TNO Innovation for life

Memorandum

To

Bakker Oilfield Supply

From

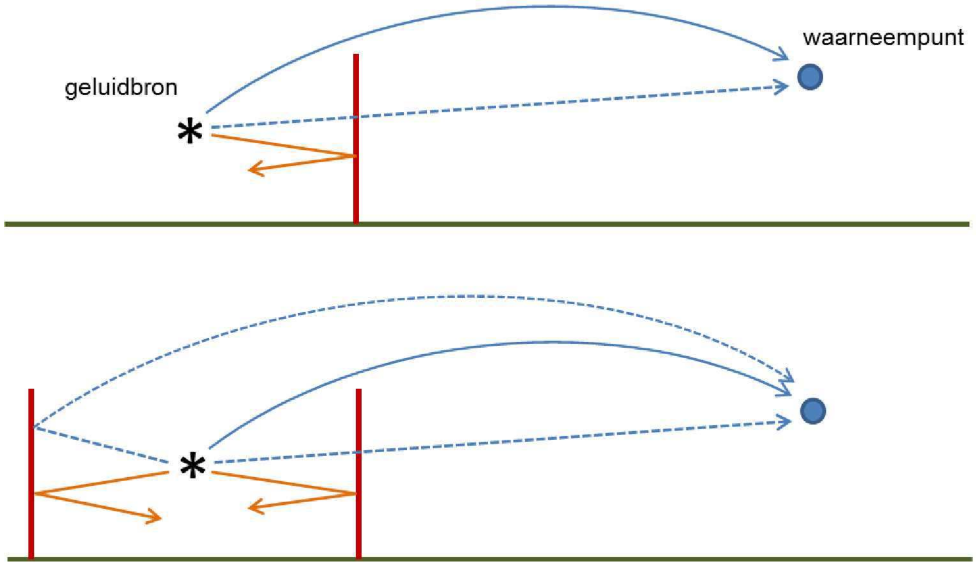
Subject
Acoustic assessment of demountable noise barrier

A demountable noise barrier measuring 10 metres in height has been erected at the Bakker Oilfield Supply installation. It was designed to surround installations for the purpose of mitigating the environmental effects of noise caused by equipment and activities inside the barrier. TNO conducted an evaluation of the acoustic effects of this barrier. It comprises of sections that are 2m or 2.5m in width, constructed in HEA140 steel sheet piling profiles that are 0.63mm thick plus a 0.63mm thick perforated steel plate, padded with 50mm mineral wool insulation between the sheets.

Principle
The sound that is generated within the barrier is generally capable of reaching perception positions behind the barrier via sound transfer over the upper and side edges (where the barrier surrounding the installation is not fully closed, as shown in the photo below) and via sound transfer through the barrier. Due to the reflective action of sound, a higher level of sound may occur at the source of the noise within the barrier than would be the case in the absence of a barrier. This is illustrated in the figure on the next page. Sound reflection can also cause the sound to travel more easily over the barrier, thus diminishing the barrier effect.

The sound transfer over and alongside the sides of the barrier (the screen) is determined by the frequency spectrum of the sound source and the geometry of the arrangement: the barrier height, the distance to the sound sources and the observation point, the location of openings in the barrier and the height of the sound sources and of the observation point. The volume of sound that penetrates the barrier will depend on the sound insulation properties of the construction. In general, when noise barriers are used, the principle is to ensure that the insulation properties are such that the amount of noise that gets through the barrier is negligible compared with the noise that will reach the observation point via the noise paths over and alongside the barrier sides. If that is achieved, there is no point in further increasing the insulation, because this will not further reduce the noise level at the observation point.


foto: Bakker Oilfield Supply



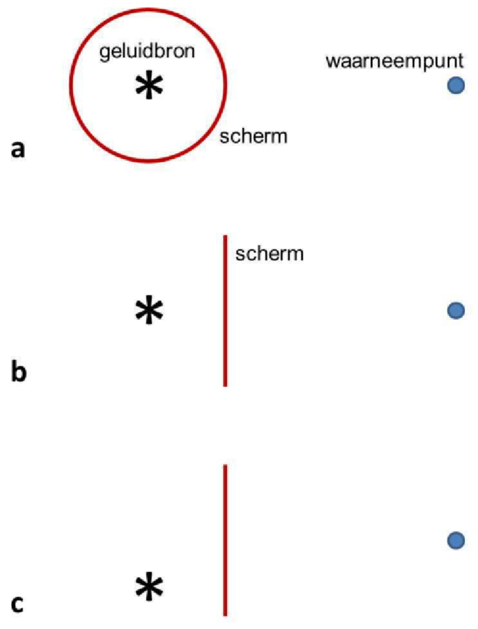
Sound source *Observation point*

Noise originating at the source will reach the observation point via the different noise paths (shown in blue): over the barrier, through the barrier and (where there are barriers on both sides of the source), via sound reflection against the barrier that is behind the source when viewed from the observation point. Sound reflection can also produce a higher noise level at the source side of the barrier (see the orange noise paths).

