Noise management practices enable, promote drilling operations in densely populated areas

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OVER A PERIOD of 60 years, the **Nederlandse Aardolie Maatschappij** (NAM) has drilled from some 1,000 onshore locations in the Netherlands. Today, the majority of the drilling sites are situated close to housing. Based on measurements and modeling, effective practices to minimise the disturbances by drilling noise have been developed. As a result, complaints from the public have been reduced to almost zero. The successful management of drilling noise has been an enabler for obtaining permits for new drilling locations and the continuation of land drilling in the Netherlands.

DRILLING NOISE AFFECTS PEOPLE

Drilling operations in the direct vicinity of housing causes disturbance in the form of light, noise, vibration, smell and traffic. Of all of these, drilling noise is the most prominent disturbance. It continues day and night, 24 hrs a day, 7 days a week for weeks and months in a row. As such, noise affects public acceptance of drilling operations in the neighbourhood.

During drilling operations, continuous noise originates from the top drive, drawworks, shale shakers, mud pumps, generators, purge/cooling air systems, trucks, forklift, equipment and pipe-handling, air and fluid power systems. In addition, there are frequent noise peaks that are particularly disturbing, e.g. squeaking drawworks band brakes, metal-to-metal contacts (elevator, pipe handling) and manual handling such as hammering.

PUBLIC CONCERNS

The public in general is not familiar with drilling operations and is often concerned about industrial activity in their neighbourhood. Concerns are related to many aspects of hydrocarbon development, but noise is a key area of concern. It intrudes on people's privacy and recreation. Noise disturbance is more severe during nights and during the summer season when people prefer to be outdoors. People may also be concerned about the effect on nature, e.g. the breeding of meadow birds. As a company, NAM respects the needs of its neighbours and strives to minimise disturbances. This is in line with sustainable hydrocarbon developments from land locations and safeguards the reputation with the public.

Drilling in areas close to residential housing demands practices to minimise disturbances by drilling noises, according to NAM. With measurements, modeling and use of devices such as a cocoon structure (seen above), NAM has been able to reduce noise complaints to almost zero.

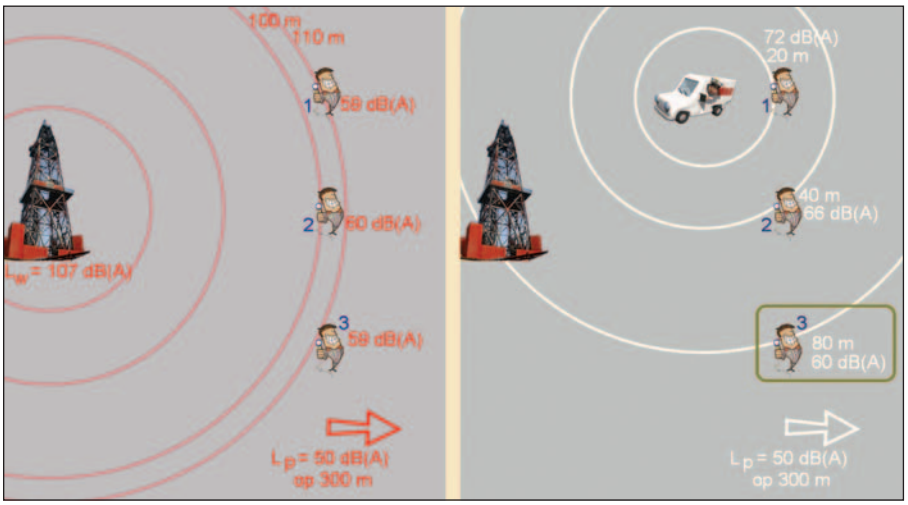
Contour maps help assess expected noise levels at nearby dwellings and what protective measures are needed.

Once drilling operations are ongoing, NAM invites neighbours to visit the rig and understand the sources of noise, e.g. block travel and top drive noise. This removes uncertainty and increases acceptance. It also facilitates contact with the site staff if noise becomes disturbing.

