

Appendix – 3.4

FLS Noise Engineering Methods

Noise

Engineering method

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1. Noise emission data

Assessment of noise emission from FLSmidth equipment is based on statistical data collected on multiple cement plants.

These noise levels are measured under normal operation of the equipment as a part of the process, and not as a separate measurement of a single machine. The estimated noise level for each machine (see chapter 9) is derived from this huge database of noise measurements (in compliance with EN ISO 11202 and EN ISO 11204).

2. Noise emission to surroundings, external noise.

FLSmidth follows the development in local requirements, for instance of noise levels measured at the fence to the neighbours.

In case of local noise limits, and FLSmidth is only supplying equipment, FLSmidth will work out a noise estimate and propose means of noise reduction if needed, such as buildings, enclosure of fans etc.

3. Noise emission close to the equipment, internal noise.

FLSmidth comply with the requirements of the "EU machinery directive 2006/42" and directive 2003/10/EC ("Noise directive"), which means:

- Provide information on all equipment with noise level above 70 dBA.
- Reduce risks from noise to the lowest level taking account of the technical possibilities.
- Eliminate unnecessary noise.
- Inform / Warn of noise levels at or above lower and higher exposure action values (80/85 dBA) ref. directive 2003/10/EC.

FLSmidth will produce a Noise Assessment for supply within EU and on special request.

FLSmidth will supply safety signs for areas with noise levels above 85 dBA (as a part of the safety sign package).

FLSmidth will supply a list of expected noise levels of the equipment.

4. Standards

FLSmidth uses the following standards as basis for measurements and calculations of noise levels.

- EN ISO 3744, determination of sound power levels using sound pressure, engineering method
- EN ISO 3746, determination of sound power levels using sound pressure, survey method
- EN ISO 4871, Declaration and verification of noise emission values of machinery and equipment.
- EN ISO 11201, Measurement of emission sound pressure levels at a work station and at other specified positions, engineering method
- EN ISO 11202, Measurement of emission sound pressure levels at a work station and at other specified positions, survey method in situ.
- EN ISO 11203, Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level.
- EN ISO 11204, Measurement of emission sound pressure levels at a work station and at other specified positions, method requiring environmental corrections.

Reference by FLSmidth to any International Standard does not incur an obligation on FLSmidth to provide any recipient, reader or user of the documentation with samples or copies of the said standard(s).

5. Internal noise from machinery in working areas

Maximum noise levels are often referred to as:

- 1 Noise emission values, e.g. measured 1 m from machinery surface, 1.5 m above floor level
- 2 Noise exposure values for the protection of employees

EU legislation requires for example that the manufacturer provides information on noise emission values from machinery, enabling the owner to deal with the exposure action values (that trigger obligations to provide employees with individual hearing protectors / make it mandatory to use them).

The most appropriate way to control noise for the protection of the employees is to keep the noise level as low as possible, and in any case comply with in-house or legislative maximum exposure levels by using preventive measures, see chapter 8. Where this is not feasible, individual hearing protectors must be worn. Machinery emission values cannot be used directly in noise control at the workplace.

In a cement plant there are few fixed work places, but there are various jobs, such as cleaning and maintenance, where workers are temporarily present at certain locations. Most of the big and noisy machinery (crushers, mills, compressors etc.) can be enclosed within buildings, which are not working areas and where employees will have to wear ear protection when entering. In some areas small noise insulated "control rooms" can be established to protect the operators.

As mentioned above, the exposure limit value normally applies as an average during a working day (7-8 hours), where the personnel will be exposed differently in various areas of the plant.

Based on an exposure limit of 85 dBA (8 hours) the following exposures entail the same risk of hearing damage:

- 85 dBA for 8 hours
- 88 dBA for 4 hours
- 91 dBA for 2 hours
- 94 dBA for 1 hour

6. External noise from cement plants

External noise levels can be difficult to predict, as they result from the total number and location of all noise sources.

The enclosed diagram for external noise (based on measurements), may give an idea of the noise level at a certain distance from the kiln axis.

The two examples in the diagram are based on A) a plant with open or semi open buildings and no noise reduction, and B) a modern plant with enclosed buildings and silencers on all fans. Closed buildings will generally lead to reduced noise levels of 10 to 20 dB.

