

**Enhancing the ecological performance of  
rail transport**  
**- challenges, good examples, further tasks**

**Workshop of Allianz pro Schiene e.V.**

**Berlin, 19<sup>th</sup> September 2006**

**Enhancing the ecological performance of rail transport  
- challenges, good examples, further tasks**

**How to design a low-noise locomotive?  
Concept and noise emissions of the  
locomotive Eurorunner 20**

**Ingo Anhorn  
Siemens Transportation Systems  
Erlangen (Germany)**

## Structure

- Introduction
- Acoustic management
- Noise avoiding measures and elements
- Measured noise levels
- Costs

# Siemens Transportation Systems



Electrification



Rail Automation



Turnkey Systems



Locomotives



Mass Transit



Trains



Trains



Integrated Services



Europrinter ES64U4

## Locomotives division

- Electric locomotives
- Diesel locomotives



Eurorunner ER20

## Eurorunner 20

- Part of diesel locomotive platform Eurorunner (1800 kW – 3000 kW)
- Passenger and freight traffic
- Main focus on fulfillment of strong environmental requirements, i.e. exhaust and noise emission
- Start in 2001 with first customer Austrian Federal Railways (ÖBB)
- Up to now 8 customers !



# Multipurpose Locomotive for Austrian Federal Railways (ÖBB)

**SIEMENS**



## Eurorunner Rh 2016

Wheel arrangement	Bo'Bo'
Diesel power [kW]	2000
Continuous rating [kW]	1500
Starting tractive effort [kN]	235
Maximum speed [km/h]	140
Weight [t]	80
Track gauge [mm]	1435
Units	100

# Multipurpose Locomotives for Private Operators in Austria

**SIEMENS**



Eurorunner ER20	LTE	STLB
Wheel arrangement	Bo'Bo'	
Diesel power [kW]	2000	
Continuous rating [kW]	1500	
Starting tractive effort [kN]	235	
Maximum speed [km/h]	90	
Weight [t]	80.5	
Track gauge [mm]	1435	
Units	1	2

# Multipurpose Locomotives for Private Operators in Germany

**SIEMENS**



<b>Eurorunner ER20</b>	<b>Press</b>	<b>EVV</b>	<b>Connex Verkehr</b>
Wheel arrangement		Bo'Bo'	
Diesel power [kW]		2000	
Continuous rating [kW]		1500	
Starting tractive effort [kN]		235	
Maximum speed [km/h]		90	
Weight [t]		80.5	
Track gauge [mm]		1435	
Units	2	3	3

# Multipurpose Locomotive for Siemens Dispolok GmbH

**SIEMENS**



## Eurorunner ER20

Wheel arrangement	Bo'Bo'
Diesel power [kW]	2000
Continuous rating [kW]	1600
Starting tractive effort [kN]	235
Maximum speed [km/h]	140
Weight [t]	80
Track gauge [mm]	1435
Units	15

# Multipurpose Locomotive for Kowloon Canton Railways Corp., Hong Kong

**SIEMENS**



## Eurorunner Series 8000

Wheel arrangement	Bo'Bo'
Diesel power [kW]	2000
Continuous rating [kW]	1500
Starting tractive effort [kN]	235
Maximum speed [km/h]	90
Weight [t]	80
Track gauge [mm]	1435
Units	5

# Freight Locomotive for Lithuanian Railways

**SIEMENS**



## Eurorunner ER20CF

Wheel arrangement	Co'Co'
Diesel power [kW]	2000
Continuous rating [kW]	1600
Starting tractive effort [kN]	450
Maximum speed [km/h]	120
Weight [t]	138
Track gauge [mm]	1520
Units	34