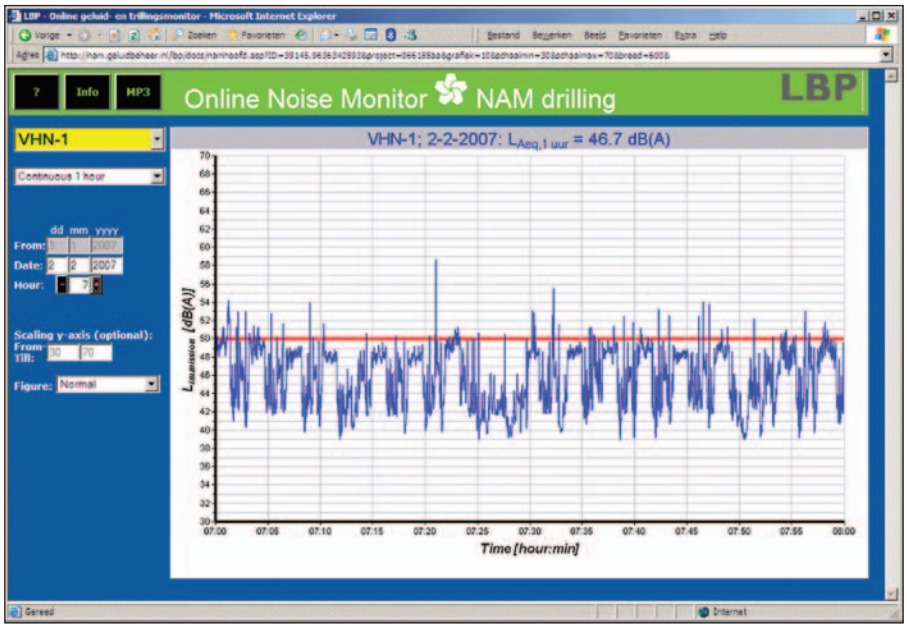
LEGAL CONTEXT

Driven by public concern about industrial noise in general, the Dutch government has taken the lead in setting maximum levels for noise emissions from drilling operations. Requirements that typically apply include continuous noise levels at a 300-m distance, noise levels inside dwellings and peak noise levels during various times of the day. The requirements can be made site-specific through the assignment of environmental permits.

The environmental permit application involves national and provincial regulators and municipalities. It takes nominally 6 months and is subject to publication and appeal, hence represents a risk of drilling delay and potentially stand-by



Above: A multi-microphone monitoring (M3) system can help to correct for external sources (traffic, wind noise, etc) when assessing the impact of drilling noise. The measurements are available in real time online. Below is an example online monitor.



of the drilling rig. Fortunately such incidents have not occurred in NAM's operations.

Noisy environments are, of course, also a concern for staff working on-site. Areas where noise levels can exceed 85 dB require protective hearing equipment in line with Dutch Labour Law.

MANAGING DRILLING NOISE

A general principle in managing noise is to remove or suppress noise emissions at source and not to "treat" at the "receiver" end — such as by means of sound insulation of houses. The following sections discuss how the impact of drilling noise is assessed, followed by measures to combat noise at source, with examples of 2 rigs, crew awareness and traffic aspects. Thereafter, measures to minimise propagation of sound will be presented, including use of sound walls and a cocoon structure.

NOISE ASSESSMENT

The impact of drilling noise is assessed for every location using noise contours overlaid on the location map. This reveals the expected noise levels at nearby dwellings or nature areas. Protective measures are based on this assessment. Contour maps are an important part of Environmental Permit applications.

There are 2 ways of establishing the noise contours:

• Based on sound measurements of individual noise sources (equipment), recombined through a complex calculation of sound transmission;

• Based on measurements at a distance from the site.

Until a few years ago, only the first method was used because accurate measurements at houses could not be performed due to the presence of other sound sources, especially traffic, wind noise, other industries, etc.

More recently, NAM introduced an advanced multi-microphone-monitoring (M3) system that can correct for such external influences. The measurements (every second) are available in real time over the Internet. NAM has established a large database of measurements covering many wells. This has made the prognosis of the expected noise simpler and more accurate. The measurements are compiled into noise contours around the rig, indicating the distance at which the continuous noise level has been reduced to 50 dB.