The noise insulation will depend on the construction and on the type of materials used. The type of materials will also influence the level to which the barrier reflects the noise.

Maximum achievable noise reduction

The maximum noise reduction that may be achieved with the 10 metre high barrier occurs where the contribution of the noise passing via the transfer paths through the barrier and via sound reflection against the barrier is negligible. This maximum reduction is calculated based on the calculation method outlined in the Industrial Noise Measuring and Calculation Manual [Handleiding meten en rekenen industrielawaai (2004)] for the following situations (see the illustration):



[*Geluidbron = noise source waarneempunt = observation point scherm = screen*]

a) A barrier placed around the sound source, with one sound source at 2m or at 25m distance from the barrier;
b) a 25m long barrier along a straight line, perpendicular to the line between the source and the observation point, which lies centrally in front and centrally behind the barrier, with one sound source at 2m or at 25m distance from the barrier;
c) same as in b) above but with the source point not centrally in front of the barrier but rather 2m from the side.

When the source is at a 2m distance from the barrier, the source height is 2m above the ground.
When the source is at a 25m distance from the barrier, a source height of 5m applies. The observation height in all cases is 5m.

In expressing the noise reduction in dB(A) terms, a source spectrum has been selected for reasons of safety[1] in which the low frequencies are relatively strongly represented compared with traffic noise (see Annex B). The results are shown in the table below as the noise reduction in dB(A) for different distances from the observation point to the barrier.

Situation	Source position		Indication of noise reduction [dB(A)] in proportion to the distance from the observation point to the barrier				
	d [m]	h m]	10m	20m	50m	100m	200m
a	2	2	25	25	25	25	25
	25	5	20	15	15	15	15
b	2	2	20	20	20	20	20
	25	5	15	15	15	10	10
c	2	2	20	20	15	15	15
	25	5	15	15	10	10	10

*Indication of noise reduction effect of a 10m high barrier in the above situations **a**, **b** and **c**, depending on the source position (d = distance from source to barrier; h = source height) and on the distance from the observation point to the barrier (observation height = 5 m).*

Sound insulation

As observed above, the noise reduction in the above table can only be achieved when the sound insulation is sufficiently adequate. This will be the case if the insulation is at least 10 dB more than the achievable effect (noise reduction) of the barrier. This requirement also applies to barriers along roads as specified in the relevant manual ‘Noise-reducing Barriers Along Roads’ [*Geluidwerende constructie langs wegen* (GCW)].

The sound insulation (*RA*) of the wall, calculated in accordance with the BASlab calculation model developed by TNO and based on the data in Annex A, is equal to 30 dB(A). This is on the basis of the source spectrum shown in Annex B and on a fully closed wall with no gaps or cracks. In the event of cracks that take up 1% of the wall surface, the maximum sound insulation will be 20 dB(A). The sound insulation with a well-closed wall will therefore be

[1] The effect of a barrier will be reduced accordingly as the ratio of low frequencies in the noise spectrum source is greater.

sufficiently adequate to achieve a noise reduction of 20 dB(A) in an observation point. The insulation calculation details are to be found in Annex B.