## Need for Acoustic Management

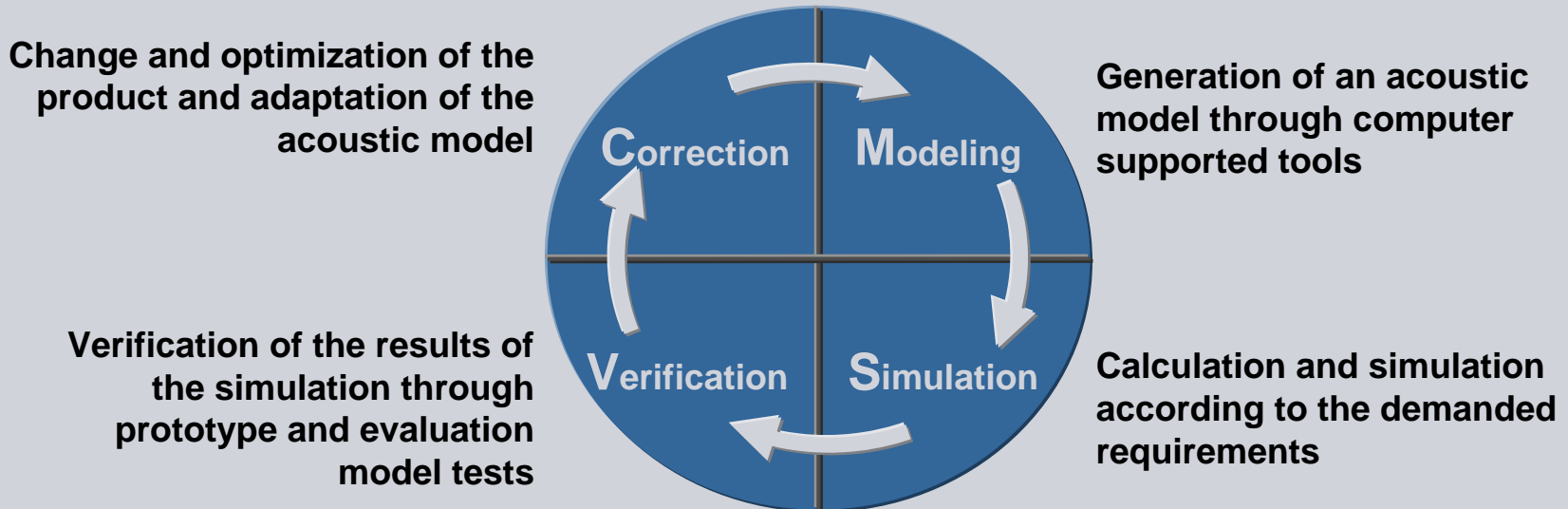
### Noise requirements

- National: e. g. Austrian law „Schienenfahrzeug-Lärmzulässigkeitsverordnung“ (SchLV; 1993)
- Europe: Technical Specification of Interoperability (TSI) -> TSI Noise (23.06.2006)

### Consequence for railway industry

- Development of acoustic-optimized locomotives
- Acoustic management accompanying the development process from the early beginning

