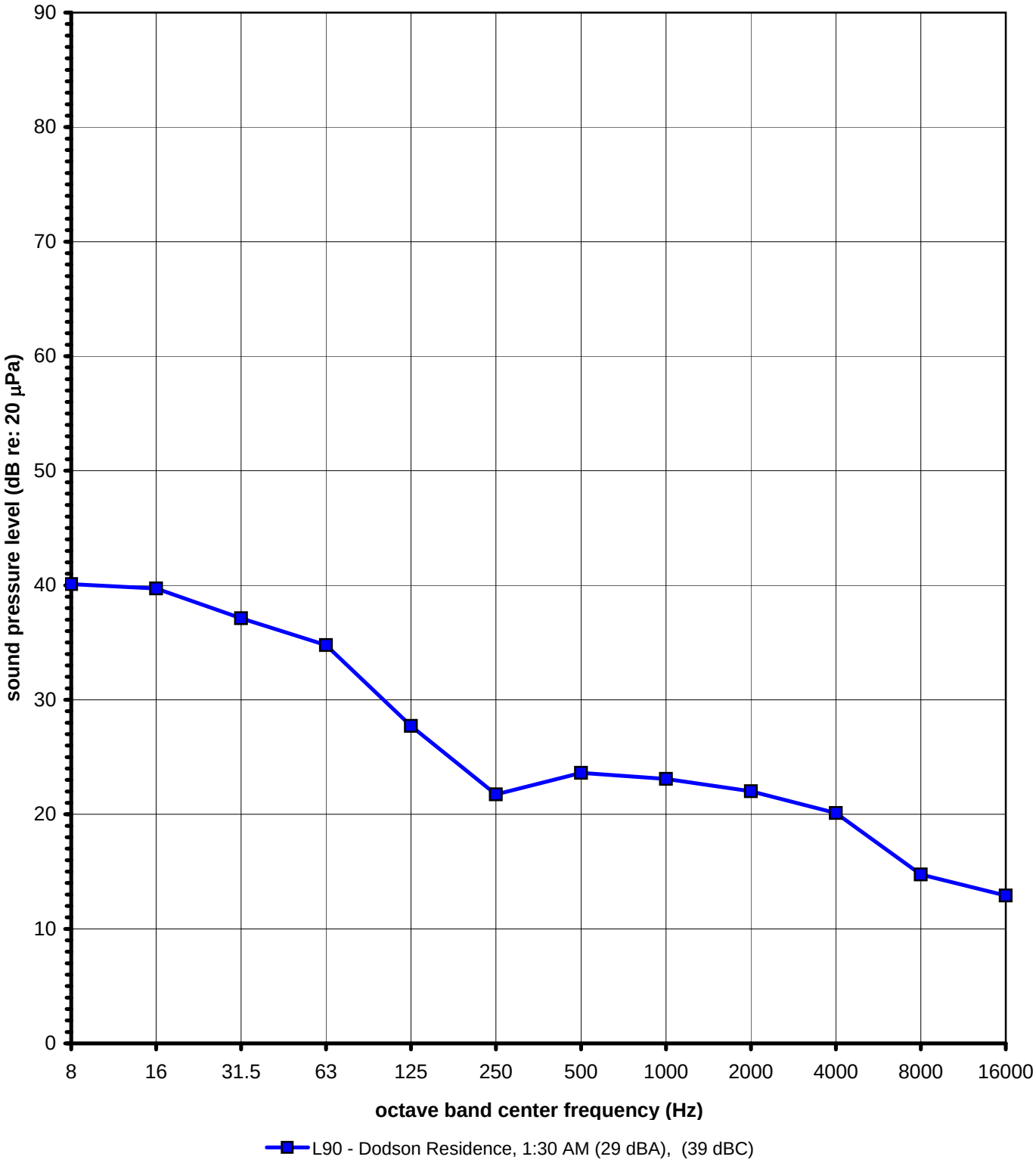
Dodson Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