In addition to noise contours, a peak noise assessment is also made. The basis is again the extensive noise recording with the M3 system, which counts how many noise peaks are generated and at what level. The assessment uses the area where a noise peak that exceeds 60 dB will be heard. For instance, a 70 dB peak may travel 975 m before it has reduced to 60 dB. The circular area and the number of people living in this area is used to assign the severity of a noise peak. With the rig's noise profile and background noise levels (non-drilling related) as input, the assessment on whether additional measures will be necessary.

To minimize drilling noise at the source, sound walls are put up around the drill floor and fingerboard.

MINIMISE NOISE AT SOURCE

Rig modifications to KCA DEUTAG T46: KCA DEUTAG 2,000-hp land rig T46 was manufactured in the early 1980s. Noise emission was not considered a main design driver. The T46 was contracted by NAM in 1996. Noise measurements were taken during drilling operations on the 1st well. Noisy equipment and noisy rig activities were identified. Rig modifications/upgrades were needed to comply with the regulations.

The modifications included the housing in sound-insulated containers of the air compressors, the drawworks cooling unit, the hydraulic power pack, the BOP test pump and the 4 generators (with double exhaust mufflers). The 3 electrically driven 14P200 mud pumps were equipped with sound covers over the power ends. The **Emsco** C2 drawworks band brakes were replaced by a silent 4Q braking system with an emergency disk brake. Sound walls surround the drill floor and the fingerboard. A hydraulic racking arm eliminates the use of the derrickman's air winch while racking back stands at the setback area. The pipe-handling package, consisting of the iron roughneck, hydraulic elevators, top drive system and the mechanised cat-

walk system further reduced the noise emission levels while running drillpipe, casing and other tubulars.

Owing to these upgrades and the attention the crew pays to noise avoidance, the T46 has been transformed into a low-noise rig that can meet the legal requirements (although sound walls are often required, as explained below).

NEW RIG DESIGN

The **Drilltec** Synergy rig was designed and built in 2004 to support low-cost land drilling in the Netherlands. It is a highly automated singles rig. The rack and pinion system delivers 380 MT. Noise emission has been a particular focus during the design.

One of the advantages of a singles rig is that the mast is less high than a triples rig (33 m above ground). The hydraulically operated top drive has been completely encased in soundproof material. This includes both the rotating and the push/pull motors that drive the pinions. The hydraulic powerpacks are situated at the rear of the rig floor in soundproof containers. The hydraulic motors inside the powerpack container have been installed on a heavy vibration dampening to reduce vibrations and resonances in the structure. The mast, called Lafette, is a hollow steel structure. Early noise measurements revealed that this could work as a resonance box for noise. Noise-absorbing plating has therefore been installed.

The singles system using an automated pipe grabber arm, hydraulic elevators, prevents the metal-to-metal banging of drillpipe stands in the mast. Additionally, the typical "click" of the elevators is not an issue.

For a singles rig, the forklift is an important part of the pipe-handling system, as all tubulars are laid down and are transported to storage cradles. It is imperative that the forklift is a modern low-noise vehicle.

With sound walls, the Drilltec Synergy rig can operate within the legal requirements.

RIG CREW AWARENESS

In addition to rig upgrades, the awareness and actions of people working on the rig are a key aspect. An active sound-monitoring system has been used to change the way people work and behave on the rig. A set of traffic lights has been used to give direct feedback to the rig floor in case a pre-set limit of (peak) noise is exceeded.

From the measurements and increased awareness, many operational learnings have been established over the years. These include avoidance of high drillstring speed and use of downhole motors, schedule noisy activities to daytime, avoid metal-to-metal contacts (tripping, pipe handling, hammering), pre-installation centralisers in yard offsite, avoid running empty shakers (resonance), no shouting/whistling, etc.

The cocoon — a steel structure with horizontal braces — is clad with sound insulation panels and can provide a sound reduction of about 10 dB.

TRANSPORT, LOGISTICS

Trucks can be a cause of significant noise disturbance to neighbours. Transport is therefore scheduled between 7 am and 7 pm. There is no heavy traffic at night except for in operational emergencies. A well-planned operation is crucial for this.