# The Core of the Acoustic Management – The Iterative Process of Acoustic Development

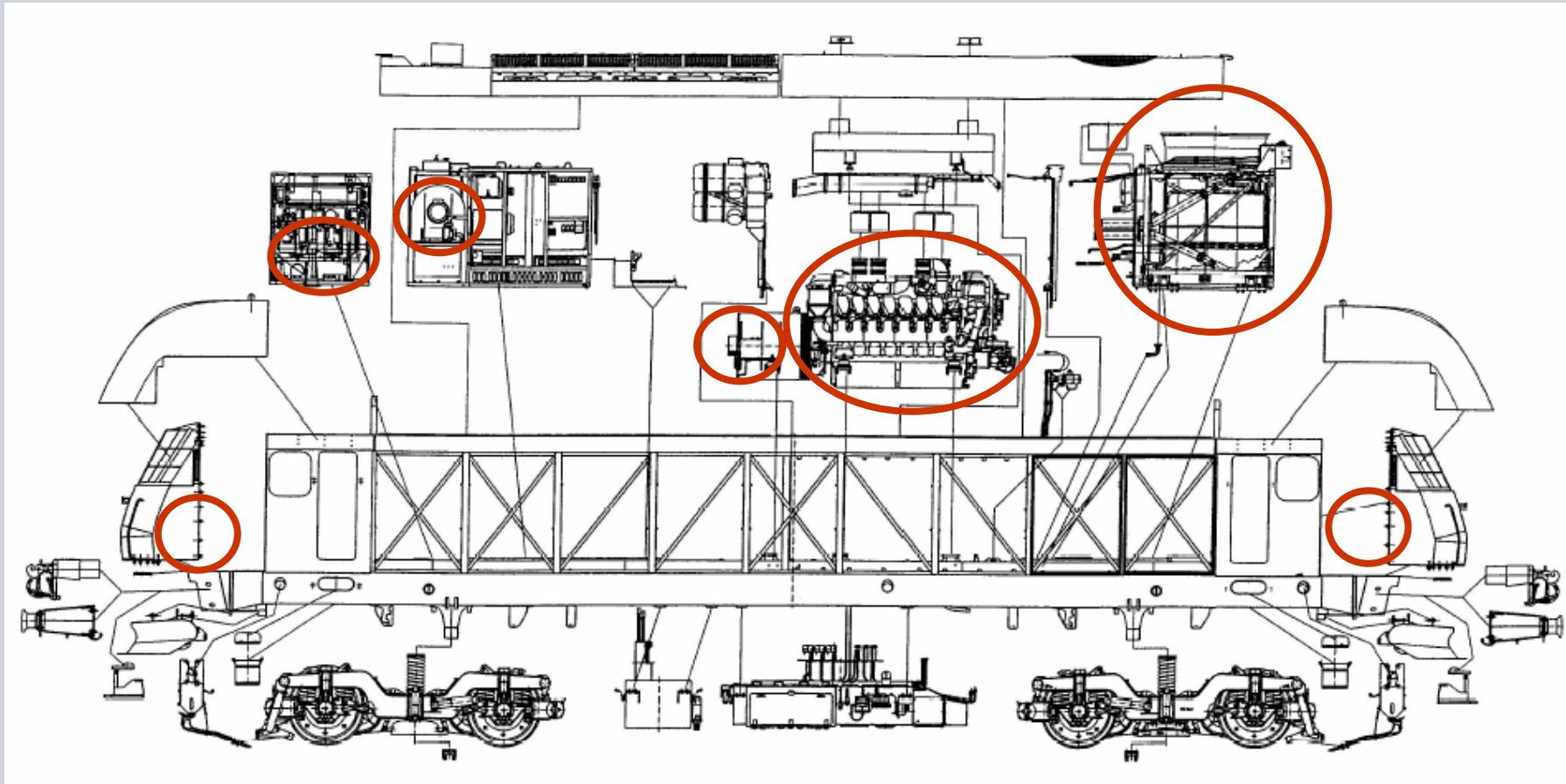


## Advantages

**Quick and easy way to identify effective acoustic measures  
and product properties of the measures**