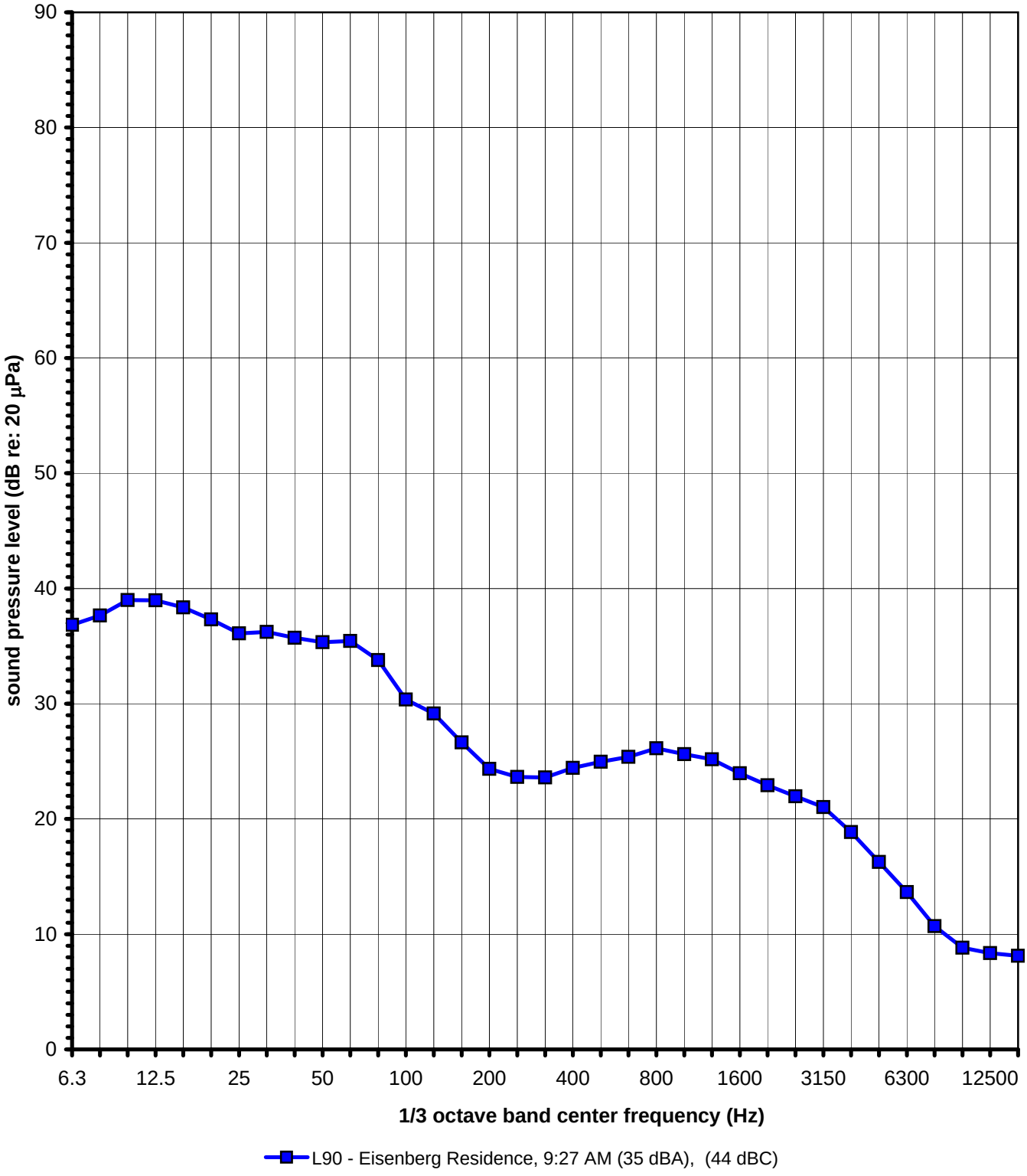
Dodson Residence - Octave Band Sound Levels

Monday, October 4, 2010



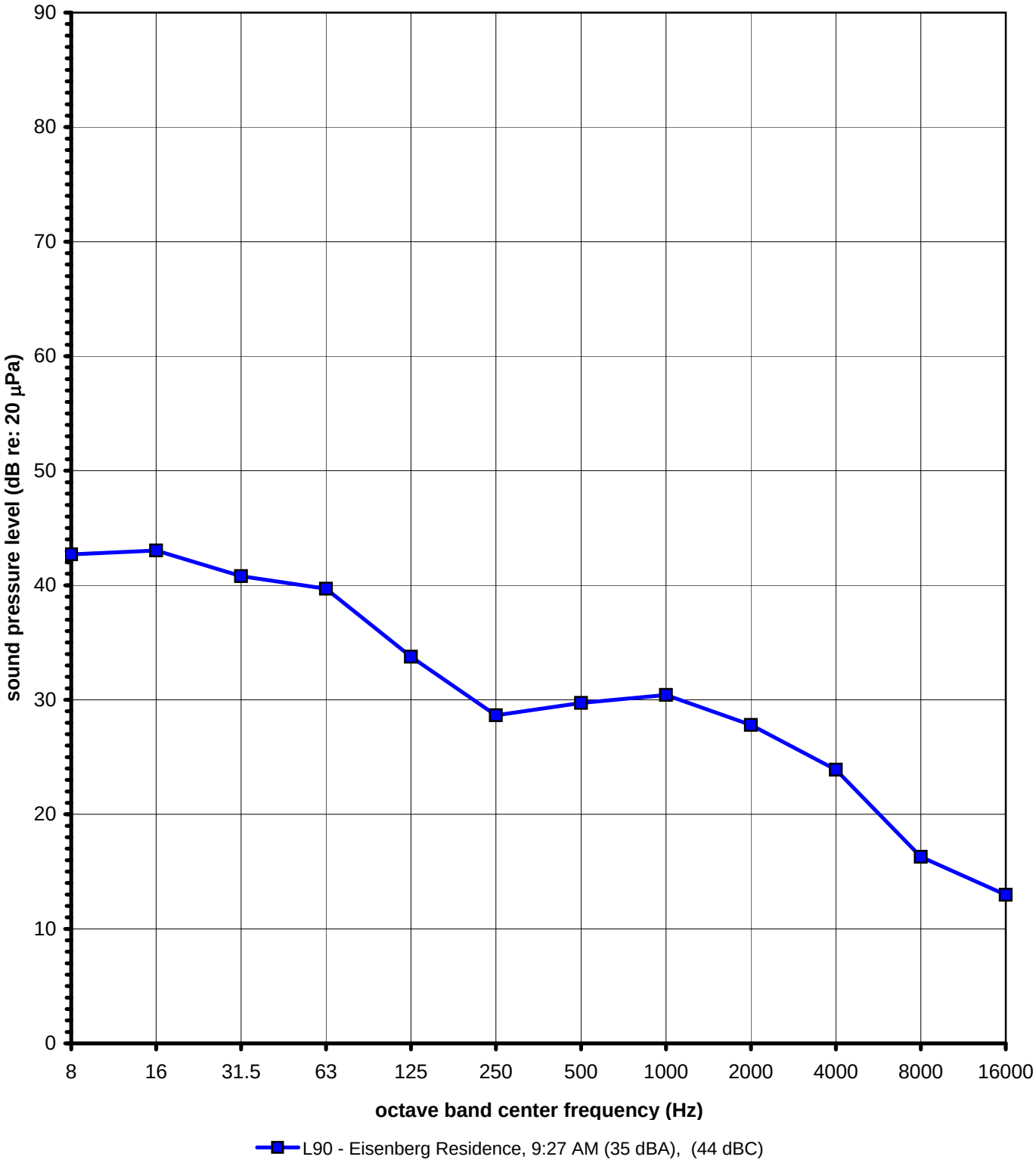
Eisenberg Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