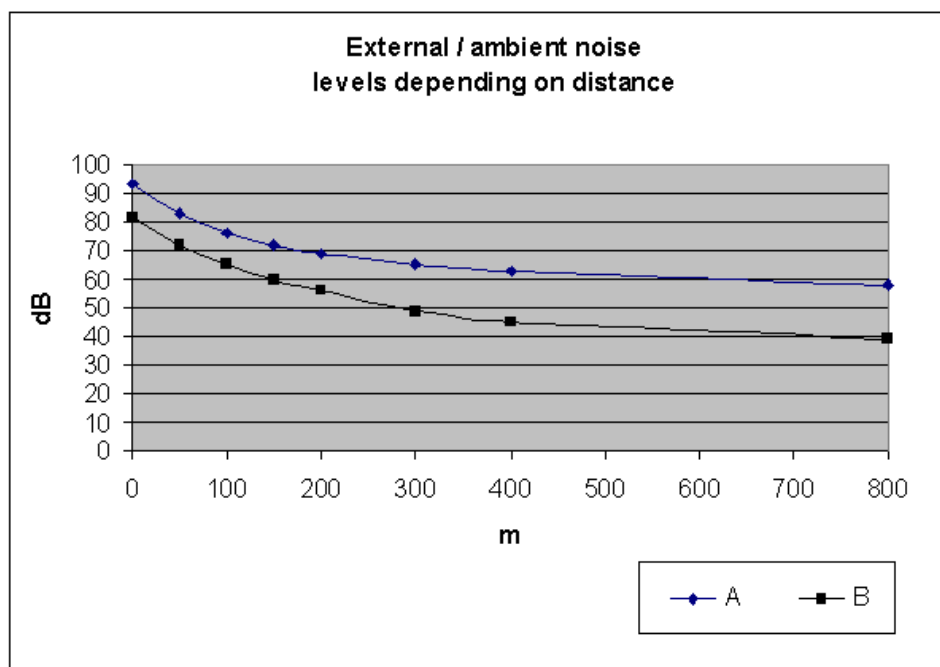
The noise reduction of a given building structure is based on the weight per m² and on how open or enclosed the total structure is.

Light building structures (partly open) as e.g. steel cladding, will produce approx. 8-12 dB noise reduction, lowest at low frequencies.

Medium weight structures (enclosed construction) as sandwich panels, with insulation core and steel plate on both sides, will produce 10-15 dB noise reduction

Heavy building structures (enclosed construction) as e.g. brick walls or concrete will produce approx. 20-30 dB noise reduction.

The internal noise level will rise up to 3-9 dB with hard surrounding walls. Noise absorbing materials (mineral wool) on the walls can reduce this noise created by the reflections.



A: Cement plant without noise reduction, open buildings

B: Cement plant with noise reduction, closed buildings

7. Noise levels and prevention

All rotary blowers as well as compressors are delivered with noise reduction hoods.

All fans with free suction or exhaust are delivered with silencers (baffle type)

Axial blowers, if any, for kiln shell cooling and heat exchanger are however without silencers.

Chapter 9 contains a complete list on estimated noise emissions from all single FLSmidth machines with noise levels above 70 dB, including methods of noise reduction.

Please note that the noise levels given are indicative (but estimated on the high side!) for the machine type indicated, as it might vary with size and production capacity and speed.

The noise level at the plant boundary line will vary, depending on the distance from the kiln, mills and crushers and on the degree of enclosure for each building. See enclosed diagram in chapter 6 for the relations between noise level and distance from the plant.