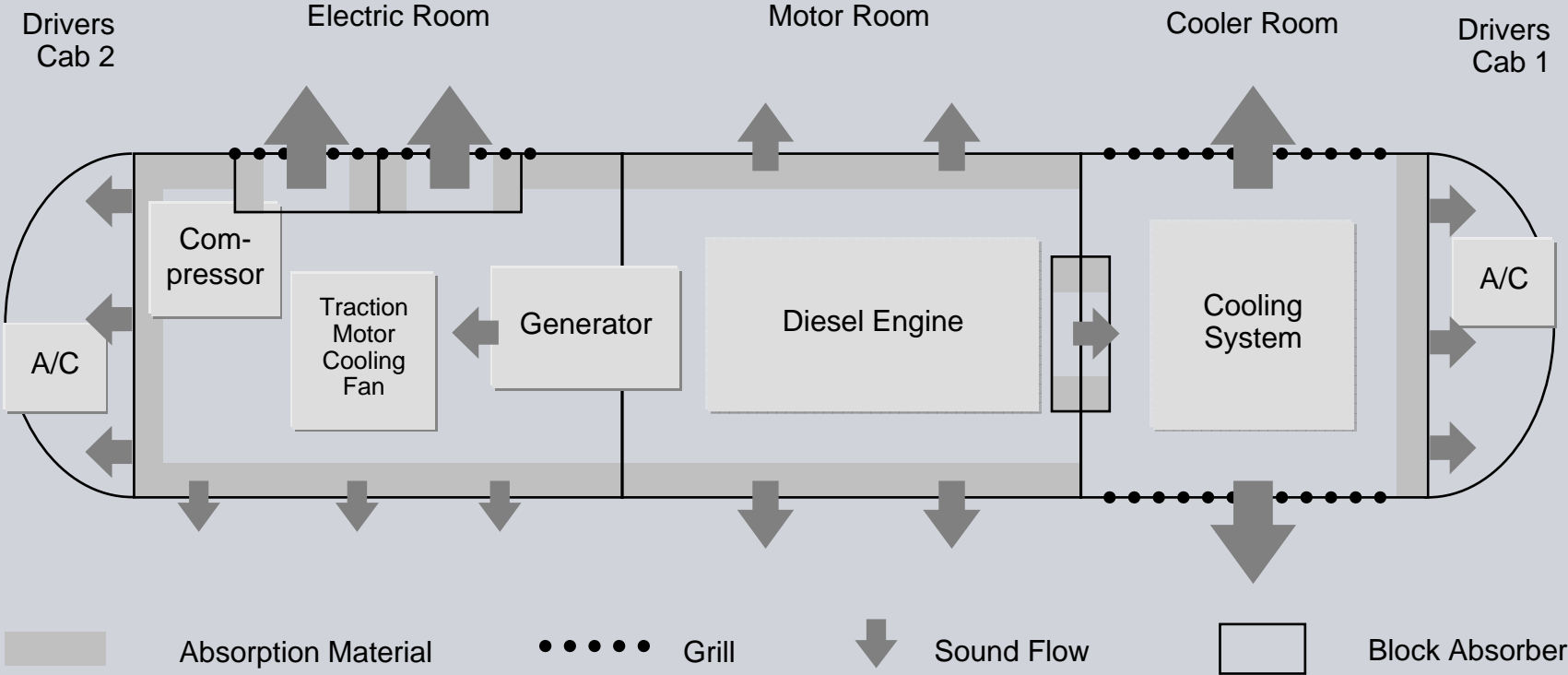
# Acoustic Management Process

Modular concept of Eurorunner platform – **main noise sources**



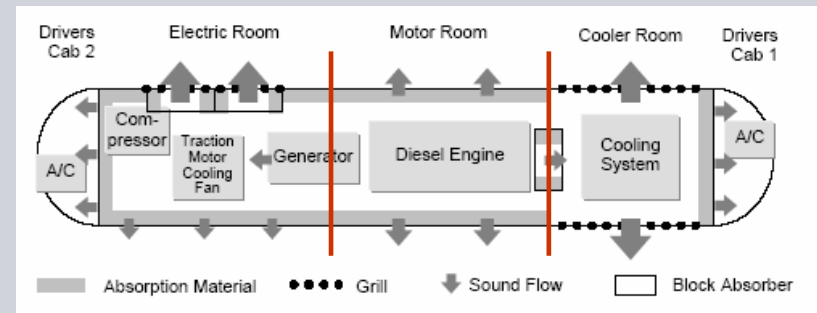
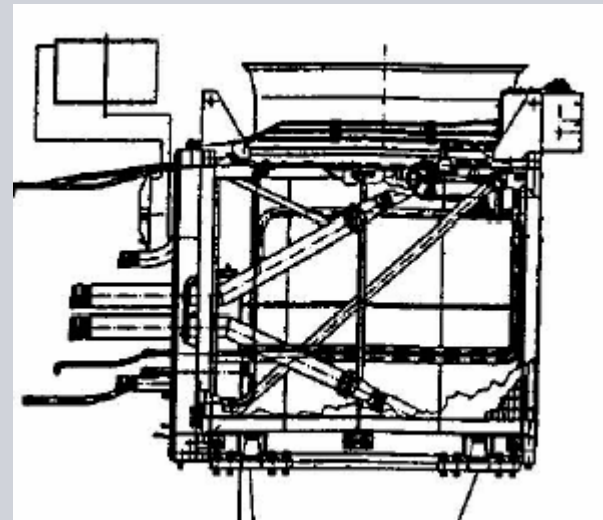
# Acoustic Management Process