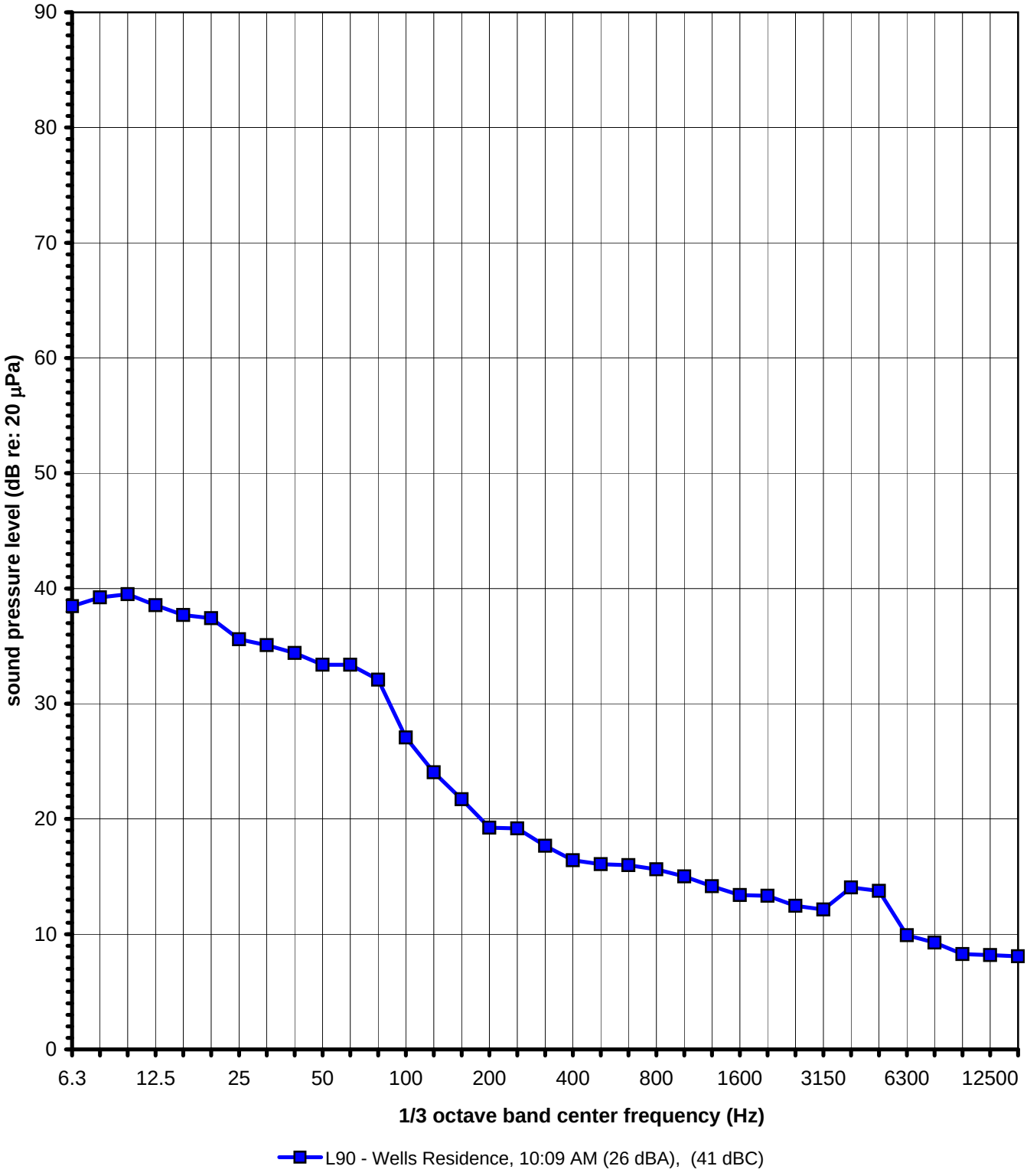
Eisenberg Residence - Octave Band Sound Levels

