

# **Eliminating Acoustical Barriers to Learning in Classrooms**

## **Case Study**

## **Reverberation Reduction in Elementary School Gymnasiums**

**Bennett M. Brooks, PE**

Brooks Acoustics Corporation

27 Hartford Turnpike, Vernon, CT 06066

1-800-817-5831

[www.brooks-acoustics.com](http://www.brooks-acoustics.com)

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## Paper 3pAA3 -- Abstract

### Eliminating Acoustical Barriers to Learning in Classrooms

#### *Case Study* - Reverberation reduction in elementary school gyms

A gymnasium can be a highly reverberant space. This is a consequence of the large room volume coupled with an abundance of hard surfaces. School designers frequently overlook the need for reverberation control in gymnasiums, cafeterias, and other large school rooms. The high level of reverberation promotes a high noise level and interferes with speech intelligibility, degrading the primary functions of those spaces. Moreover, those rooms are often used for additional functions, such as student assemblies, community meetings and school performances, which will also suffer from excess reverberation. A case study is presented for two elementary school gymnasiums, each with mid-frequency reverberation times of about 5 seconds. Renovation treatments to control reverberation were developed using simple computer models. Significant reductions in reverberation and noise level were achieved. As a result, student manageability was improved, and teacher sanity was restored.

# EXCESS ROOM REVERBERATION

**Major cause of gymnasium acoustical problems**

**What causes excess reverberation?**

**How does room reverberation interact with noise and speech?**

**How does it affect the learning environment?**

## **EXCESS REVERBERATION:**

- **Due to a combination of hard surfaces and large room volume**
  - **Typical features of a gymnasium.**
- **In highly reverberant environments:**
  - **Sound of speech lingers, with one word blending into the next -- making understanding difficult, i.e. reduced intelligibility**
- **Noise from HVAC & children not absorbed**

## **EXCESS REVERBERATION:**

- **High noise and low intelligibility environment**
- **Seriously impedes learning**  
**Students cannot hear teachers**  
**Teachers cannot hear students**
- **Safety hazard since children cannot hear warnings and instructions**
- **High levels may cause pain in some children**

## **Specific Affects of Noise on Learning:**

- Cause of distraction, loss of attention**
- Garbling of perceived speech**
- Cause of listener fatigue**
- Cause of vocal strain**

# **CASE STUDY - TWO ELEMENTARY SCHOOLS**

- **Newly constructed gymnasiums (Plainfield, CT)**
  - **Moosup Elementary School**
  - **Shepard Hill Elementary School**
- **Complaints by teachers about noise**
- **School Superintendent directed that problem be analyzed and corrected.**

## **BAC asked to conduct a study**

- Measured noise levels**
- Measured reverberation times (RT60)**
- Metrics studied:**
  - Reverberation time (RT60)**
  - A-weighted level (dBA)**
  - Speech interference level (SIL)**
  - Balanced noise criteria rating (NCB)**



## Reverberation Time study results

- Moosup worse than Shepard Hill -- *both bad*
- Mid-frequency RT60 very high ~ 5 seconds!!
- High background noise levels
  - NCB 66 at Moosup - HVAC on
  - NCB 53 at Shepard Hill - HVAC on