Other measures include rubber mats over steel gratings, non-curved steel driving plates, silencers on truck depressurising vents, sound-isolated compressors on bulk trucks, switch off reversing beeps / replace with flash lights and watch man, etc. Another element of noise reduction is traffic routing. Supply trucks must follow a route that avoids cities and villages as much as possible. Often, a general waiting area is assigned away from the rig, e.g. a parking place at a highway. Trucks will be called to the rig site when needed. This practice avoids traffic congestion and running engines at the drilling site.

OTHER MEASURES

The measures to silence rig equipment, to increase crew awareness and to manage transport are often insufficient due to the proximity of dwellings. Additional measures are required to break the propagation of sound, such as sound walls around the drilling site, or occasionally a so-called cocoon structure.

SOUND WALLS

Sound walls are used to shield nearby dwellings from noise. They consist of sound insulation panels that measure 2.5 m wide and 10 m high and are connected to a concrete counterweight block of 10 tonnes. Each panel is held upright by a diagonal beam; the wall can survive a wind force of 12 Beaufort. A location may require up to 400 m of sound wall. At times, sections of sound wall have been used within the location to shield off mud pumps, shakers and generators.

Erected a week prior to rig arrival, the walls include large rolling gates for transport and escape doors for personnel. The panels have to fit exactly to avoid air gaps that can become a noise source itself.

The noise reduction is approximately 25 dB immediately behind the wall; far field it is about 5 dB, measured at a height of 5 m above grass level (the first floor of a house). This is due to the bending of sound waves over the sound wall.

COCOON STRUCTURE

For a location with houses less than 100 m from the location, a noise insulation tower has been designed and built. This structure is 47.5 m tall with a footprint of 20 m-by-20 m (Figure 8). A heavy drilling rig can be skidded into the structure. The cocoon is designed such that it can house almost any drilling rig.

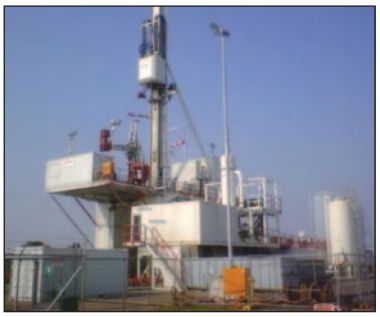
The cocoon is a steel structure that consists of 4 legs with horizontal braces and is erected using a crane. Subsequently it is clad with sound insulation panels that measure 2 m-by-10 m. The fully completed cocoon weighs 600 MT. It can withstand wind forces of 12 Beaufort.

It is equipped with gas sensors and alarms in order to prevent it from

becoming gas filled. The insulation panels are connected with break systems and suspension chains to prevent explosion overpressures, thus minimising escalation effects.

The effectiveness of the cocoon has been measured with the M3 monitoring system, verifying a sound reduction of about 10 dB, i.e. 90% reduction of the emitted sound energy. With this large sound reduction, it was possible to perform the drilling operations at less than 100 m from the most nearby dwelling. The effectiveness of sound-reducing measurements can be verified with the online M3 monitoring system.

The number of complaints from neighbours measures the final success of managing drilling noise. Founded complaints are very few, perhaps 1 per year. Complaints may also be unfounded, such as from 20 km distance. However, all complaints are investigated. The online M3 monitoring system is a valuable tool for this. Sometimes crew awareness needs to be sharpened; other times local circumstances can give rise to specific resonances. In one case the shakers brought vibrations into the weak soil, which excited a low frequency in the close-by sound wall. Keeping one shaker tank filled up with water cured this.



Modifications were made to the KCA DEUTAG T46 (above left) to improve its noise control characteristics, since noise emission was not a main design driver when it was manufactured in the early 1980s. The Drilltec Synergy rig (above right), however, was built in 2004 with noise emission as a particular design focus.

CONCLUSION

Drilling noise can be disturbing for neighbours and can limit permit grants for onshore locations in densely populated areas. Comprehensive practices, including minimising noise at the source and breaking the propagation, have been developed over the years to manage the noise emissions. This has allowed drilling of wells in densely populated areas with virtually no noise complaints.

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