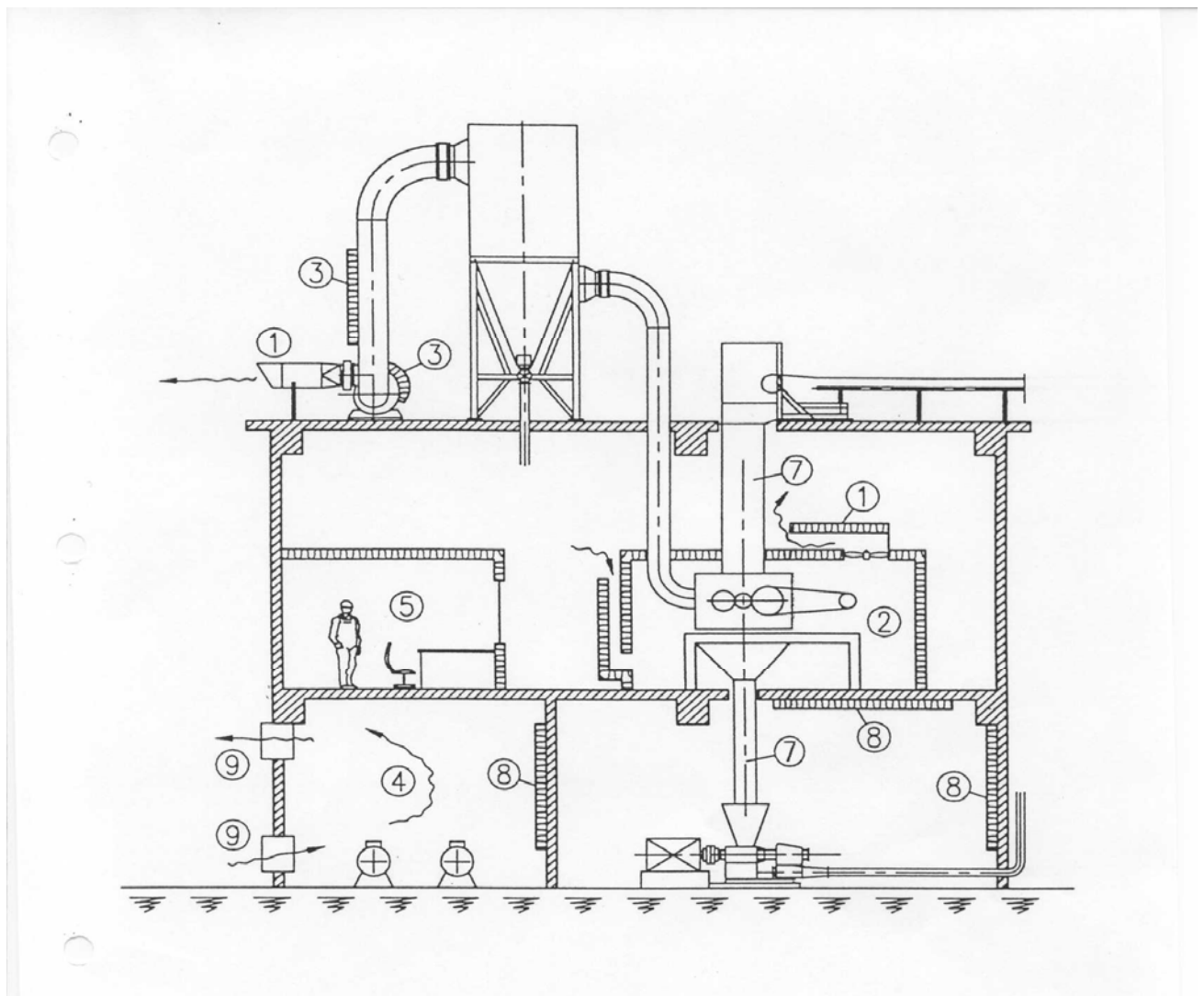
The figures in chapter 9 are only valid for new equipment and do not cover any other existing simultaneously operating equipment.

Chapter 10 lists estimated noise levels in different plant departments where hearing protection is needed.

8. Noise reduction methods

Possible noise reduction methods:

1. Silencer on inlet and/or outlet
2. Noise enclosure
3. Noise insulation
4. Machinery in separate rooms (Not working areas)
5. Operators to be in noise proof rooms
6. Change arrangement of machinery
7. Wear parts on inside of steel chutes or bins
8. Noise absorbing material on building walls or ceilings
9. Silencers in walls for cooling air inlet/outlet



9. Noise levels for machinery in cement plants

Survey over maximum measured noise levels, measured approx. 1 m from machinery surface

The noise levels given in the following list are average maximum levels, as FLSmidth can expect them to be on most plants under normal operation. All special or abnormal noise measurements have been screened out from this list.