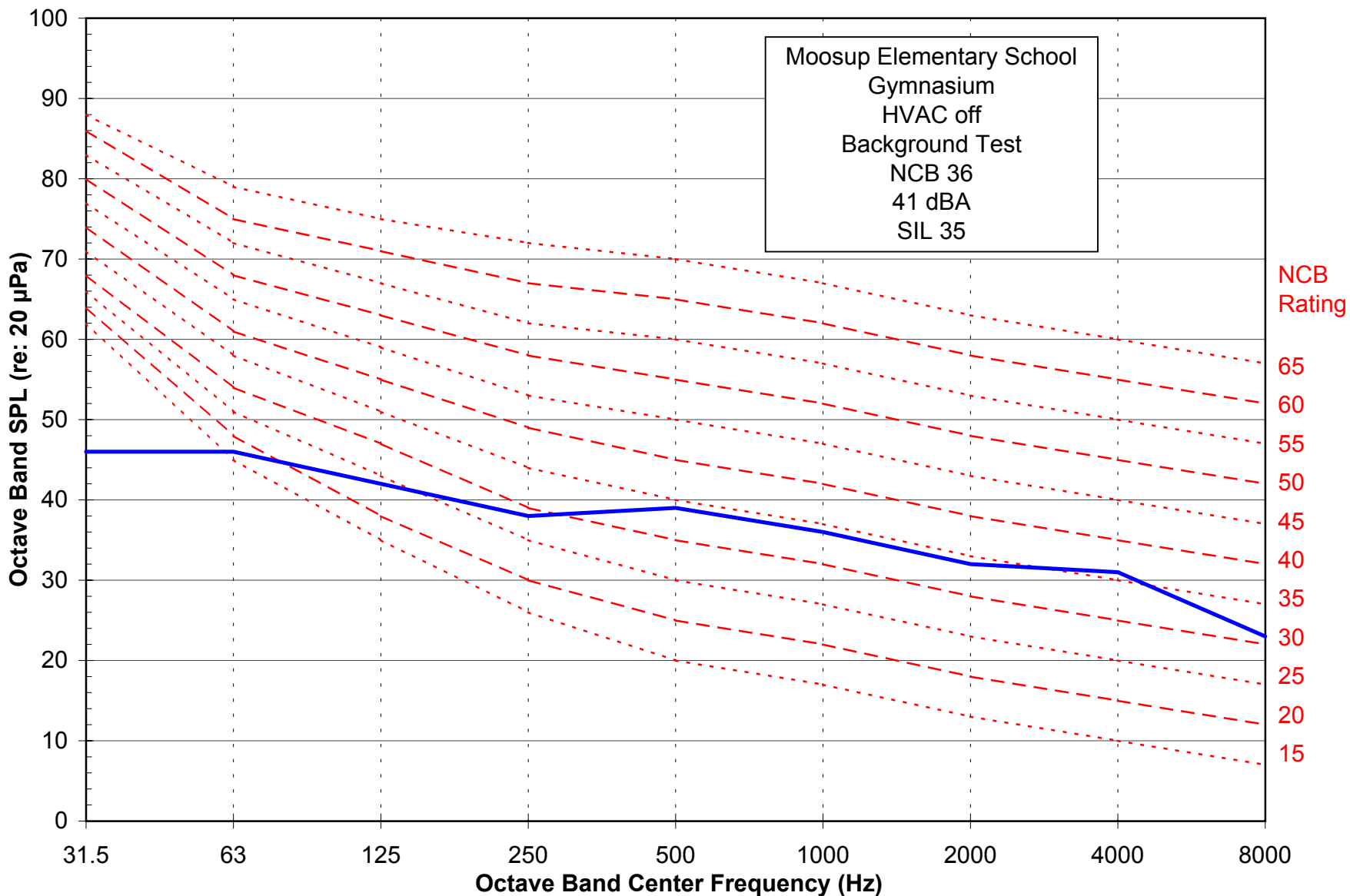
## Design study results

- **Simple computer models of gyms (RT calc)**
- **Based on computer analysis, recommended that 2700 to 3300 sq ft of absorbent material (NRC 0.75 or better) be installed in each gym**
- **Material needs to be durable (basketball tough)**
- **Calculated RT (mid freq) reduced to 1 - 1.5 secs**
- **Calculated noise levels reduced up to 5 dB**

