Det grønne skiftet – yrkeshygieniske konsekvenser.

Norsk Yrkeshygienisk Forening
Årskonferansen 27.-29. oktober 2019
Clarion Stavanger

Grønt = godt arbeidsmiljø?

Halvor Erikstein
organisasjonssekretær
yrkeshygieniker SYH
SAFE www.safe.no

“Det grønne skiftet” – mangler hensyn til arbeidsmiljø i sine vurderinger

Bildet hentet fra; www.svanemerket.no/

- Dieseleksos blir tilsatt urea for å redusere utslipp av nitrøse gasser uten at arbeidsmiljøeksponering er vurderet eller tatt hensyn til.
- I vindturbinindustrien er eksponering for lavfrekvent støy fullstendig neglisjert.

SCR (Selective Catalytic Reduction) – «Rensing av eksos»

- SCR er en prosess hvor urea benyttes til å redusere nitrøse gasser til N_2 . Redusert utslipp av nitrogenoksider er et klimatiltak og får store tilskudd.
- Ved bruk av urea dannes også reaktive nitrogenforbindelser (reactive nitrogen compounds, RNC).
- SCR teknologi installeres på store dieselmotorer hvor eksosutslippet kan gi kraftig eksponering av personell.
- Arbeidsmiljøeksponering og helsekonsekvenser er ikke vurdert når NOx-fondet støtter installering av SCR.

SCR – Selective Catalytic Reduction

SCR er en metode for å fjerne nitrøse (NOx) gasser fra dieseleksos.

AdBlue er en vandig *urea* løsning som består av 32.5% *urea* and 67.5% vann. tilsetning blir ofte framstilt som en prosess som gjør dieseleksosen ufarlig;

*«*Dieselbilen slipper ut nitrogenoksidgass, noe som er med på å forurense området hvor det slippes ut. Ved å tilsette det som kalles AdBlue, omdannes dette til ammoniakk og karbondioksid.*

Når nitrogenoksidgassene fra eksosrøret reagerer med ammoniakken inne i katalysatoren blir de skadelige NOx-molekylene i eksosen omdannet til harmløst nitrogen og vann, med andre ord, nærmest uskadeliggjort.»

MEN – ingenting om at urea kan omdannes til HNCO (isocyanatsyre).

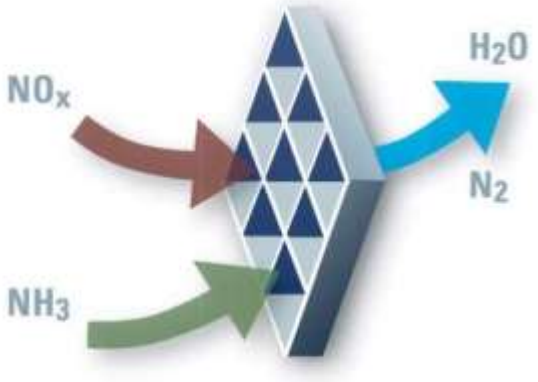
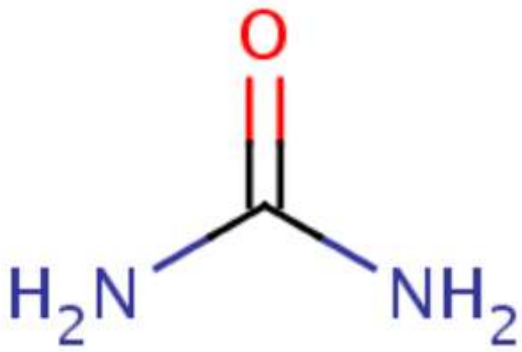


Figure 2.1 Basic principle of SCR system solution for Nox reduction

Urea

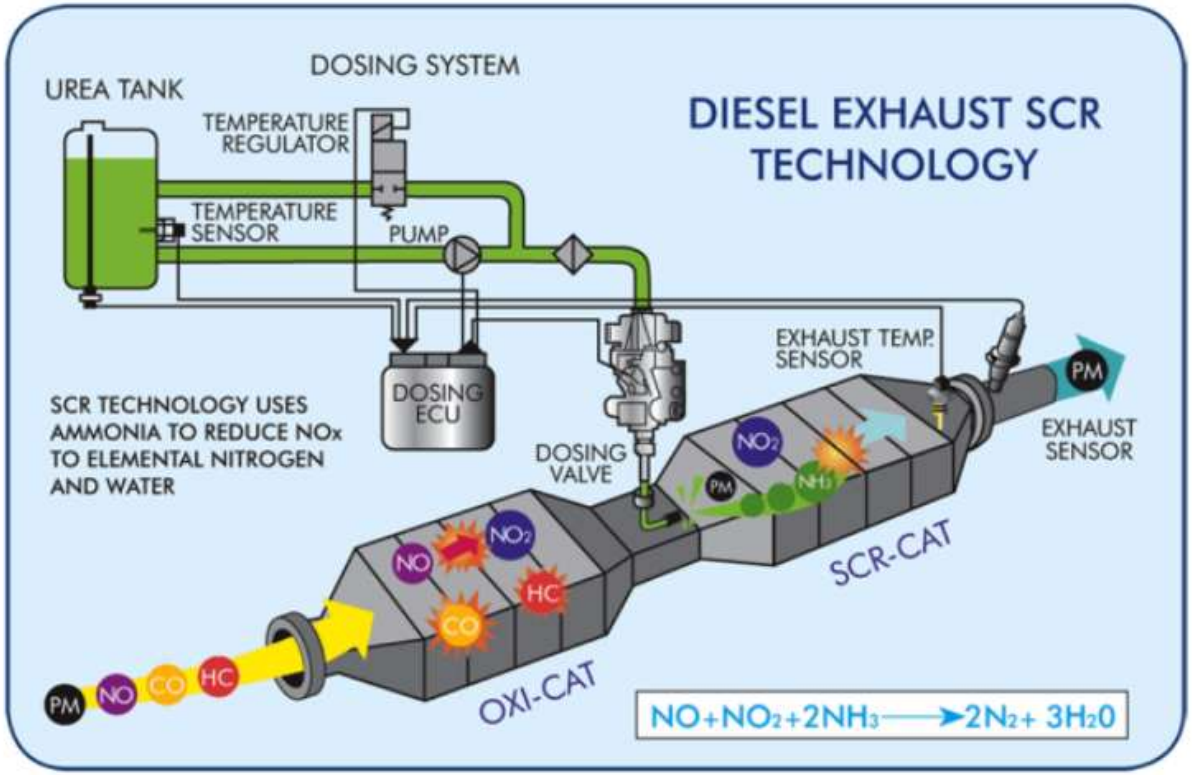


https://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:16199

https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/1022tr.pdf

* https://www.dinside.no/motor/vet-du-hvordan-du-etterfyller-adblue/61045870

Litt teknisk om selective catalytic reduction SCR



Selective Catalytic Reduction (SCR) of NOx using an ammonia compound as a reduction has been used for many years in stationary diesel engine applications, as well as for mobile applications.

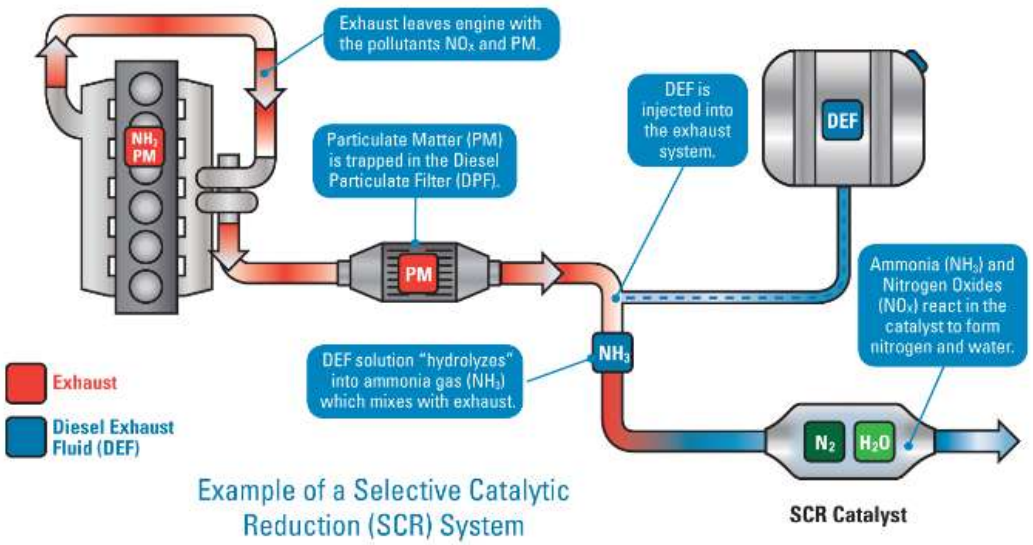
How does a SCR work?

In the SCR process, NOx reacts with the ammonia, which is injected into the exhaust gas stream before a special SCR Catalyst. SCR is the only technology capable of reducing diesel NOx emissions to levels required by future emission standards.

https://www.autoconverterrecyclers.com/selective-catalytic-reduction

Men ved innsprøytin av urea blir det ikke bare H_2O og N_2 som dannes.