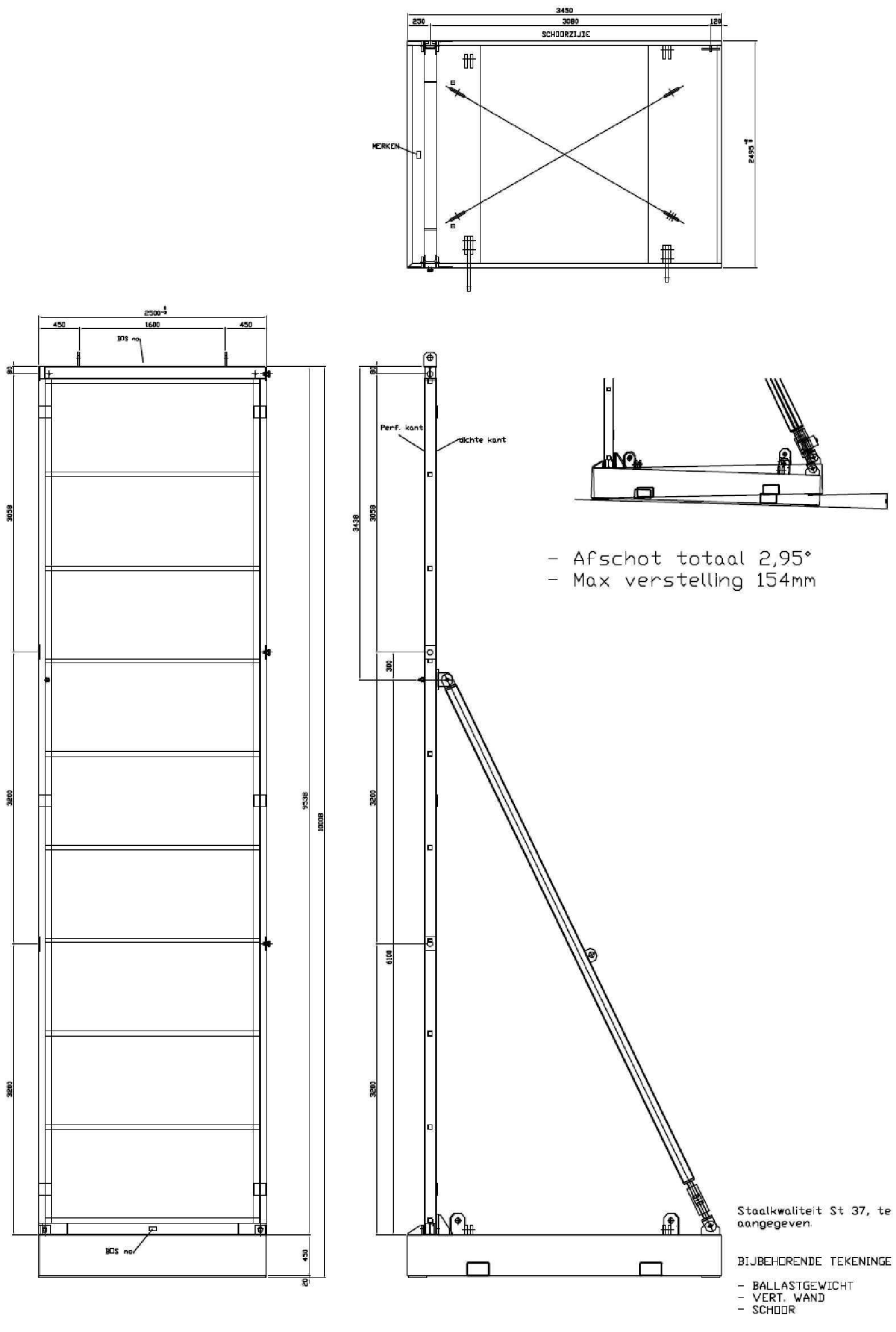
Sound reflections

The elements of the barrier at the source side are comprised of perforated sheeting behind which mineral wool has been placed. The sound absorption here is calculated on the basis of BASlab calculation model developed by TNO. The result can be expressed with reference to the GCW as a level reduction of the reflection (ΔL_a) in dB(A). Based on the calculations, this level reduction will be approx. 9 dB(A). See also Annex B. This means that in most cases the reflection via absorption of the walls will be resisted to such an extent that the reflected noise both within and without the barrier will add no significant increase to the overall noise level.

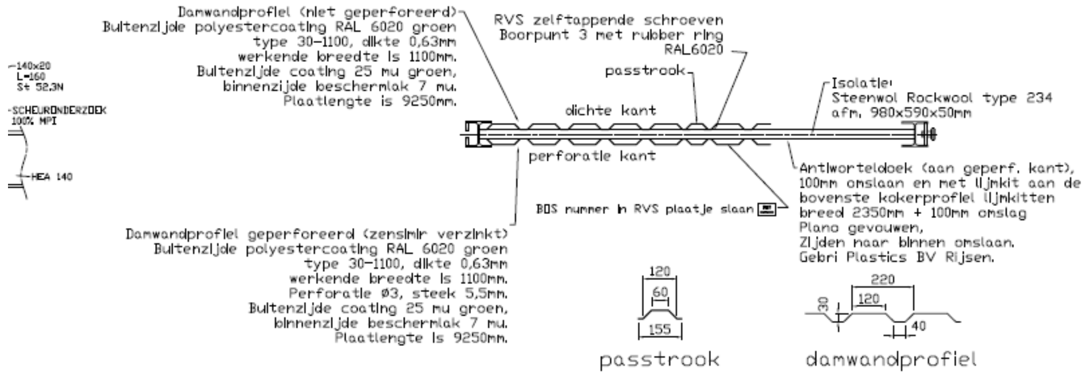
Conclusion

A noise reduction of 10 to 15 dB(A) can be achieved with a demountable noise barrier, providing there are no gaps or cracks in the wall. Under favourable (geometric) conditions, a noise reduction of up 20 dB(A) may be obtained. The reflection of noise against the barrier elements does not lead to a significant increase in the noise level at the workplace within the barrier.