Acoustic modeling based on the acoustic sound flow



# Noise Avoiding Measures and Elements

- Reduction of fan speed
- Intelligent fan control system
  
- Division of the machinery room by walls
  - > to block the spreading of the sound



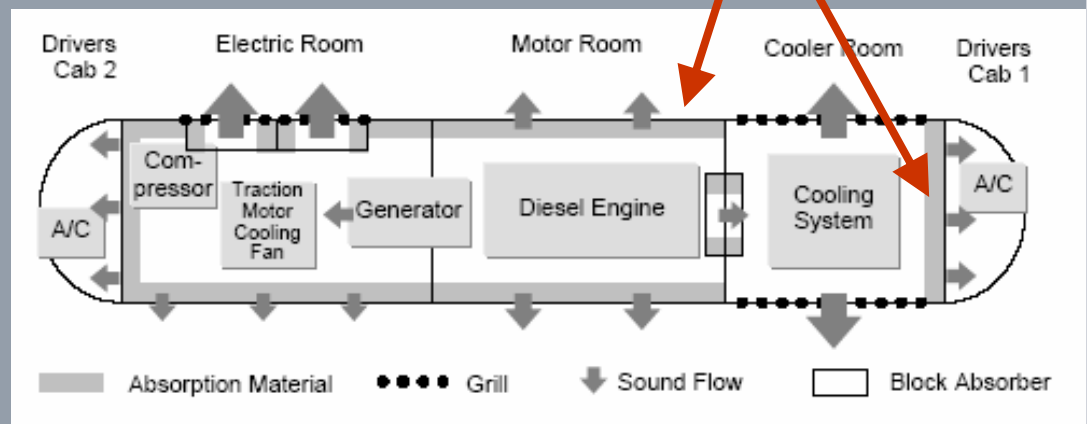
# Noise Avoiding Measures and Elements

- Sound absorption materials  
-> to reduce reverberant sound fields

considering

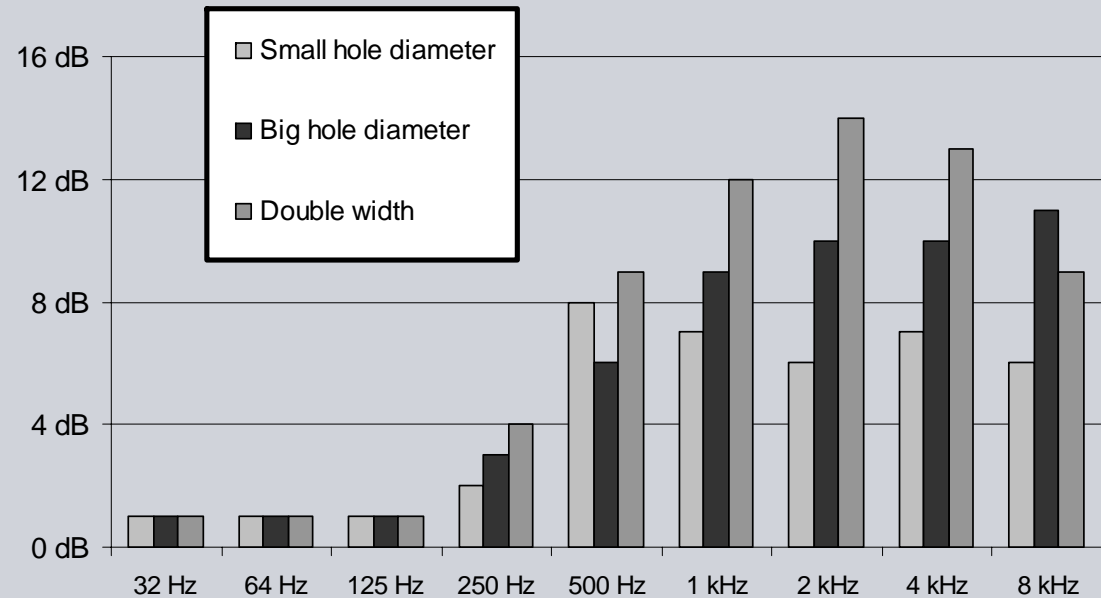
- fire protection,
- resistance against detergents,
- environmental stability.