Selective Catalytic Reduction | How it works



Example of a Selective Catalytic Reduction (SCR) System

Selective Catalytic Reduction (SCR) technology uses ammonia to break down dangerous NOx emissions produced by diesel engines into nitrogen and water. In automotive applications SCR delivers ammonia through a urea solution – Diesel Exhaust Fluid (DEF) – which is sprayed into the exhaust stream by an advanced injection system and then converted into ammonia on a special catalyst.

$$H_2N - CO - NH_2 \rightarrow NH_3 + HNCO. \quad \text{(R1)}$$

The HNCO rapidly hydrolyzes on the catalyst surface to yield another NH_3 molecule:

$$HNCO + H_2O \rightarrow NH_3 + CO_2. \quad \text{(R2)}$$

NH_3 is the active agent that reduces NO and NO_2 to N_2 and H_2O:

$$2NH_3 + NO + NO_2 \rightarrow 2N_2 + 3H_2O, \quad \text{(R3)}$$
$$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O \quad \text{(R4)}$$
$$8NH_3 + 6NO_2 \rightarrow 7N_2 + 12H_2O. \quad \text{(R5)}$$

Atmos. Chem. Phys., 17, 8959–8970, 2017
https://doi.org/10.5194/acp-17-8959-2017

https://www.tersusdef.com/about/how-selective-catalytic-reduction-scr-works/

Environmental Science & Technology

Article

pubs.acs.org/est

Effects of a Combined Diesel Particle Filter-DeNOx System (DPN) on Reactive Nitrogen Compounds Emissions: A Parameter Study

Norbert V. Heeb,*[,†] Regula Haag,[†] Cornelia Seiler,[†] Peter Schmid,[†] Markus Zennegg,[†] Adrian Wichser,[†] Andrea Ulrich,[†] Peter Honegger,[‡] Kerstin Zeyer,[‡] Lukas Emmenegger,[‡] Yan Zimmerli,[§] Jan Czerwinski,[§] Markus Kasper,[⊥] and Andreas Mayer[∥]

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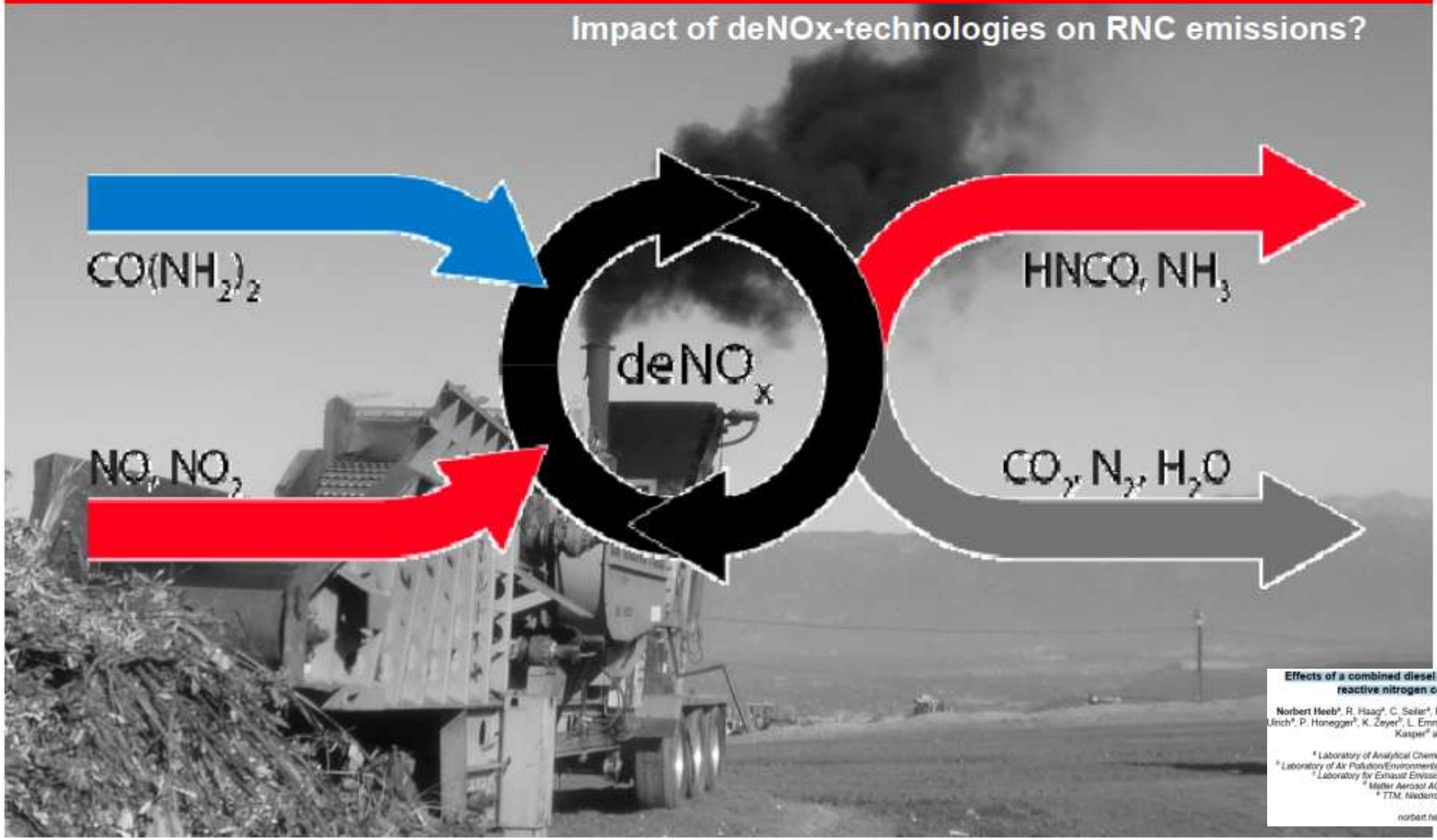
Supporting Information

ABSTRACT: The impact of a combined diesel particle filter-deNO$_x$ system (DPN) on emissions of reactive nitrogen compounds (RNCs) was studied varying the urea feed factor (α), temperature, and residence time, which are key parameters of the deNO$_x$ process. The DPN consisted of a platinum-coated cordierite filter and a vanadia-based deNO$_x$ catalyst supporting selective catalytic reduction (SCR) chemistry. Ammonia (NH_3) is produced in situ from thermolysis of urea and hydrolysis of isocyanic acid (HNCO). HNCO and NH_3 are both toxic and highly reactive intermediates. The deNO$_x$ system was only part-time active in the ISO8178/4 C1cycle. Urea injection was stopped and restarted twice. Mean NO and NO_2 conversion efficiencies were 80%, 95%, 97% and 43%, 87%, 99%, respectively, for α = 0.8, 1.0, and 1.2. HNCO emissions increased from 0.028 g/h engine-out to 0.18, 0.25, and 0.26 g/h at α = 0.8, 1.0, and 1.2, whereas NH_3 emissions increased from <0.045 to 0.12, 1.82, and 12.8 g/h with maxima at highest temperatures and shortest residence times. Most HNCO is released at intermediate residence times (0.2−0.3 s) and temperatures (300−400 °C). Total RNC efficiencies are highest at α = 1.0, when comparable amounts of reduced and oxidized compounds are released. The DPN represents the most advanced system studied so far under the VERT protocol achieving high conversion efficiencies for particles, NO, NO_2, CO, and hydrocarbons. However, we observed a trade-off between deNO$_x$ efficiency and secondary emissions. Therefore, it is important to adopt such DPN technology to specific application conditions to take advantage of reduced NO$_x$ and particle emissions while avoiding NH_3 and HNCO slip.

- Ved innsprøytning av urea dannes det reaktive nitrogenforbindelser (Reactive Nitrogen Compounds, RNC).
- Urea omdannes også til den svært reaktive HNCO hydrogenisocyanat (isocyanatsyre).

https://pubs.acs.org/doi/10.1021/es3029389

Urea-based SCR



Effects of a combined diesel particle filter-deNOx system on reactive nitrogen compounds emissions