Max. noise levels Machinery/Equipment	Possible noise reduction method, ref. chapter 8	FLSmidth Standard, ref. chapter 8
Above 100 dBA		
Air blasters (peak when blowing)		
Axial fans for cooling of kiln shell	1, 6	
UMS ball mill for cement	4, 8	
TIRAX ball mill for coal	4, 8	
Chute (un-insulated) for limestone	6, 7, 3	
Crusher for limestone	4, 5	
Drag chain for dust	3, 6, 7	
UNAX planetary clinker cooler		
Special chute below CHO circular storage		
95-100 dBA		
UMS ball mill for cement, fine grinding after pre-grinder	4, 8	
Central vacuum cleaning unit	4	4
Chutes for gypsum (un-insulated)	6, 7, (3)	
Crusher for gypsum	4, 5, (8)	
Crusher for shale	4, 5, (8)	
DOSIMAT, outlet chute for hard materials	7, 3	
Material inlet to ATOX raw mill, below sluice	3	
Roller press drive station	4, (2)	
SYMETRO gear and motor	4	
Vibrating conveyor for ATOX raw mill recirculation		
90-95 dBA		
Burners platform (pilot burner)		
Cement cooler drive	(2)	
Fans for grate cooler in closed ducting	3	
Fans for grate cooler, with silencer	1, (3)	1
Fans for primary air to kiln firing, with silencer (single stage)	1, 2, 3, 4	1, 4
Hammer mill dryer ET	4, 8, 9	4
ID-fan		
Insertable filters, excl. silencer on fan		
Large fans, HAF type	2, 3	
Fan MT-SS for SEPAX separator		

Max. noise levels Machinery/Equipment	Possible noise reduction method ref. chapter 8	FLSmidth standard ref. chapter 8
Hammer crusher for clinker from grate cooler		
Large fans, non FLSmidth	2, 3	
Fan SPW for cement mill filter		
Pfister feeders		
Vertical mill, raw mill ATOX	4	
Vibrating feeder for limestone	3, 7	
Water cooling unit for cooling water		
Water pumps for cooling water (several in operation)	4, 8	
85-90 dBA		
Air to air heat exchanger		
Axial fans for heat exchanger	(2)	
Bulk loaders with filter		
Chutes for clinker	3, 6, 7	
Chutes for coal	3, 6, 7	
Compressors, enclosed (screw type)	1, 2, 4, 8	1, 2, 4
Drag chain for electrostatic precipitator, insulated		
Fans for secondary bag filter, with silencer on exhaust air	1	1
Fans for kiln seals	1	1
Fan, primary air (2-stage)		
Kiln drive station, mechanical	2	
Roller press, excl. motor and gear	4	
Rotary blowers, enclosed	1, 2, 4, 8, 9	1, 2, 4
Screw pump	2, 4	
Separator drive		
Stacker and reclaimer		
Vertical mill, coal mill ATOX	4, 8	
Vertical cement mill OK		
Vibrating screens		
80-85 dBA		
FLUXO slide along the lines		
Belt conveyor along the line		
Belt conveyor drive, excl. material		
Booster fan MT for hot gas to coal mill		
Bucket elevator, top and bottom, kiln feed	3	
Chimney top (for kiln process gas)		
Fans for FLUXO slide, with inlet filter	1	
Hydraulic pump unit for ATOX raw mill	4, 8	4
Hydraulic room for ATOX coal mill		
Large FLSmidth fans, MT type – for ESP	2, 3	
Packing machines	8	
Screw conveyors	2, 4	

Max. noise levels Machinery/Equipment	Possible noise reduction method ref. chapter 8	FLSmidth standard ref. chapter 8
70-80 dBA		
Pan conveyor for clinker (Aumund)		
Chain feeders		
Screw conveyors for coal		
Kiln shell cooling "Nozzles" for separate fan		

10. Ear protection areas

<i>Plant Department</i>		Noise level
Limestone crushing	In crushing room	100-110 dB
Shale crushing	Hard shale	> 90 dB
Limestone transport	Chute for limestone (large size, 100 mm as used for vertical mills)	> 100 dB
Raw material storage		> 85 dB
Raw mill feeding	Chute after weigh feeder	> 85 dB
Raw mill	Around the mill: - Vertical mill - Tube mill	> 90 dB > 100 dB
Raw meal homogenizing silo	Rotary blower room Silo extraction FLUXO slides	> 100 dB 83-87 dB
Kiln feed	Cyclone preheater tower	< 85 dB
Kiln	Kiln drive Axial cooling fans for kiln shell	> 85 dB > 95 dB
Clinker grate cooler	Primary air fan Cooling air fans Hydraulic room Clinker crusher	> 95 dB > 100 dB > 90 dB > 85 dB
Clinker transport		< 85 dB
Cement mill	Roller press Tube mill	> 85 dB > 100 dB
Cement transport	Mechanical Pneumatic	< 85 dB
Cement silos	Rotary blowers room	> 100 dB
Compressor rooms		> 90 dB
Water treatment	Water pumps	> 90 dB