Monday, October 4, 2010



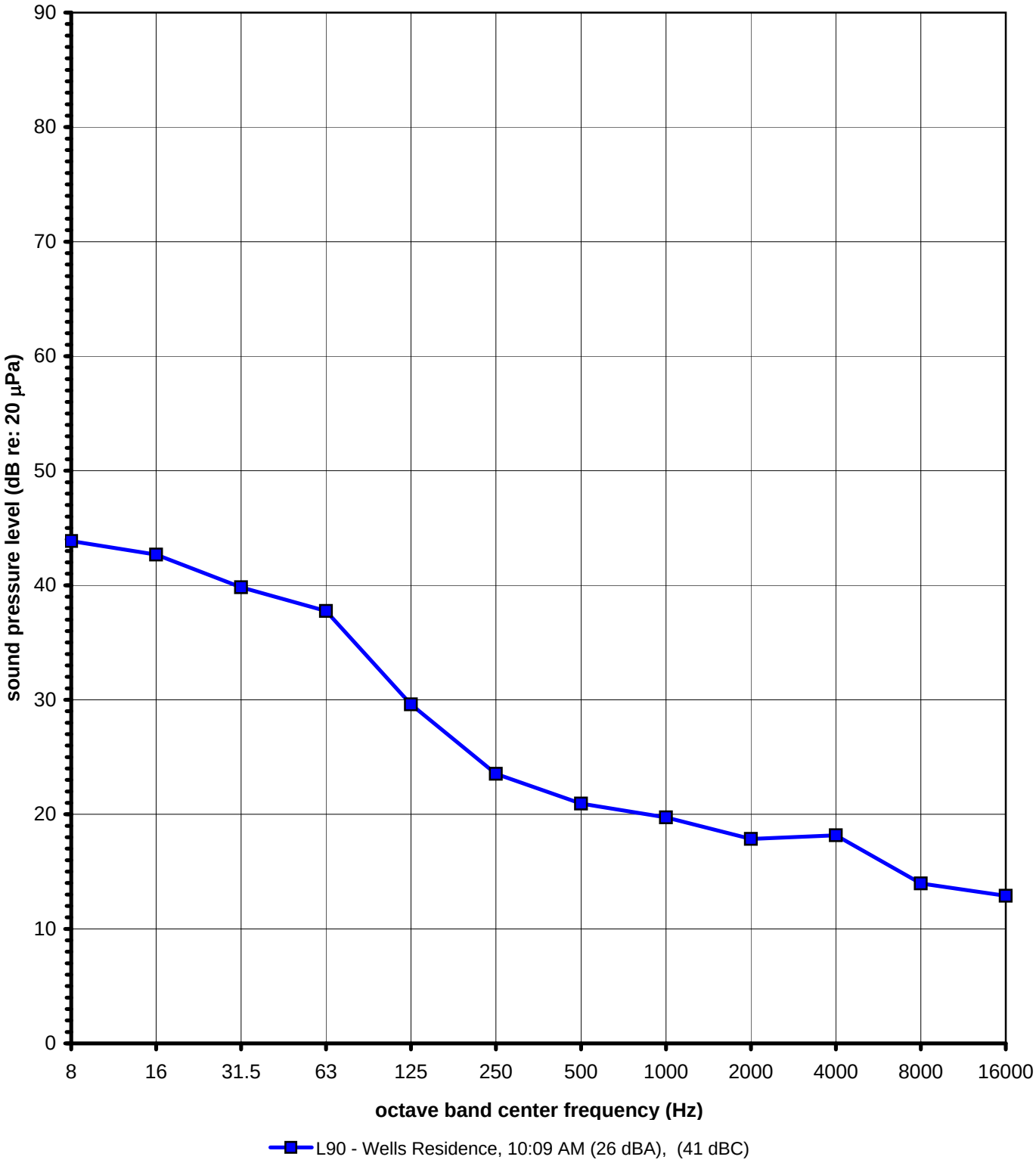
Wells Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