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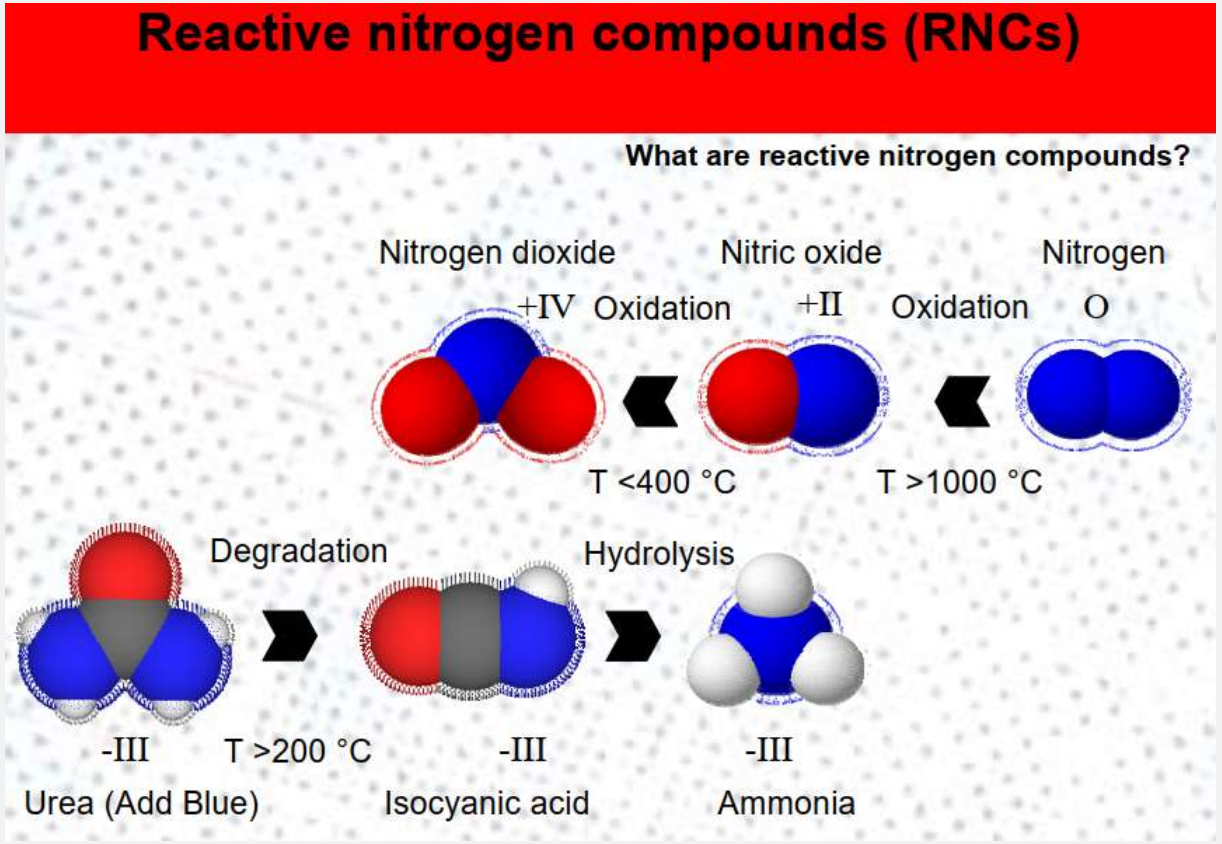
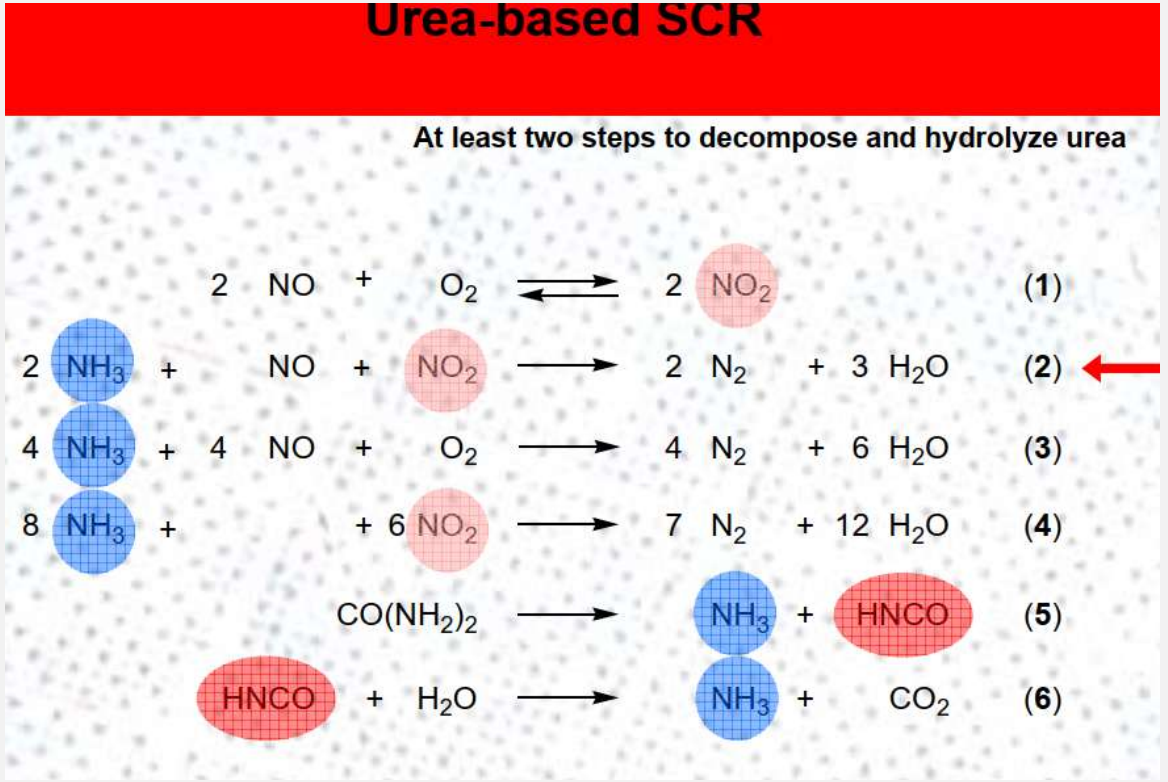
Kjemien involvert;





Kopiert fra:

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Nox-fondet har eget støtteprogram for hybridisering (batteri) og installering av SCR anlegg

Riggen Songa Enabler har fått støtte fra NOx-fondet. Foto: Songa Offshore Management AS

NOx-fondet lanserer eget støtteprogram for rigger. Hovedformålet med programmet er å gi støttebetingelser som gjør det lettere for riggene å få støtte fra NOx-fondet.

Del denne siden:

Støtten gjelder for tiltak med installering av batteri, SCR-anlegg og lav-NOx ombygginger. Andre tiltak kan etter NOx-fondets vurdering inkluderes i støtteprogrammet, men tiltaket må ha over 10 % NOx-reduksjon på totalutslippet.

Alle som får tilsagn under støtteprogrammet får en minsteutbetaling på 5 mill. kr (oppad begrenset til 80 % av kostnaden NOx-tiltaket innebærer).

Følgende betingelser gjelder:

https://www.nho.no/samarbeid/nox-fondet/nyheter/stotteprogram-for-offshore-rigger/

- Det er så langt ikke gjort noen arbeidsmiljøvurdering av mulig eksponering for reaktive nitrogenforbindelser i eksosen fra et anlegg med SCR.
- Installering av batteri (hybridisering) er positivt. Det gir mindre eksoseksponering.
- Er risiko ved “thermal rundown” for lite kjent?
- Installering av SCR gir en ny eksponering reaktive nitrogenforbindelser som eksempelvis isocyanatsyre.

EHCA om HNCO
(sensibiliserende for åndedrett)

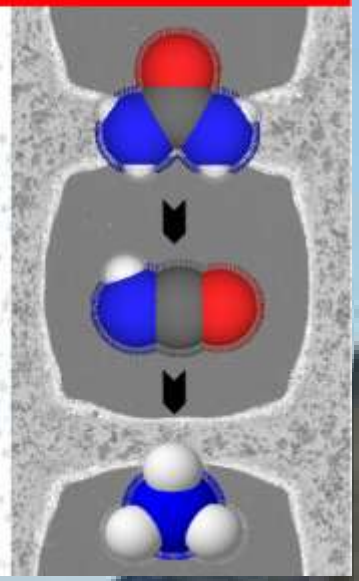
Secondary pollutants of deNOx-technologies

The HNCO problem

- Isocyanates are toxic
- Highly reactive, react with -OH, -NH_2, and -SH groups (molecules of life)
- Methyl isocyanate accident Bhopal, India (42 t released on 3.12.1984)

Risks

- On-board HNCO formation
- Over dosage of urea
- Reacts with other exhaust constituents to form secondary pollutants



Effects of a combined diesel particle filter-deNOx system on reactive nitrogen compounds emissions

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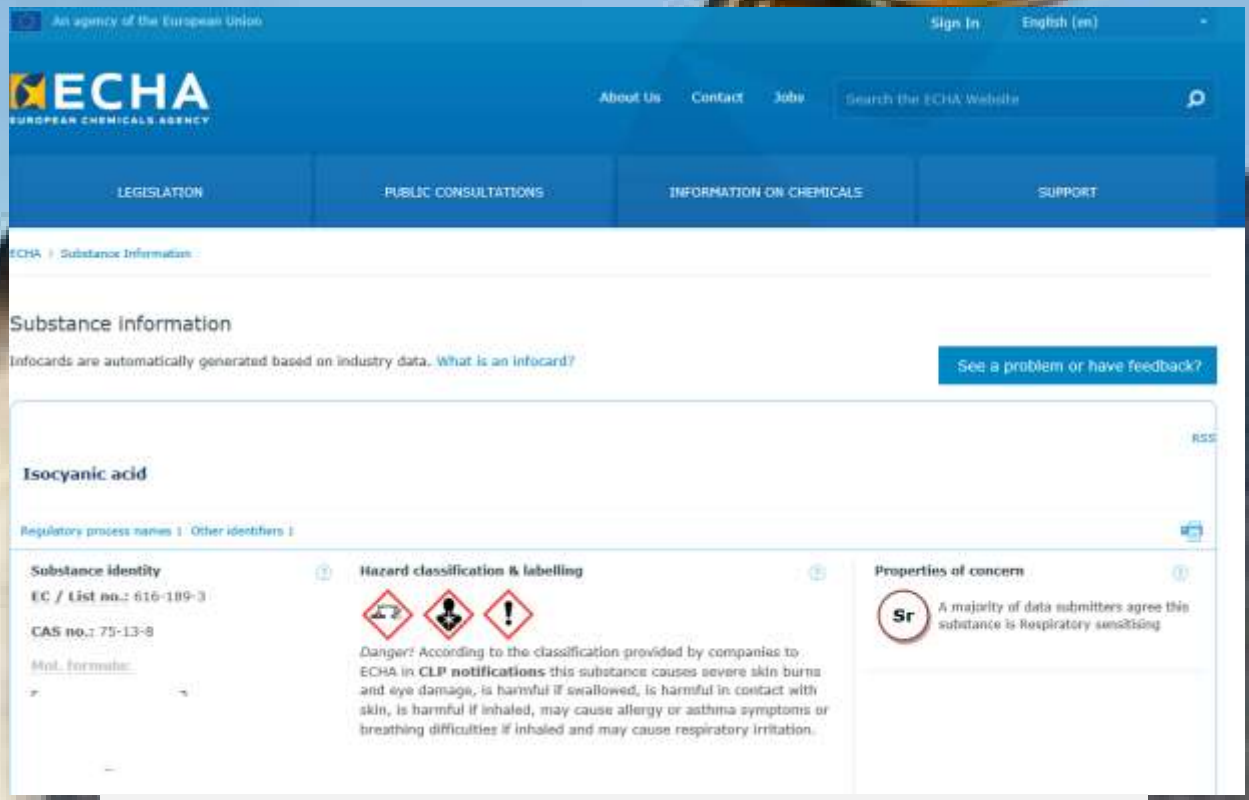

https://echa.europa.eu/substance-information/-/substanceinfo/100.109.068

EN DE FR CONTACT INTRANET LOGIN SEARCH

Empa
Materials Science and Technology

WELCOME | CHEMICAL ANALYSIS | RESEARCH | PUBLICATIONS | TEACHING | LAB INFO

Empa > 500 - Mobility, Energy and Environment > 502 - Advanced Analytical Technologies > Research > Instrumental Chemical Analysis (Bleiner) > Engine Spectroscopy