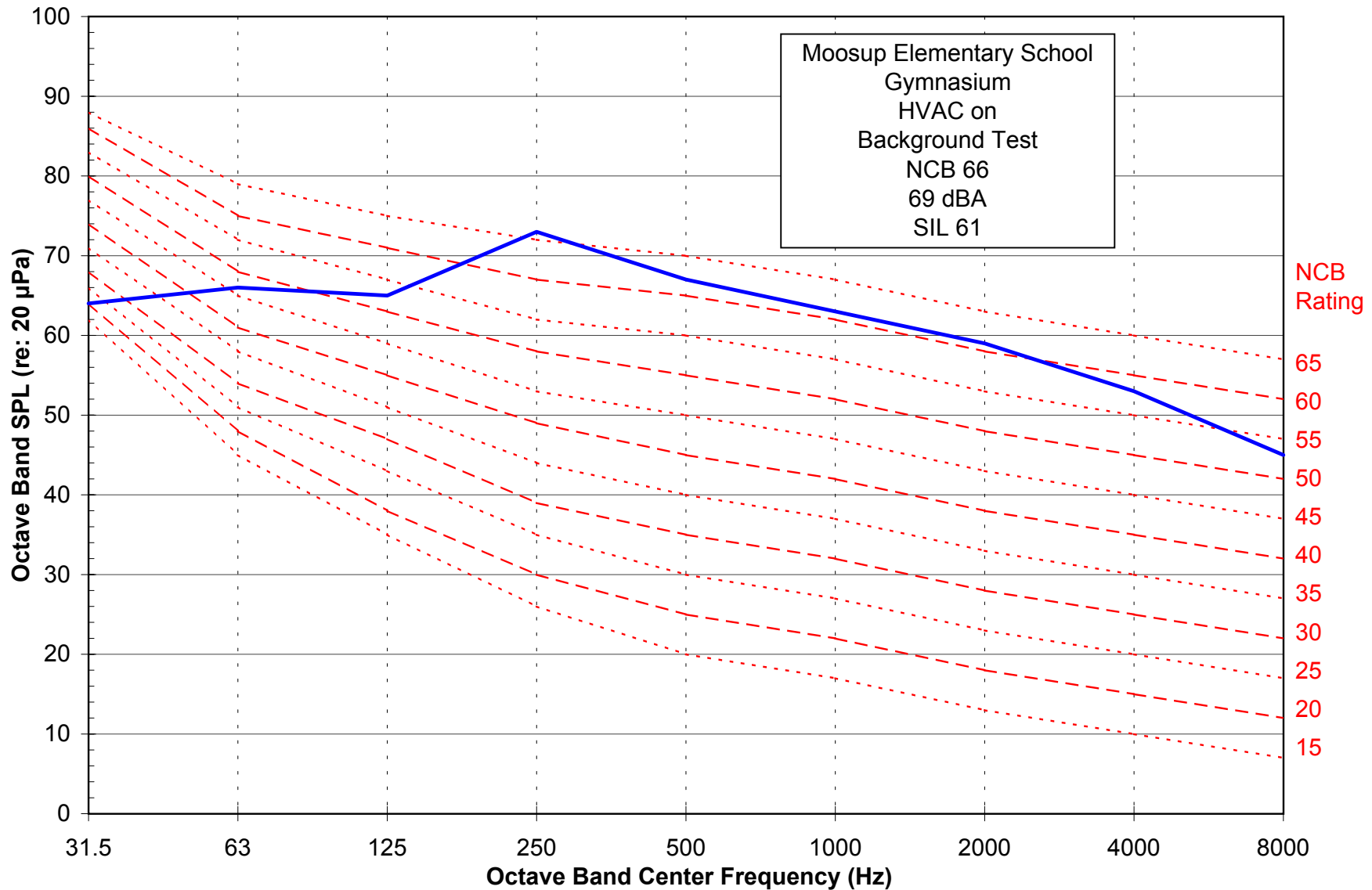
## Conclusions

- **Construction proceeded according to specifications**
- **Completed gyms in service**
- **Teachers report much improved environment**
  - **better communication**
  - **better control of class activities**
  - **less potential for injury**
- **Timely action by school system**  
***improves education !!***