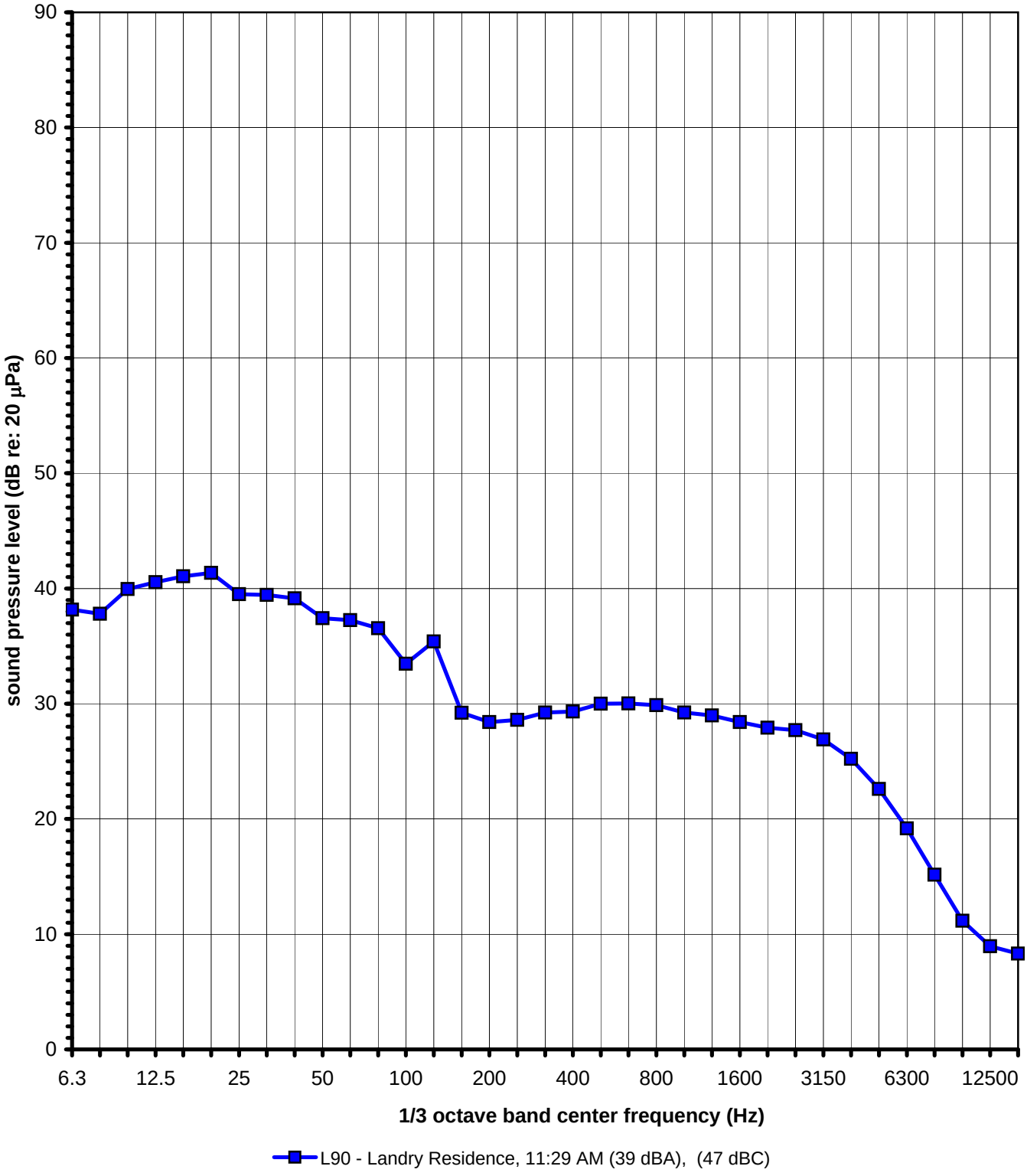
Wells Residence - Octave Band Sound Levels