EMPA
500 - MOBILITY, ENERGY AND ENVIRONMENT
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CHEMICAL ANALYSIS
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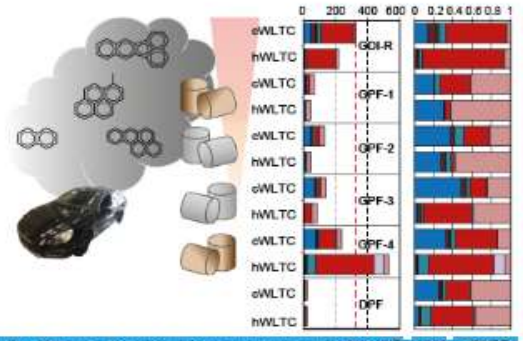
INSTRUMENTAL CHEMICAL ANALYSIS (BLEINER)
High-Resolution Mass Spectrometry
Laser Microanalysis
Extreme Ultraviolet
Engine Spectroscopy
HYDROGEN SPECTROSCOPY (BORGSCHULTE)
AIR QUALITY & PARTICLES ANALYSIS (WANG)
PUBLICATIONS
TEACHING
LAB INFO

Combustion Engine Spectroscopy

Car engine emissions are responsible for large parts of air pollution in cities. The large range engine types and fuels produce numerous gaseous and particle-bound pollutants which makes research extremely complex and impactful. We study the chemical mechanisms that lead to pollutant formation, assess abatement technology to reduce pollution, in collaboration with industry. Further, somehow pollutants are linked to incomplete combustion, which also reduces the engine efficiency. We tackle the fundamental chemical processes within a combustion engine, by means of optical and mass spectrometry, and with that we will advance knowledge for greener and more performing cars.

Car Exhaust Toxicity

Is blue technology green enough yet? DeNOx technologies currently used for on-road diesel vehicles are not where they should be. This has become clear not only because of recent scan-dals but is evident when looking at long term trends of on-road emission data. Trends proved that gasoline vehicles followed the NOx emission limits which were lowered by 95% from 1990 to 2009. The opposite was found for diesel passenger cars and light duty vehicles. On road measurements indicate that NO_x emissions, especially those of toxic and reactive NO_2 have increased from 1990 until 2005 and are only slowly decreasing and one order of magnitude higher than those of comparable gasoline vehicles.



These findings indicate that deNOx technologies in real world operation are not efficient enough and have to be improved considerably. Current deNOx technologies emit toxic and environmentally relevant reactive nitrogen compounds like NO_2, NH_3, HNCO and N_2O. These compounds contribute to the overall exhaust toxicity but are not limited by current vehicle legislation which lacks behind here.

Like for particle filters, Advanced Analytical Technologies and partners have established specific analytical procedures to assess the

deNOx renseteknologi avgir reaktive nitrogenforbindelser. Teknologien er ikke utviklet med hensyn på arbeidsmiljøeksponering.

- These findings indicate that deNOx technologies in real world operation are not efficient enough and have to be improved considerably.
- Current deNOx technologies emit toxic and environmentally relevant reactive nitrogen compounds like NO_2, NH_3, HNCO and N_2O.
- These compounds contribute to the overall exhaust toxicity but are not limited by current vehicle legislation which lacks behind here.

https://www.empa.ch/web/s502/denox-technologies

Partikler og ultra fine partikler

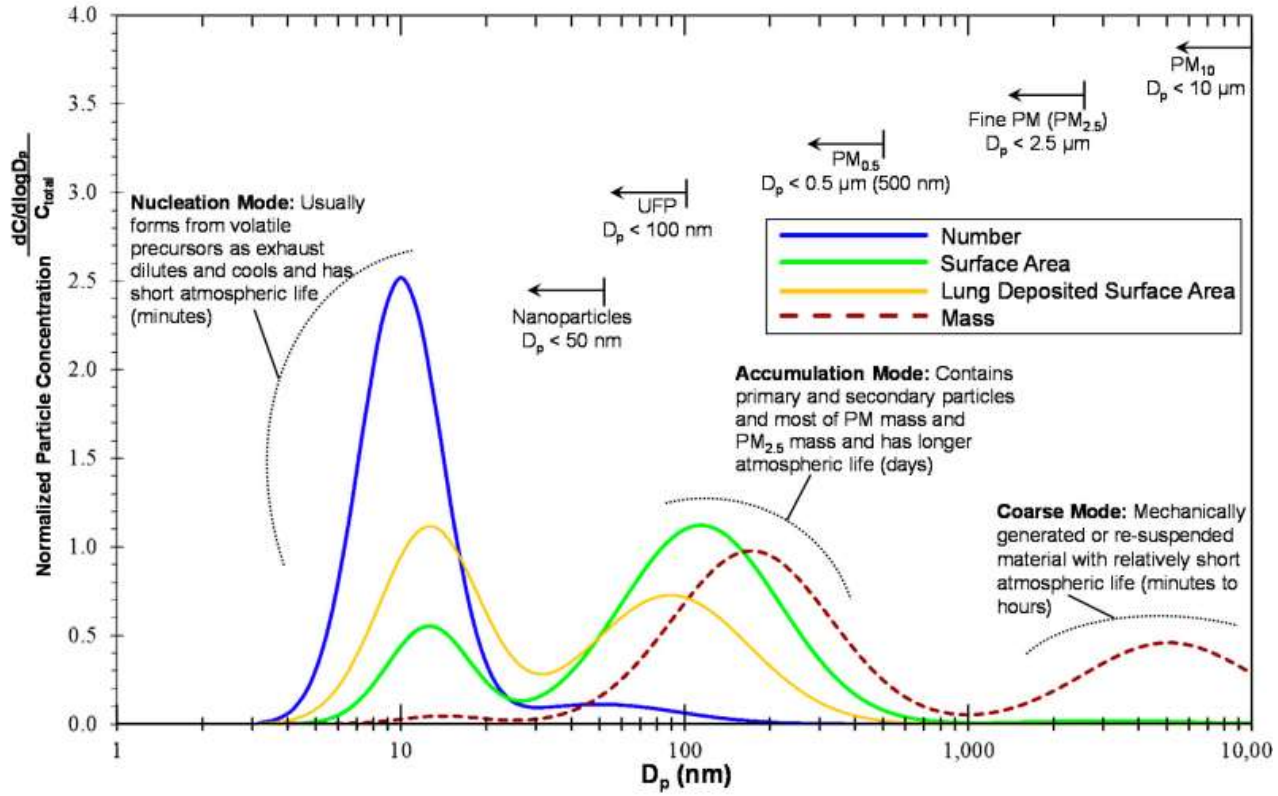
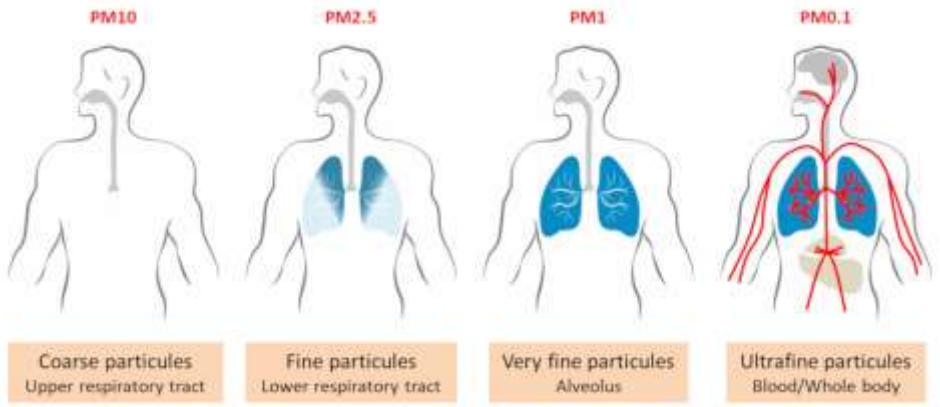


Figure 1. Tri-modal particle size distributions using different particle metrics (number, surface area, lung deposited surface area, and mass). For this figure, D_p is the particle diameter, UFP are ultrafine particles, and PM stands for particulate matter.



https://www.encyclopedie-environnement.org/en/health/airborne-particulate-health-effects/

Conference Report

Ultrafine Particle Metrics and Research Considerations: Review of the 2015 UFP Workshop

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5129264/

Forskning knytter forurensning demens og Alzheimer

BIOMEDICAL JOURNAL 41 (2018) 141–152

Available online at www.sciencedirect.com

ScienceDirect

Biomedical Journal

journal homepage: www.elsevier.com/locate/bj

Review Article

The emerging risk of exposure to air pollution on cognitive decline and Alzheimer's disease – Evidence from epidemiological and animal studies

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Center for Occupational and Environmental Health, Department of Medicine, University of California, Irvine, CA, USA