Absorption material at side walls



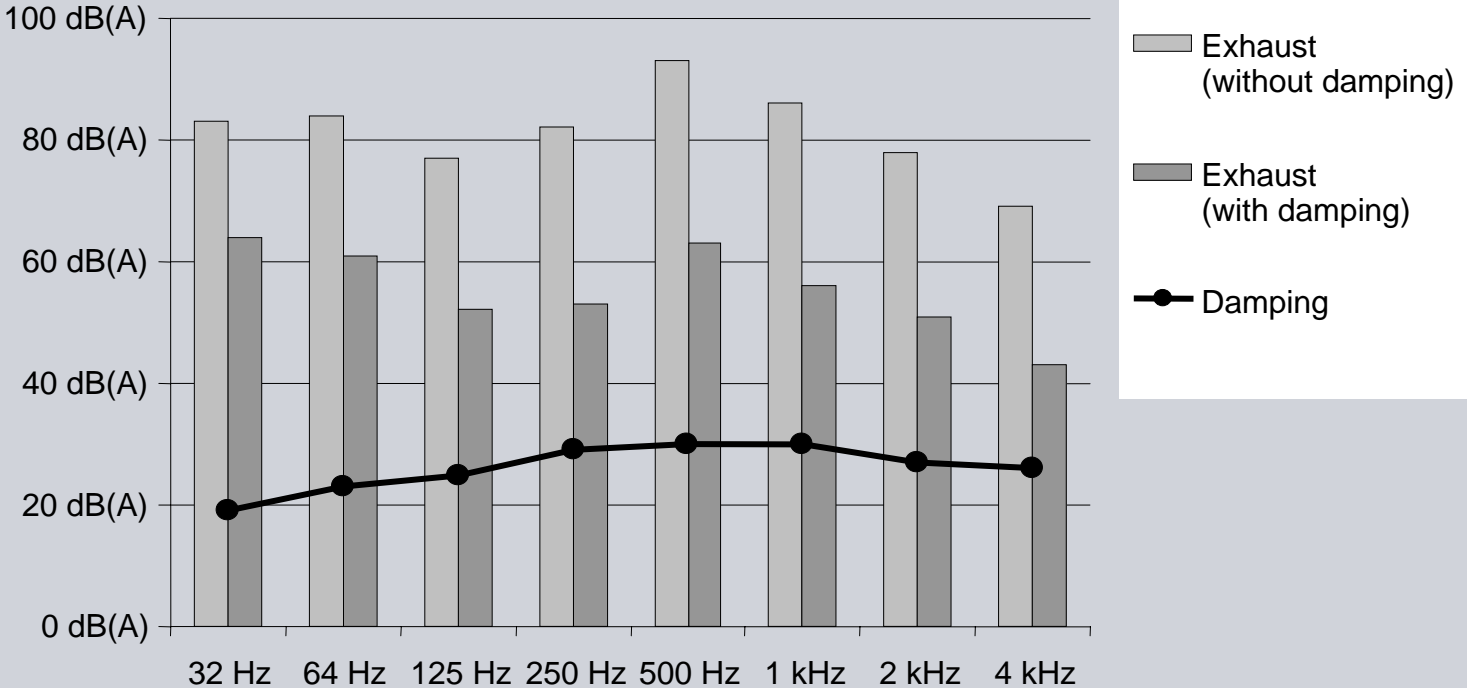
# Noise Avoiding Measures and Elements

- Special block absorbers mounted at the grilles



# Noise Avoiding Measures and Elements

- Modified exhaust sound absorber  
-> Reduction of sound pressure level > 20 dB

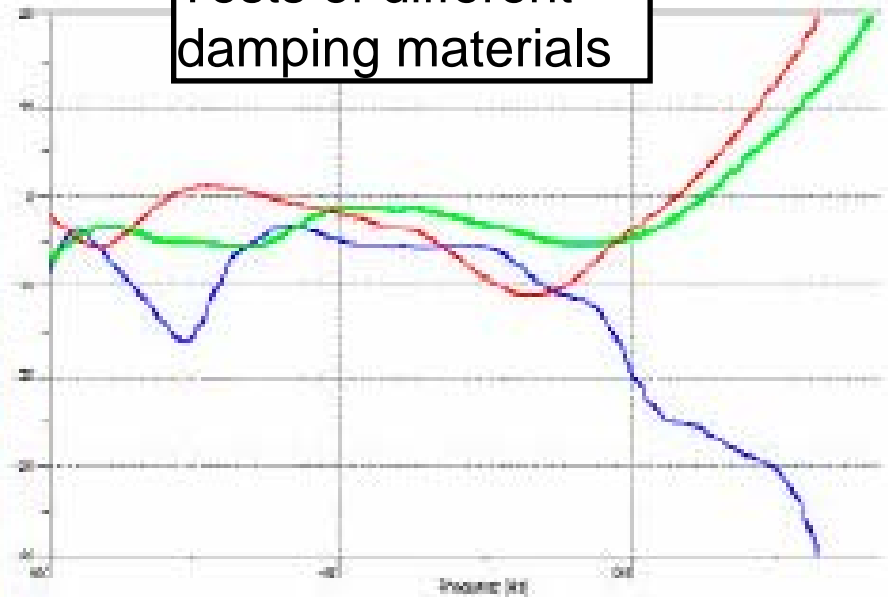


## Noise Avoiding Measures and Elements

- Implementation of damping materials  
-> Reduction of vibration of certain panels



Tests of different damping materials



# Noise Emission Values

Measurement	Conditions	Sound Pressure Level [dB(A)]		
		Measured $L_{pAFmax}$	SchLV Limit ( $L_{pAFmax}$ )	TSI Limit ( $L_{pAeq}$ )
<b>Stationary Noise Inside</b>	Engine with maximum idling; SchLV: Auxiliary equipment with full load and traction motor fan half load; TSI: Auxiliary equipment at normal load	65	66	see below
<b>Stationary Noise Outside (7.5 m)</b>		67	80	75
<b>Stationary Noise Inside</b>	During external acoustical warning with the maximum sound	-	-	95
<b>Pass-by Noise Inside</b>	Max. Speed (140 km/h); power at a level necessary to maintain a constant speed (at normal load)	73	80	78
<b>Pass-by Noise Outside (7.5 m)</b>		89	93	92
<b>Starting Noise</b>	All auxiliary equipment operating at normal load	-	-	$L_{pAFmax}$ 89

-> Very low values  
-> All TSI noise values reachable

$$L_{pAeq,Tp}(80 \text{ km/h}) = L_{pAeq,Tp}(v) - 30 \cdot \log(v/80 \text{ km/h}).$$

## Costs

Additional costs referring to noise reduction measures for

- Additional hardware, e. g.
  - sound absorption material,
  - block absorber.
- Acoustic management

-> Additional costs per loco heavily depending on quantity of locomotives produced

## Conclusion

Because of this consequent acoustic management during the whole developing process and the implementation of various noise reducing measures

- Locomotive Eurorunner20 fulfills the high requirements referring to noise emissions
  - > Extremely environmental-friendly
  - > Successfully in operation for some years
  - > Substantial contribution to the reduction of annoyance due to noise for the population

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