Monday, October 4, 2010



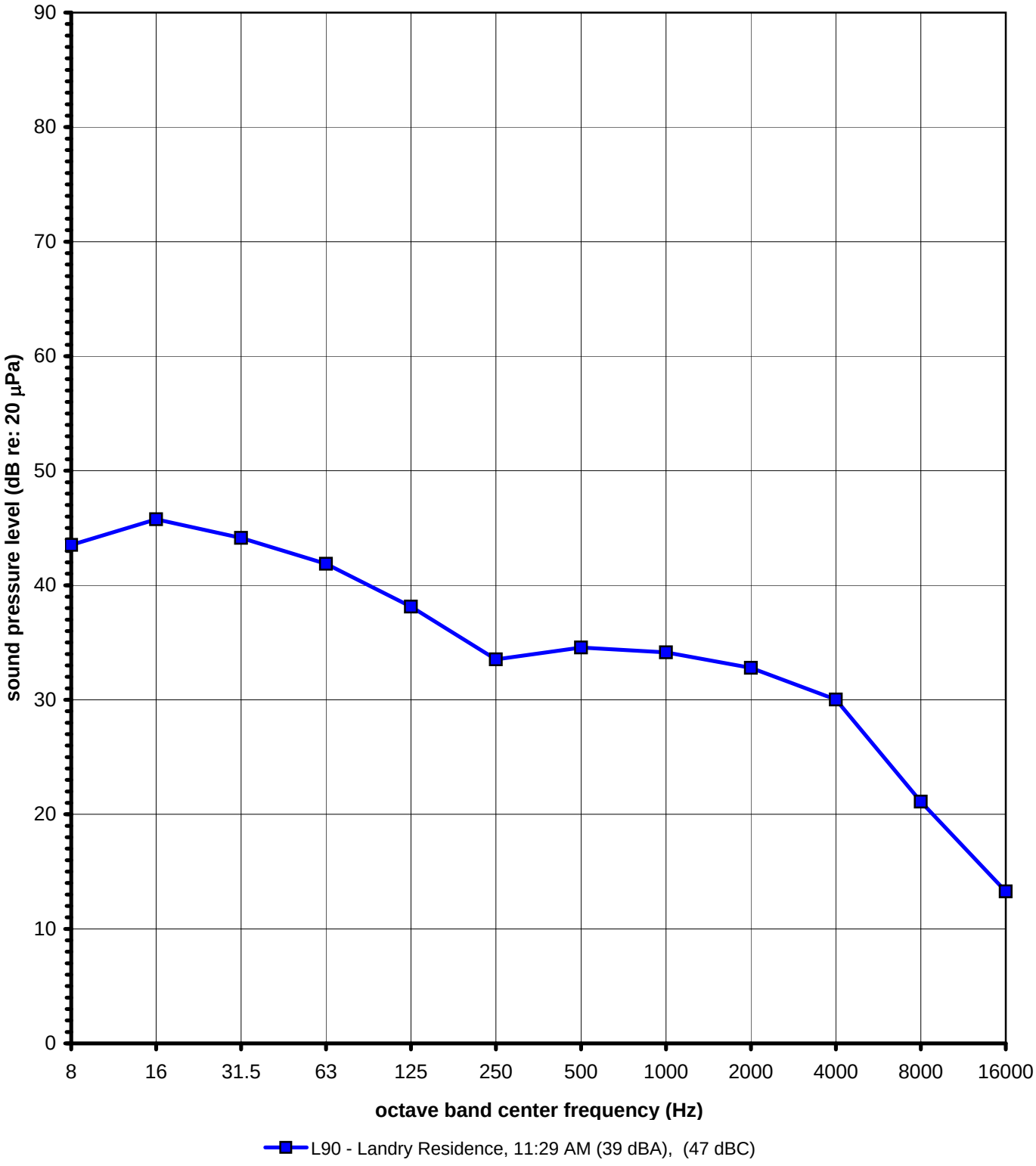
Landry Residence - One Third Octave Band Sound Levels

Monday, October 4, 2010



Landry Residence - Octave Band Sound Levels

Monday, October 4, 2010



Garvin Residence - One Third Octave Band Sound Levels

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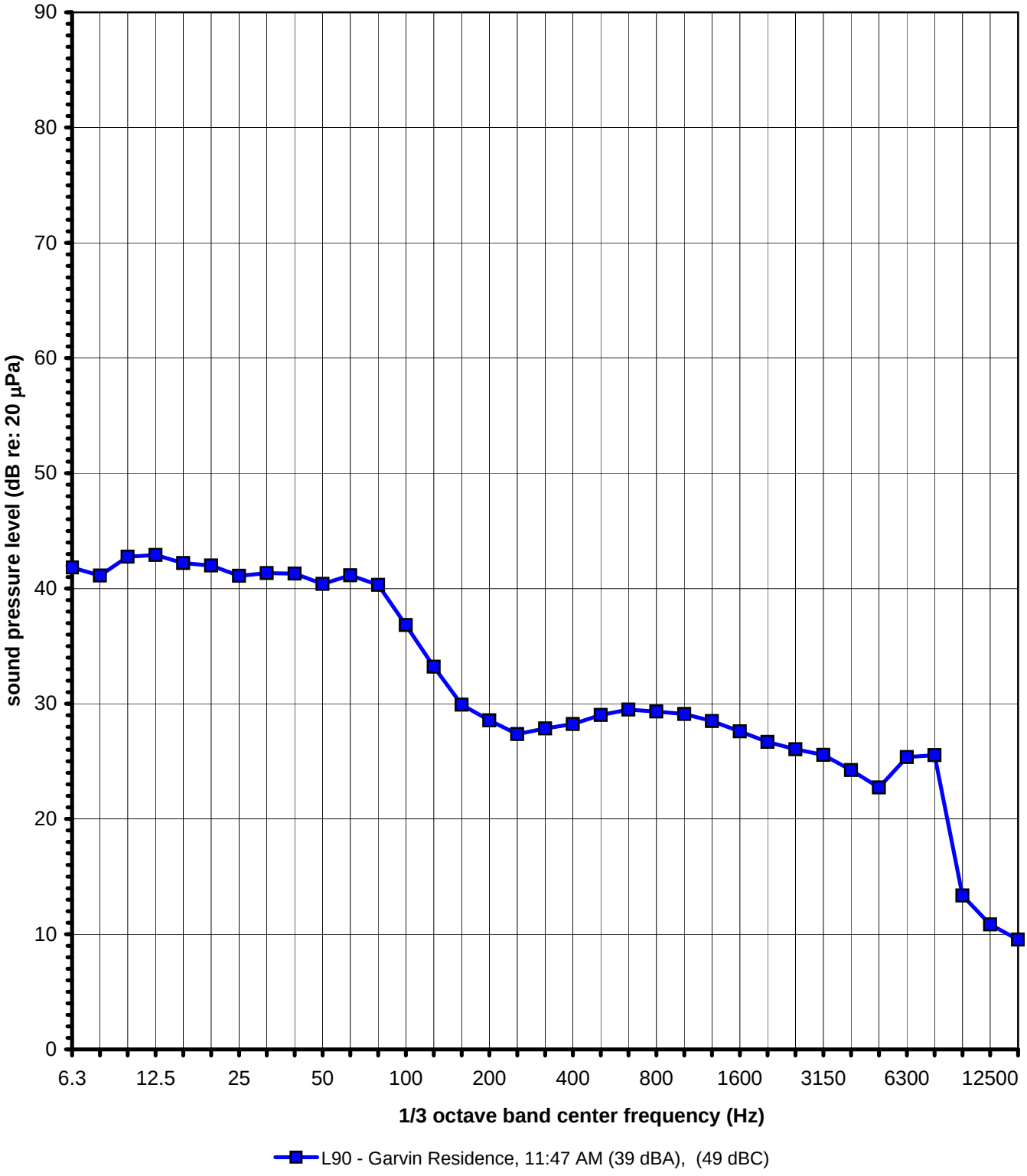