Dr. Masashi Kitazawa

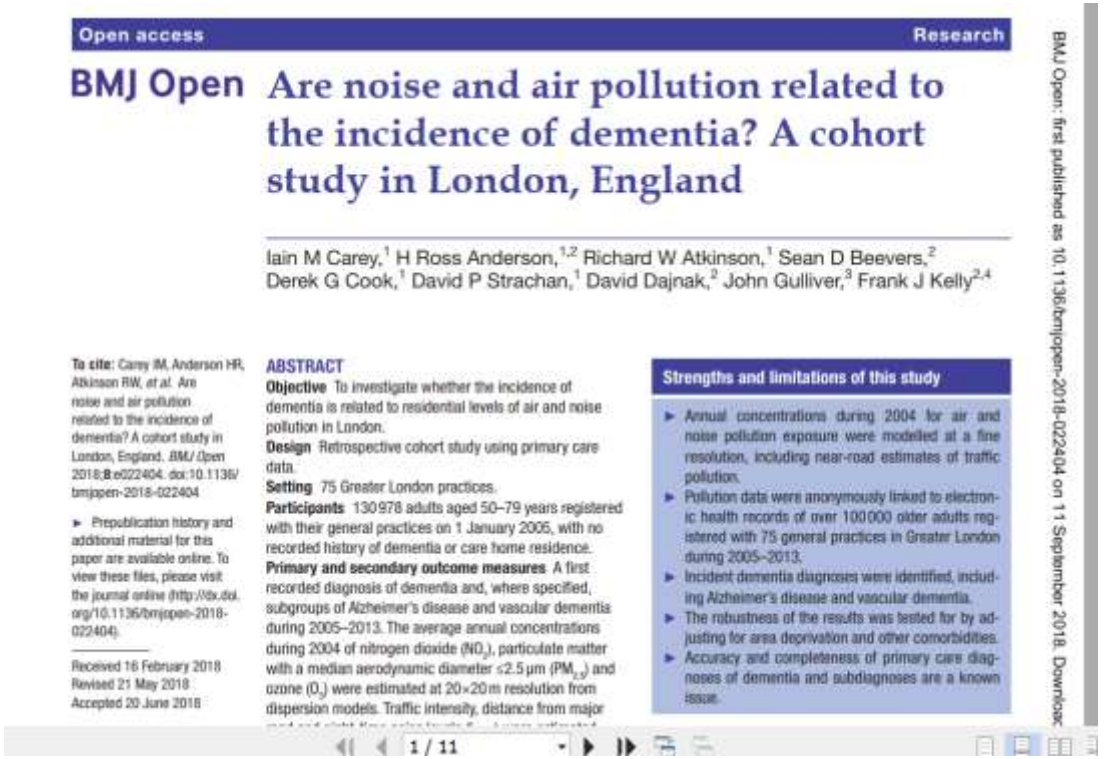
ARTICLE INFO

Article history:

ABSTRACT

As incidence of Alzheimer's disease (AD) and other neurodegenerative diseases rise, there

https://www.sciencedirect.com/science/article/pii/S2319417018300805?via%3Dihub



Open access Research

BMJ Open

Are noise and air pollution related to the incidence of dementia? A cohort study in London, England

Iain M Carey,[1] H Ross Anderson,[1,2] Richard W Atkinson,[1] Sean D Beevers,[2] Derek G Cook,[1] David P Strachan,[1] David Dajnak,[2] John Gulliver,[3] Frank J Kelly[2,4]

To cite: Carey IM, Anderson HR, Atkinson RW, *et al*. Are noise and air pollution related to the incidence of dementia? A cohort study in London, England. *BMJ Open* 2018;**8**:e022404. doi:10.1136/bmjopen-2018-022404

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2018-022404).

Received 16 February 2018
Revised 21 May 2018
Accepted 20 June 2018

ABSTRACT

Objective To investigate whether the incidence of dementia is related to residential levels of air and noise pollution in London.

Design Retrospective cohort study using primary care data.

Setting 75 Greater London practices.

Participants 130 978 adults aged 50–79 years registered with their general practices on 1 January 2005, with no recorded history of dementia or care home residence.

Primary and secondary outcome measures A first recorded diagnosis of dementia and, where specified, subgroups of Alzheimer's disease and vascular dementia during 2005–2013. The average annual concentrations during 2004 of nitrogen dioxide (NO_2), particulate matter with a median aerodynamic diameter ≤2.5 µm ($PM_{2.5}$) and ozone (O_3) were estimated at 20×20 m resolution from dispersion models. Traffic intensity, distance from major

Strengths and limitations of this study

- Annual concentrations during 2004 for air and noise pollution exposure were modelled at a fine resolution, including near-road estimates of traffic pollution.
- Pollution data were anonymously linked to electronic health records of over 100 000 older adults registered with 75 general practices in Greater London during 2005–2013.
- Incident dementia diagnoses were identified, including Alzheimer's disease and vascular dementia.
- The robustness of the results was tested for by adjusting for area deprivation and other comorbidities.
- Accuracy and completeness of primary care diagnoses of dementia and subdiagnoses are a known issue.

1 / 11

BMJ Open: first published as 10.1136/bmjopen-2018-022404 on 11 September 2018. Downloac

https://bmjopen.bmj.com/content/8/9/e022404

De lange sakene – avlufting fra prosessystemer, eksponering for ultrafine partikler

Oppfølging av saker

OFSA (nr. 7/8 2002)

Rydd opp! Alarm om helsefare fra turbin- og hydraulikkoljer

Skrevet av: Halvor Erikstein

Industrioljer blir tilsatt mange forskjellige stoffer for at de skal få de rette egenskapene. For turbin- og hydraulikkoljer er det krav til spesielle smørende, temperaturbestandige og brannhemmende egenskaper. Til dette formålet er det en utstrakt bruk av en gruppe kjemiske forbindelser som går under samlebetegnelsen organofosforforbindelser.

Dessverre har mange organofosforforbindelser vist seg å være svært helsefarlige ved hudkontakt, innånding og opptak gjennom mage og tarm. Helseskaden er svært sammensatt, men de alvorligste effektene er at stoffene ødelegger nervesystemet ved å blokkere/kutte det fine ledningsnettet som overfører nerveimpulser til kroppens muskler.

Eksponering kan gi en rekke ulike symptomer, som hodepine, kvalme, smerter i mageregion, nummenhet og lammelser i føtter og hender. Enkelte tilsetningstoffer kan gi en forsinket reaksjon som først gir lammelser og nedsatt førlighet flere uker etter eksponering. Det kan derfor godt tenkes at eksponering for turbin- og hydraulikkoljer er blitt oversett når folk som har jobbet med disse stoffene har utviklet sykdom.

Statfjord-feltet har den såkalte "MS-saken". Her har folk som har vært eksponert for turbinoljer utviklet nevrologiske symptomer, men uten at det er blitt satt i sammenheng med eksponering for organofosforforbindelser. Vi har også fått meldinger om at det finnes folk på andre felt som har jobbet med turbiner og fått nevrologiske utfall.

I dag er det særskilt oppmerksomhet fra flygere og cabinmannskap på episoder hvor oljelekkasjer har ført til alvorlig forgiftning av flymannskapet. Den norske flyhavarikommisjonen har nettopp frigitt en rapport om en hendelse for to år siden med røyk-/oljelukt i et SAS fly. Fartøysjefen ble senere beskrevet som alvorlig skadd, og har ikke lenger helseattest for å fly. Mens kapteinen valgte å sitte uten maske for å kunne følge med i gassutviklingen, berget styrmannen helsen fordi han benyttet åndedrettsvern.

Ulike organofosforforbindelser har meget stort anvendelsesområde. Eksempelvis tilhører flammehemmende tekstilimpregnering (Pyrovatex) og mange sprøytemidler mot insekter denne kjemiske gruppen. Det er også omfattende bruk av organiske fosforforbindelser som flammehemmende midler i polyuretanskum.

Det er vist at kraftig oppvarming (termisk dekomponering) av organofosforforbindelser kan utvikle kjemiske forbindelser som virker som nervegasser utviklet for kjemisk krigføring. Det er blant annet slike mekanismer en tror kan ha medvirket til akutt forgiftning av flymannskap.

Hva må gjøres?

På årets OFS kongress ble det vedtatt følgende resolusjon; "OFS krever at det blir full gjennomgang av arbeidsmiljø og helsekartlegging av personer som har vært/ er eksponert for turbin- og hydraulikkoljer som inneholder organofosforforbindelser."

Vi har informert om denne helsefaren i Sikkerhetsforum 5. desember. Vi stiller gjerne opp på årsmøter, verneombudssamlinger eller møter med HMS-avdelingen. Vi vil jobbe aktivt for at problemstillingene skal etableres som eget forskningsprosjekt, og gjennomføres sammen med det svenske forskningsmiljøet (Skarping og Dalene) på isocyanater. Vi oppfordrer medlemmer og andre om å ta kontakt både med spørsmål - og med mistanke om helseskader. Nærmere opplysninger vil finnes på www.ofsa.no/oljer

https://www.safemagasinet.no/wp-content/uploads/2016/05/SAFE-Magasinet-2002-Nr-07-08.pdf

Petroleumstilsynet har fått ny hjemmeside. Mange presentasjoner har fått nye lenker.