Annex A: Barrier constructional drawing (next page)



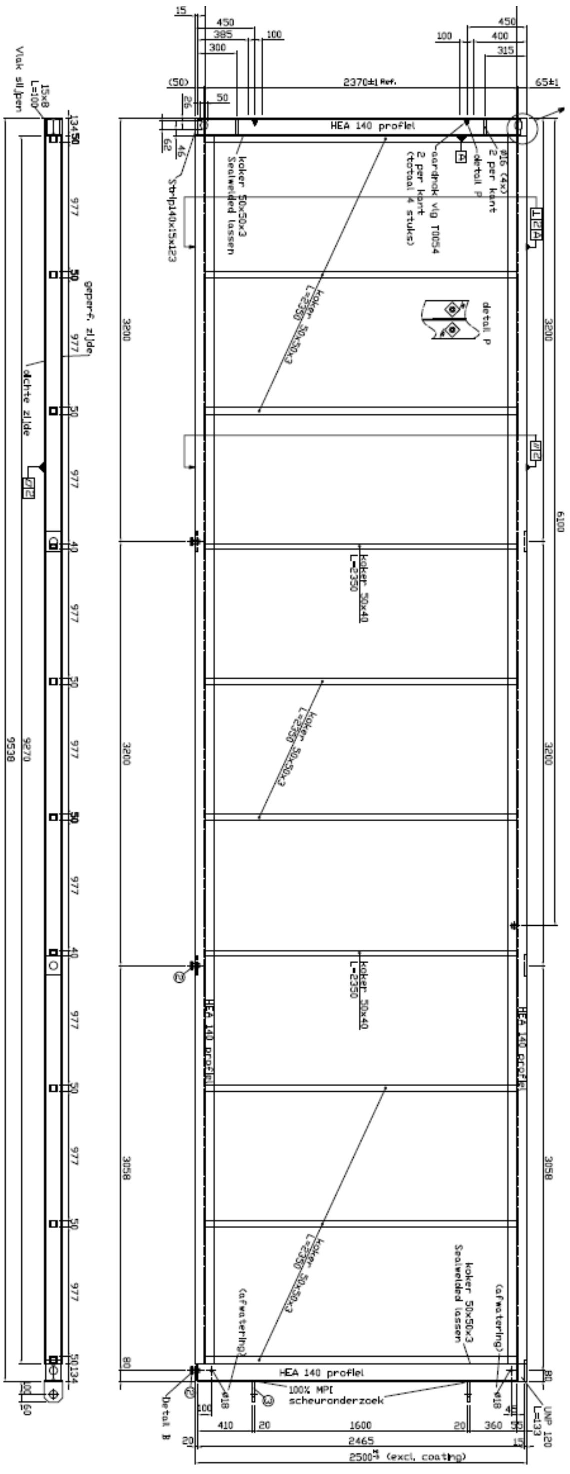
- Total sloping: 2.95°
- Max. adjustment: 154mm



Sheet piling profiles (non-perforated)
polyester coated on exterior side
RAL 6020 green type 30-1100, 0.63mm thick
Working width = 1100mm
Exterior coating 25 mu green
Interior protective coating 7 mu
Sheet length = 9250mm
Imprint BOS number in stainless steel plate

Crack inspection 100% MPI

Insulation: Rockwool type 234.
Anti-rooting membrane (on perforated side).



Geperf. zijde = perforated side
Vlak slijpen = grind smooth
Dichte zijde = closed side
Koker = sleeve
Afwatering = drainage
Scheuronderzoek = crack inspection

Annex B: Noise insulation and absorption calculation results

Value in octave band with intermediate frequency [HZ]	125	250	500	1000	2000	4000	Single figure indication
Sound insulation	19	25	34	41	52	53	30 dB(A)
Absorption coefficient	0.24	0.53	0.79	0.92	0.97	0.90	9 dB(A)
A-weighted Source spectrum [dB(A)]	-14	-10	-6	-5	-7	-14	