

**KEM Research Question (max. 4 pages + annex)**

**TITLE *Infrasound (<100Hz) generation and observation***

**Objective**

The objective of this research is to define methods, described in literature, how to assess the generation of low frequency noise (LFN), sometimes called infrasound, by mining activities, in particular by gas production, transport and storage activities, as well as activities related to the production of geothermal energy and salt, in particular:

- A systematic inventory and characterisation of generated LFN comprises both from induced earthquakes as well as the flow of gas and liquids through pipeline systems and processing facilities, as well as the potential impact of LFN on people and assets.
- A systematic inventory of methods how to use technical observational systems as well as observation by citizens or models for proper assessments of current or future infrasound generation and exposure to be expected.
- Based on literature and observation possibilities a qualitative overview of potential impacts LFN may have on the environment and people and references to any safety norms are targeted for.

**State of the art, background**

Ambient LFN, being soundwave energy (also called microbaroms) travelling through the air with frequencies lower than 100 Hz, is a well-known phenomenon. Seismic waves in the subsurface or coastal waves in water fall into the same frequency range and can generate LFN (ref. 1).

Ambient LFN waves generated by natural events (earthquakes, coastal waves) have been observed at large (10-100 km) distances in the past (ref. 2, 4 and 7), also to determine the source. LFN generated by man-made systems (subwoofer sound, pipeline systems, and machines) has been observed as well (ref. 3 and 4). The impact of LFN can be diverse to people (ref. 6); sometimes people are impacted, other people are not at the same moment and location. Besides that it cannot be measured empirically.

No systematic LFN impact assessment study of mining activities is available up to now. Also guidelines or best practices to carry out such an impact study are lacking.

**Research Question**

*This research request consists of a literature based study by international LFN experts on assessment methods for the generation, detection and impact of LFN. Specific research questions are:*

1. *Which assessment methods exist and could/should be used to predict the generation of LFN from mining activities, specifically (1) man-induced earthquakes, (2) gas transport and processing facilities for gas, (3) geothermal energy and salt facilities, such as rotating equipment (compressors, turbines, pumps) and furnaces.*
2. *Which monitoring and/or measuring techniques and networks are available internationally and in The Netherlands and could/should be used to cost-effectively monitor or measure LFN generated by mining activities.*
3. *Synthesis including recommendations for establishing a trustworthy approach to LFN triggered by production, processing and transport in mining as referenced under 1 above.*
4. *Do norms exist internationally for the level of exposure of people or fauna to LFN, comparable to either sound norms at low audible frequencies?*

**Deliverables expected**

1. Literature study report addressing research questions 1-3
2. Discussion with Dutch experts in the field
3. LFN risk management synthesis report, addressing research question 4.

All deliverables will be made public.

**Timeline**

*The duration of the project is estimated to be 9 month.*

**Expected use**

The results of the project will be used:

- By the Ministry of Economic Affairs and Climate change (MEAC), to decide upon the need for a specific approach/norm to infrasound, or adaptation of current approaches, norms.
- by SodM, to advise the Ministry responsible on LFN safety/health issues to be addressed by mining activities and guideline for best practice
- by operators and gas, geothermal energy and salt transport/processing companies to comment and use
- by the public and scientific communities in the Netherlands

**Expertise and tools preferred for the team**

The multidisciplinary and international expert team should have a track record in:

- physics of infrasound
- knowledge on infrasound generation by natural or man-induced , specifically mining activities with respect to induced earthquakes and gas transport and processing facilities
- knowledge on detection methods and monitoring or inspection approaches
- in sound safety regulation, inspection protocols, etc.
- social impact of LFN.

#### **Quality assurance, Organisational and communication requirements**

Small interdisciplinary team with professional project management,

Including independent review plan

Communication with client MEAC/SodM will take place on a regular frequent (quarterly?) basis

#### **Remarks and Suggestions**

In the Netherlands the expertise centre Sound of the National Institute for Public Health and the Environment (RIVM) safeguards infrasound noise levels and its impact, in order that it will be determined precisely monitored during time. RIVM published a factsheet "Laag frequent geluid" in 2013 (ref 5). Besides that DCMR Environmental Protection Agency in the Netherlands investigates the causes of infrasound and searches for solutions how to reduce the noise levels. At this moment RIVM is performing a new research project on LFN of which the results will be published in 2020.

At the university of Gothenburg in Sweden, experiments on the impact of LFN are performed in a laboratory.

#### **References**

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