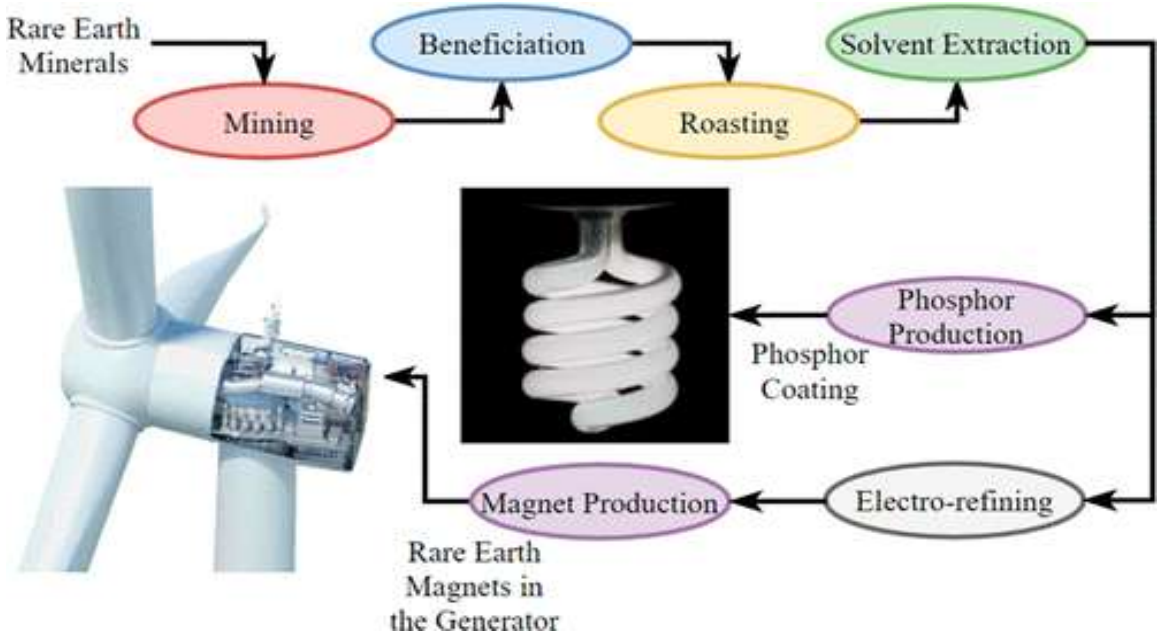
https://www.ptil.no/contentassets/ab53ee56aeff4b29a238f05df3ea85f0/kontroll-med-avluftingspunkt-prosess-og-roterende-utstyr-halvor-erikstein.pdf

https://www.ptil.no/contentassets/5bb685a14655488b96bbac27911b5b4c/halvor-erikstein-safe.pdf

https://www.norskoljeoggass.no/contentassets/67e2db9882cc40f59fb4c42c9bc87cca/10-eksos-og-ultrafine-partikler---mer-enn-lungeeffekter---halvor-erikstein.pdf

Er det grønt med vindturbiner?

Utvinning av sjeldne jordmetaller



1.Behind the Scenes of Clean Energy: The Environmental Footprint of Rare Earth Products
2.Praneet S. Arshi, Ehsan Vahidi, and Fu Zhao
3.ACS Sustainable Chemistry & Engineering **2018** *6* (3), 3311-3320
DOI: 10.1021/acssuschemeng.7b03484
https://pubs.acs.org/action/showCitFormats?doi=10.1021%2Facssuschemeng.7b03484&href=/doi/10.1021%2Facssuschemeng.7b03484

Environmental Science & Technology
Policy Analysis
pubs.acs.org/est

Global Mining Risk Footprint of Critical Metals Necessary for Low-Carbon Technologies: The Case of Neodymium, Cobalt, and Platinum in Japan

Keisuke Nansai,*,† Kenichi Nakajima,† Shigemi Kagawa,‡ Yasushi Kondo,§ Yosuke Shigetomi,†,∥,⊥ and Sangwon Suh#

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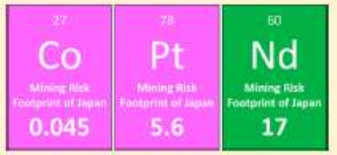
#Bren School of Environmental Science and Management, University of California Santa Barbara, 3422 Bren Hall, California United States

Supporting Information

ABSTRACT: Meeting the 2-degree global warming target requires wide adoption of low-carbon energy technologies. Many such technologies rely on the use of precious metals, however, increasing the dependence of national economies on these resources. Among such metals, those with supply security concerns are referred to as critical metals. Using the Policy Potential Index developed by the Fraser Institute, this study developed a new footprint indicator, the mining risk footprint (MRF), to quantify the mining risk directly and indirectly affecting a national economy through its consumption of critical metals. We formulated the MRF as a product of the material footprint (MF) of the consuming country and the mining risks of the countries where the materials are mined. A case study was conducted for the 2005 Japanese economy to determine the MF and MRF for three critical metals essential for emerging energy technologies: neodymium, cobalt and platinum. The results indicate that in 2005 the MFs generated by Japanese domestic final demand, that is, the consumption-based metal output of Japan, were 1.0×10^3 t for neodymium, 9.4×10^3 t for cobalt, and 2.1×10 t for platinum. Export demand contributes most to the MF, accounting for 3.0×10^3 t, 1.3×10^3 t, and 3.1×10 t, respectively. The MRFs of Japanese total final demand (domestic plus export) were calculated to be 1.7×10 points for neodymium, 4.5×10^{-2} points for cobalt, and 5.6 points for platinum, implying that the Japanese economy is incurring a high mining risk through its use of neodymium. This country's MRFs are all dominated by export demand. The paper concludes by discussing the policy implications and future research directions for measuring the MFs and MRFs of critical metals. For countries poorly endowed with mineral resources, adopting low-carbon energy technologies may imply a shifting of risk from carbon resources to other natural resources, in particular critical metals, and a trade-off between increased mining risk and deployment of such technologies. Our analysis constitutes a first step toward quantifying and managing the risks associated with natural resource mining.

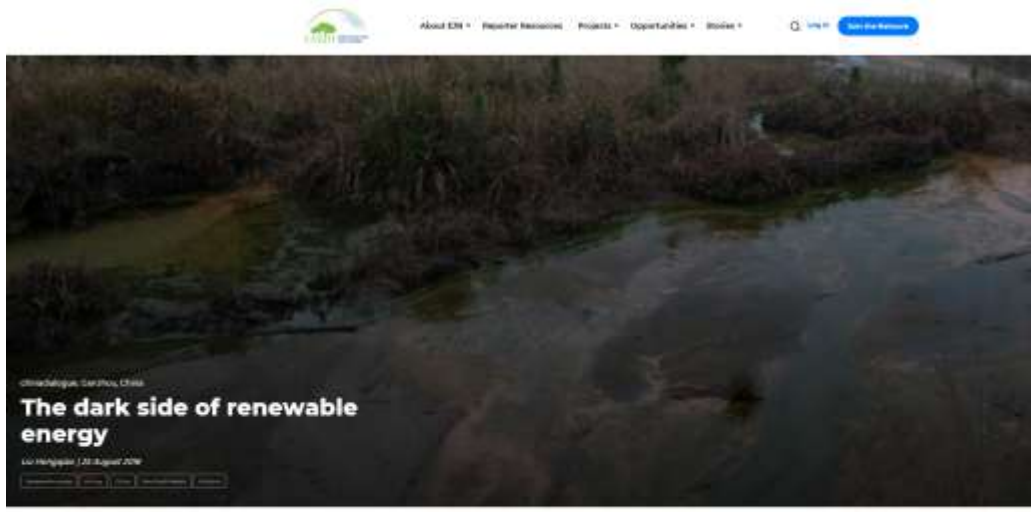


1. INTRODUCTION

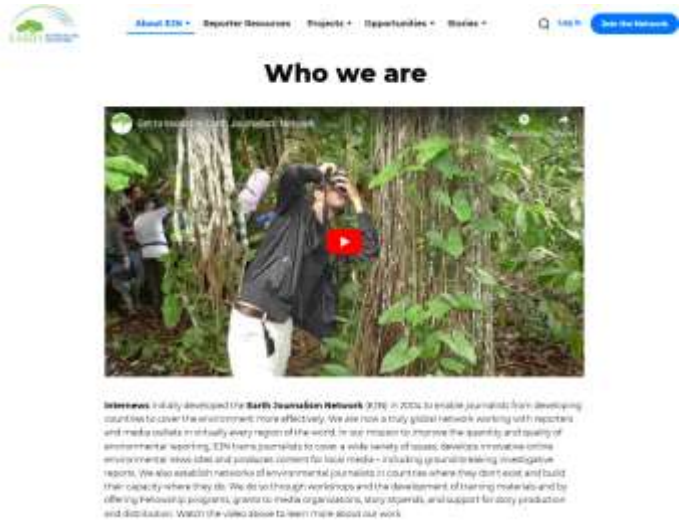
The life cycle of a metal resource begins with mining and proceeds through the phases of processing, production, recycling, and then disposal. Today, however, there are virtually no instan
within th
chains tha
resources and the global supply chains that begin with the mining process is becoming increasingly important.
One material index for quantitatively understanding the resources used in the economy of a single country via these kinds of global supply chains is the index known as the material