# Measured Room Noise vs. NCB (Balanced Noise Criterion) Curves (ANSI S12.2-1995)

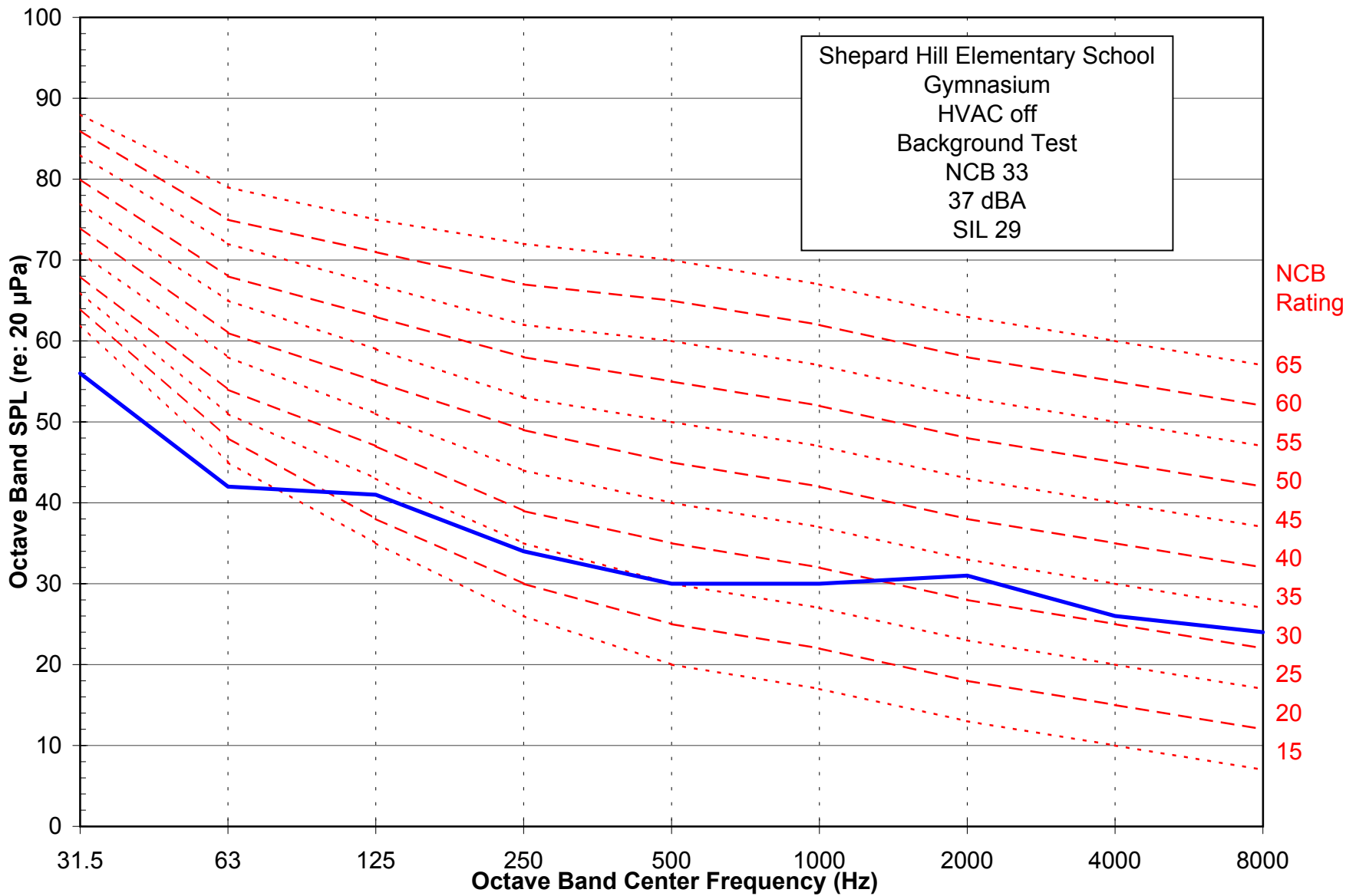


# Measured Room Noise vs. NCB (Balanced Noise Criterion) Curves (ANSI S12.2-1995)



# Measured Room Noise vs. NCB (Balanced Noise Criterion) Curves (ANSI S12.2-1995)

Shepard Hill Elementary School  
Gymnasium  
HVAC off  
Background Test  
NCB 33  
37 dBA  
SIL 29



# Measured Room Noise vs. NCB (Balanced Noise Criterion) Curves (ANSI S12.2-1995)