Garvin Residence - Octave Band Sound Levels

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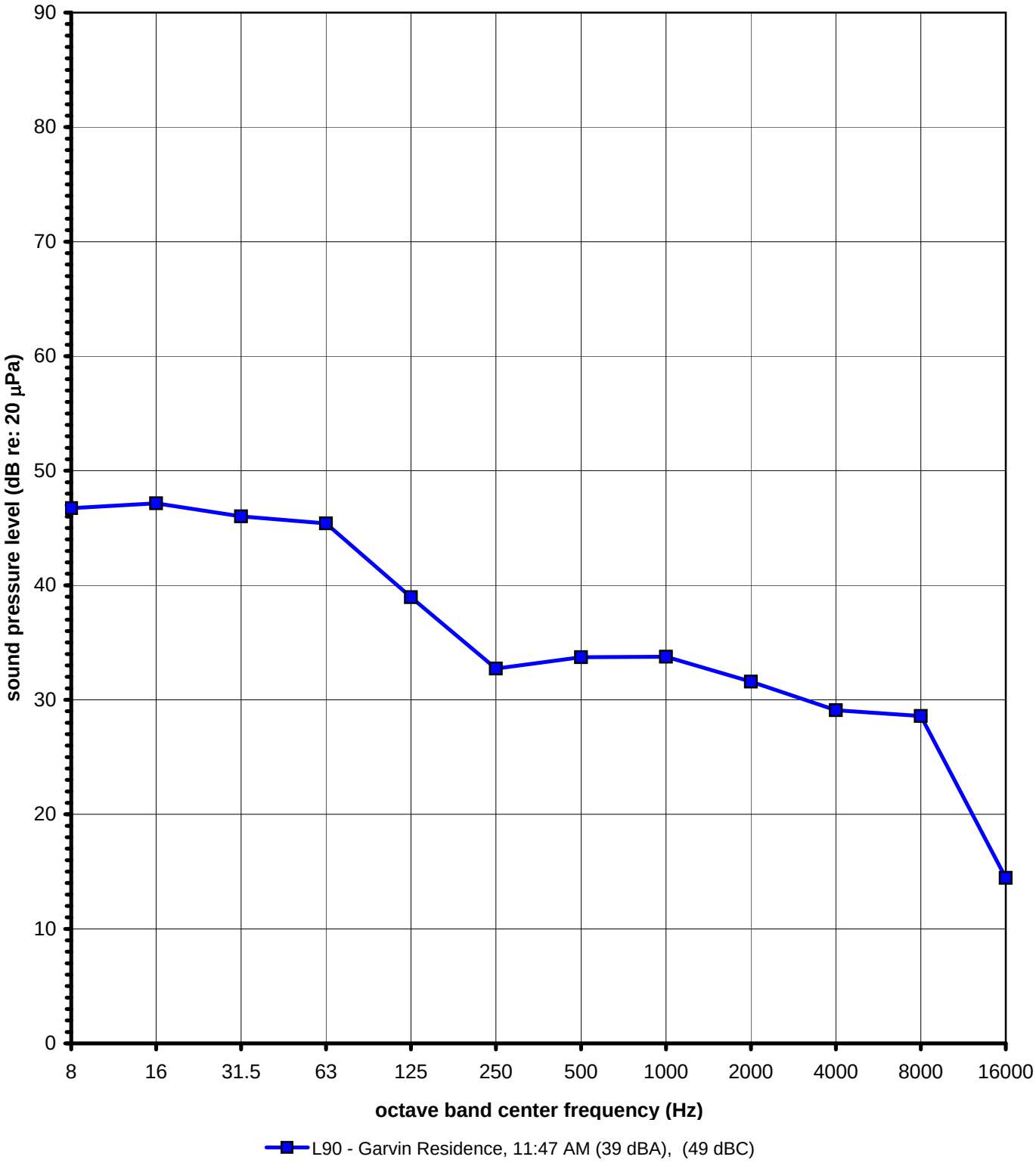