https://pubs.acs.org/doi/pdf/10.1021/es504255r

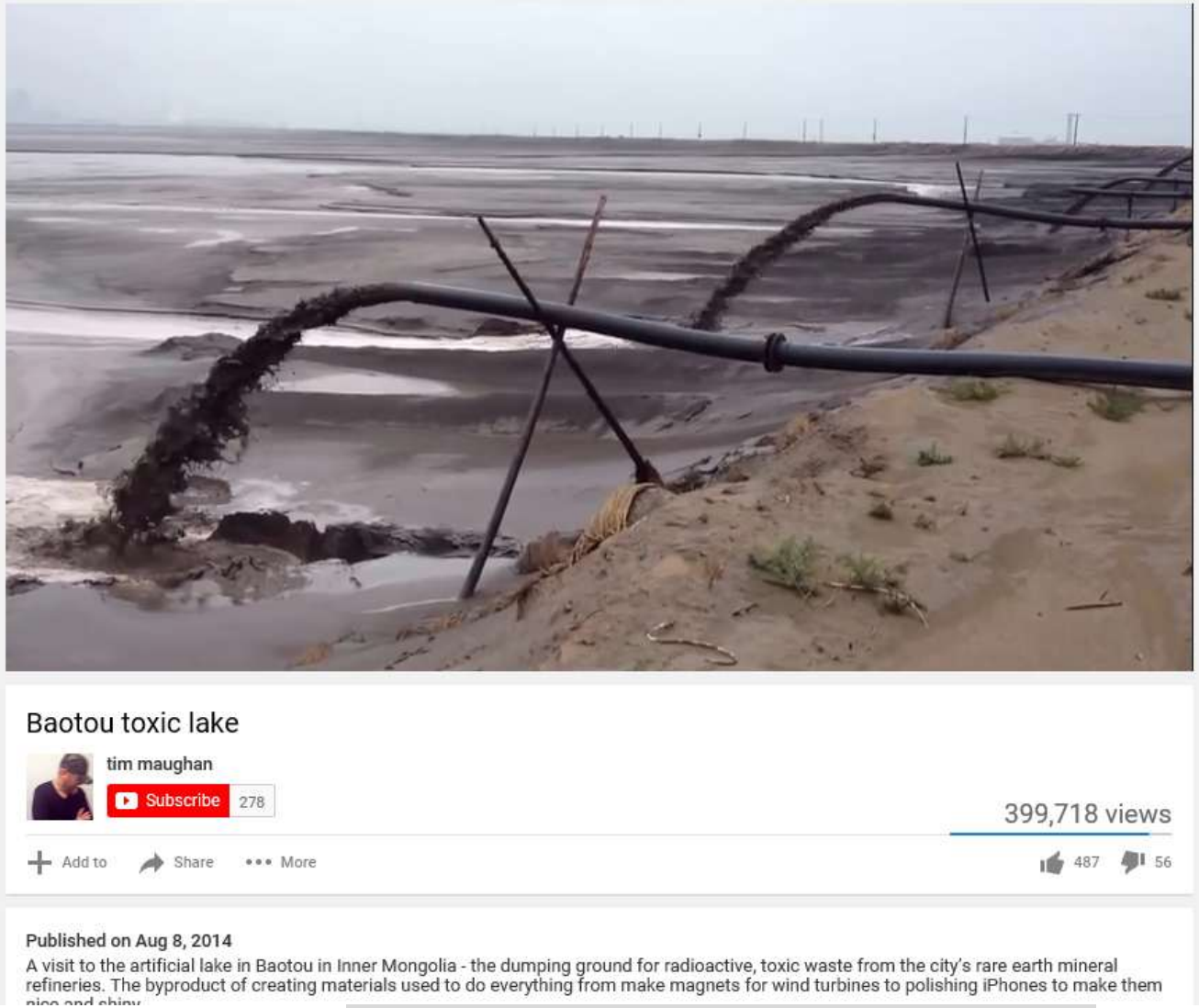
Vårt “grønne skifte” påfører miljø og mennesker alvorlige konsekvenser i råstoffproduksjonen



https://earthjournalism.net/stories/the-dark-side-of-renewable-energy



https://earthjournalism.net/network



https://www.youtube.com/watch?v=t_UdqZdFr-w

Medaljens bakside

https://www.theguardian.com/environment/gallery/2015/apr/15/rare-earthenware-a-journey-to-the-toxic-source-of-luxury-goods

https://www.businessinsider.com/the-worlds-tech-waste-lake-in-mongolia-2015-5?r=US&IR

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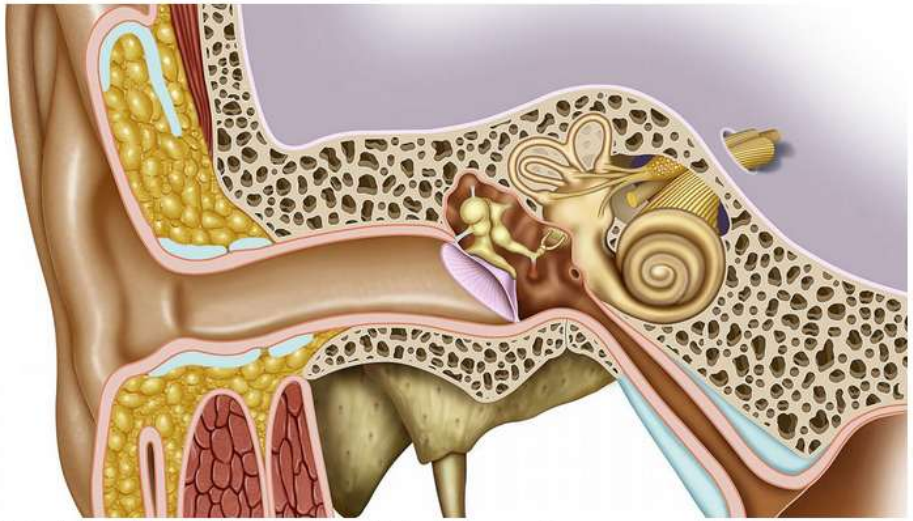

The functioning of the inner ear is at least temporarily altered by exposure to low-frequency sounds.

Alex Luengo/iStockphoto /Thinkstock

Sounds you can't hear can still hurt your ears

By Sarah C. P. Williams | Sep. 30, 2014 , 7:15 PM

A wind turbine, a roaring crowd at a football game, a jet engine running full throttle: Each of these things produces sound waves that are well below the frequencies humans can hear. But

- **A wind turbine, a roaring crowd at a football game, a jet engine running full throttle: Each of these things produces sound waves that are well below the frequencies humans can hear.**
- **But just because you can't hear the low-frequency components of these sounds doesn't mean they have no effect on your ears. Listening to just 90 seconds of low-frequency sound can change the way your inner ear works for minutes after the noise ends, a new study shows.**
- "Low-frequency sound exposure has long been thought to be innocuous, and this study suggests that it's not," says audiology researcher Jeffery Lichtenhan of the Washington University School of Medicine in in St. Louis, who was not involved in the new work.
- Humans can generally sense sounds at frequencies between 20 and 20,000 cycles per second, or hertz (Hz)—although this range shrinks as a person ages. Prolonged exposure to loud noises within the audible range have long been known to cause hearing loss over time. But establishing the effect of sounds with frequencies under about 250 Hz has been harder. Even though they're above the lower limit of 20 Hz, these low-frequency sounds tend to be either inaudible or barely audible, and people don't always know when they're exposed to them.

http://www.sciencemag.org/news/2014/09/sounds-you-cant-hear-can-still-hurt-your-ears

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Research

Cite this article: Kugler K, Wiegrebe L, Grothe B, Kössl M, Gürkov R, Krause E, Drexl M. 2014 Low-frequency sound affects active micromechanics in the human inner ear. *R. Soc. open sci.* **1**: 140166. http://dx.doi.org/10.1098/rsos.140166

Received: 10 July 2014
Accepted: 18 August 2014

Subject Areas:
biophysics/neuroscience/physiology

Keywords:
cochlea, low-frequency sound, spontaneous otoacoustic emissions, noise-induced hearing loss

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Low-frequency sound affects active micromechanics in the human inner ear

Kathrin Kugler[1,3], Lutz Wiegrebe[3], Benedikt Grothe[3], Manfred Kössl[4], Robert Gürkov[1,2], Eike Krause[1,2] and Markus Drexl[1,2]

[1]German Center for Vertigo and Balance Disorders (IFB), and [2]Department of Otorhinolaryngology, Head and Neck Surgery, Grosshadern Medical Centre, University of Munich, 81377 Munich, Germany
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1. Summary

Noise-induced hearing loss is one of the most common auditory pathologies, resulting from overstimulation of the human cochlea, an exquisitely sensitive micromechanical device. At very low frequencies (less than 250 Hz), however, the sensitivity of human hearing, and therefore the perceived loudness is poor. The perceived loudness is mediated by the inner hair cells of the cochlea which are driven very inadequately at low frequencies. To assess the impact of low-frequency (LF) sound, we exploited a by-product of the active amplification of sound outer hair cells (OHCs) perform, so-called spontaneous otoacoustic emissions. These are faint sounds produced by the inner ear that can be used to detect changes of cochlear physiology. We show that a short exposure to perceptually unobtrusive, LF sounds significantly affects OHCs: a 90 s, 80 dB(A) LF sound induced slow, concordant and positively correlated frequency and level oscillations of spontaneous otoacoustic emissions that lasted for about 2 min after LF sound offset. LF sounds, contrary to their unobtrusive perception, strongly stimulate the human cochlea and affect amplification processes in the most sensitive and important frequency range of human hearing.