Dodson Residence - One Third Octave Band Sound Levels

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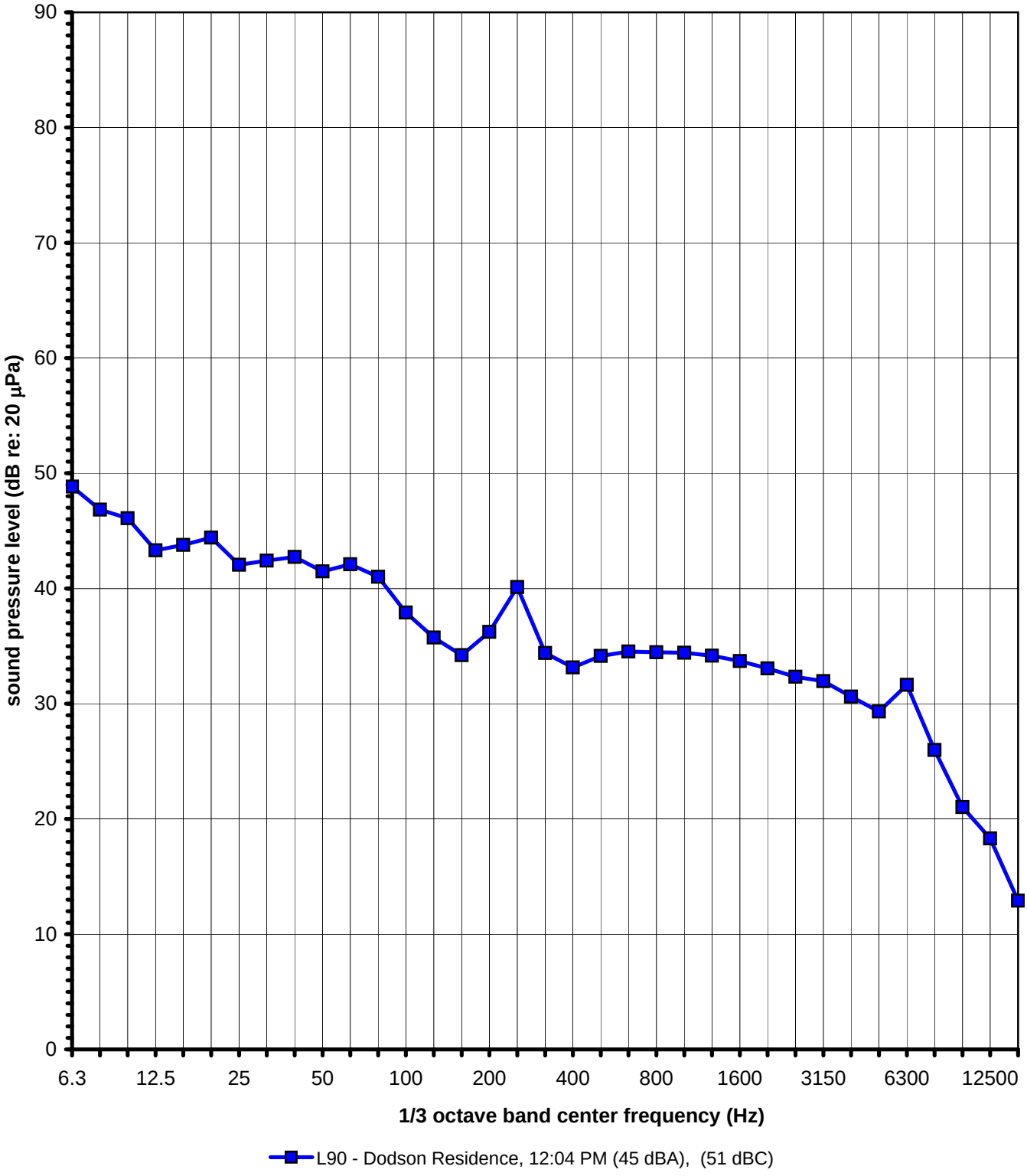

Dodson Residence - Octave Band Sound Levels

Monday, October 4, 2010