- For the new study, neurobiologist Markus Drexl and colleagues at the Ludwig Maximilian University in Munich, Germany, asked 21 volunteers with normal hearing to **sit inside soundproof booths and then played a 30-Hz sound for 90 seconds.**
- The deep, vibrating noise, Drexl says, is about what you might hear "if you open your car windows while you're driving fast down a highway."
- Then, they used probes to record the natural activity of the ear after the noise ended, taking advantage of a phenomenon dubbed **spontaneous otoacoustic emissions** (SOAEs) in which the healthy human ear itself emits faint whistling sounds. "Usually they're too faint to be heard, but with a microphone that's more sensitive than the human ear, we can detect them," Drexl says. Researchers know that SOAEs change when a person's hearing changes and disappear in conjunction with hearing loss.
- **People's SOAEs are normally stable over short time periods. But in the study, after 90 seconds of the low-frequency sound, participants' SOAEs started oscillating, becoming alternately stronger and weaker. The fluctuations lasted about 3 minutes, the team reports today in Royal Society Open Science.**
- **The changes aren't directly indicative of hearing loss, but they do mean that the ear may be temporarily more prone to damage after being exposed to low-frequency sounds, Drexl explains. "Even though we haven't shown it yet, there's a definite possibility that if you're exposed to low-frequency sounds for a longer time, it might have a permanent effect," Drexl adds.**

http://rsos.royalsocietypublishing.org/content/royopensci/1/2/140166.full.pdf

Effects of low frequency noise and vibrations: Environmental and occupational perspectives, 2011

- Abstract
- **This article provides a current knowledge base of adverse effects due to community and occupational low frequency noise (20–200 Hz). Low frequency noise has a large annoyance potential, and the prevalence of annoyance increases with higher sound pressure levels (SPLs) of low frequencies.**
- **Low frequency noise annoyance is related to headaches, unusual tiredness, lack of concentration, irritation, and pressure on the eardrum. Data suggest that sleep may be negatively affected. In occupational environments, low frequency noise may negatively affect performance at moderate noise levels, whereas the health consequences of higher SPLs are less well known.**
- Factors inherent in most low frequency noise such as the throbbing characteristics, the intrusion of low frequencies felt when other frequencies in the sound are attenuated, and the vibration sensations sometimes felt contribute to the response.
- Measurements need to properly assess the individual exposure and include spectral, temporal, and if present also vibration characteristics.

https://www.gu.se/english/research/publication/?publicationId=150522

Nyttig artikkel

Sources and effects of low-frequency noise

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(Received 14 February 1995; revised 30 March 1995; accepted 2 January 1996)

The sources of human exposure to low-frequency noise and its effects are reviewed. Low-frequency noise is common as background noise in urban environments, and as an emission from many artificial sources: road vehicles, aircraft, industrial machinery, artillery and mining explosions, and air movement machinery including wind turbines, compressors, and ventilation or air-conditioning units. The effects of low-frequency noise are of particular concern because of its pervasiveness due to numerous sources, efficient propagation, and reduced efficacy of many structures (dwellings, walls, and hearing protection) in attenuating low-frequency noise compared with other noise. Intense low-frequency noise appears to produce clear symptoms including respiratory impairment and aural pain. Although the effects of lower intensities of low-frequency noise are difficult to establish for methodological reasons, evidence suggests that a number of adverse effects of noise in general arise from exposure to low-frequency noise: Loudness judgments and annoyance reactions are sometimes reported to be greater for low-frequency noise than other noises for equal sound-pressure level; annoyance is exacerbated by rattle or vibration induced by low-frequency noise; speech intelligibility may be reduced more by low-frequency noise than other noises except those in the frequency range of speech itself, because of the upward spread of masking. On the other hand, it is also possible that low-frequency noise provides some protection against the effects of simultaneous higher frequency noise on hearing. Research needs and policy decisions, based on what is currently known, are considered.

PACS numbers: 43.50.Qp, 43.28.Dm

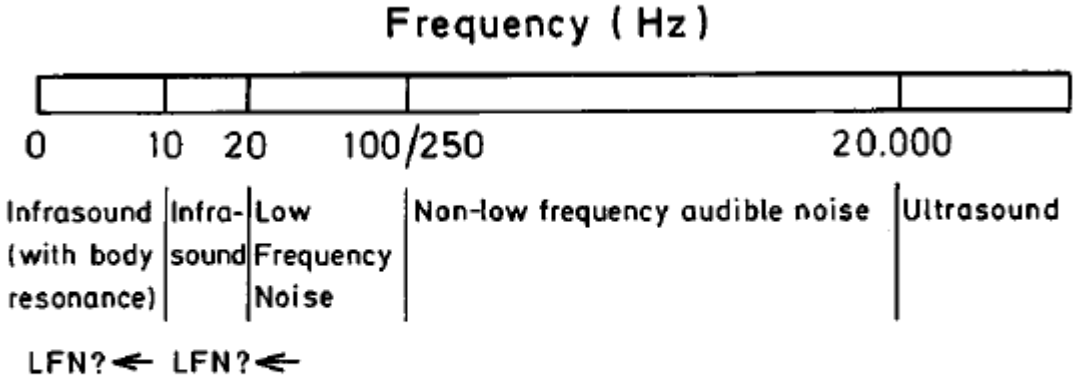

FIG. 1. The frequency spectrum of sound and its nomenclature.

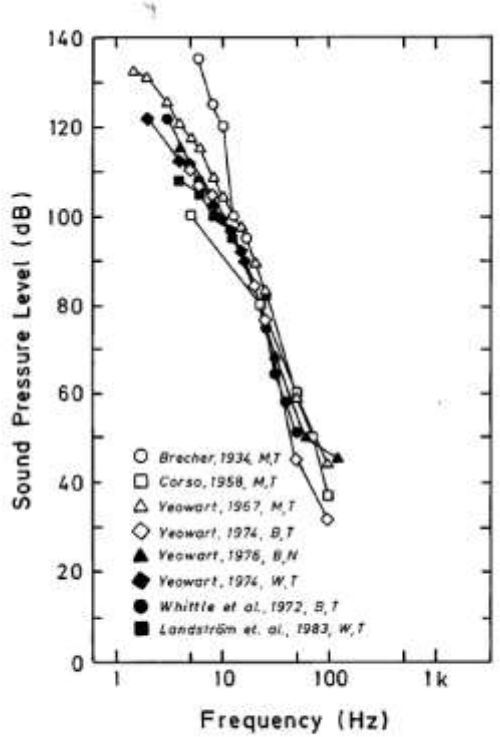

FIG. 2. Hearing thresholds as a function of signal frequency in various studies (M=monaural; B=binaural; W=whole body; T=tone; N=noise band).

http://doc.wind-watch.org/sources-effects-lfn-1996.pdf

Nyttig artikkel

Sources and effects of low-frequency noise

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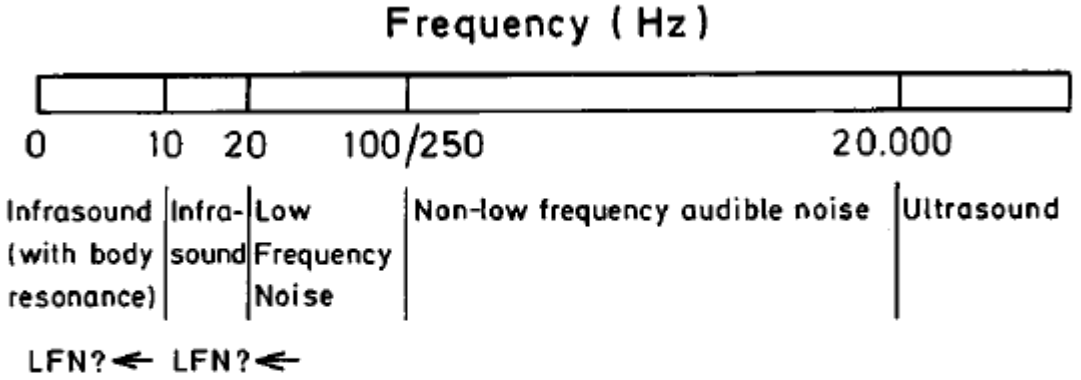

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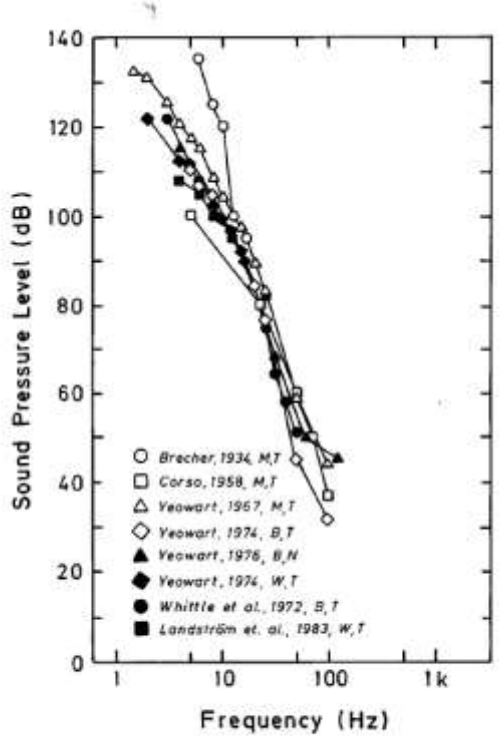

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http://doc.wind-watch.org/sources-effects-lfn-1996.pdf

Kartlegging av lavfrekvent støy.
Stående bølger i rommet kan gi en varisjon på 20-30 dB avhengig av hvor det måles

ON MEASURING LOW-FREQUENCY NOISE INDOORS

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ABSTRACT

Due to standing waves, the sound pressure within a room may vary 20-30 dB. For assessment of annoyance from low-frequency noise, it is important to measure a level that adequately represents the exposure that may give rise to the annoyance, rather than some room average level. Thus, mainly areas of the room with high sound pressure levels are of interest, since persons present in such areas are not helped by the existence of much lower levels elsewhere. Sound fields in rooms were investigated using numerical simulations and scanning measurements of the entire sound pressure distributions in three different rooms. Measurements were also performed in three-dimensional corners as well as according to Swedish and Danish guidelines. The sound pressure level that is exceeded in only 10% of the space of a room (L10) is proposed as a reasonable target for a measurement method. The Swedish method showed good results, however its use of C-weighting during scanning for maximum can lead to the maximum for wrong frequency components, i.e. components other than those that give rise to annoyance. The Danish method was found to have a high risk of significantly underestimating the noise present in a room, unless complainants can precisely appoint the measurement positions. It was found that a very good estimate of the L10 target level is obtained by measuring only in four three-dimensional corners.

https://www.researchgate.net/publication/5327784_Measuring_low-frequency_noise_indoors

«Stående bølger»

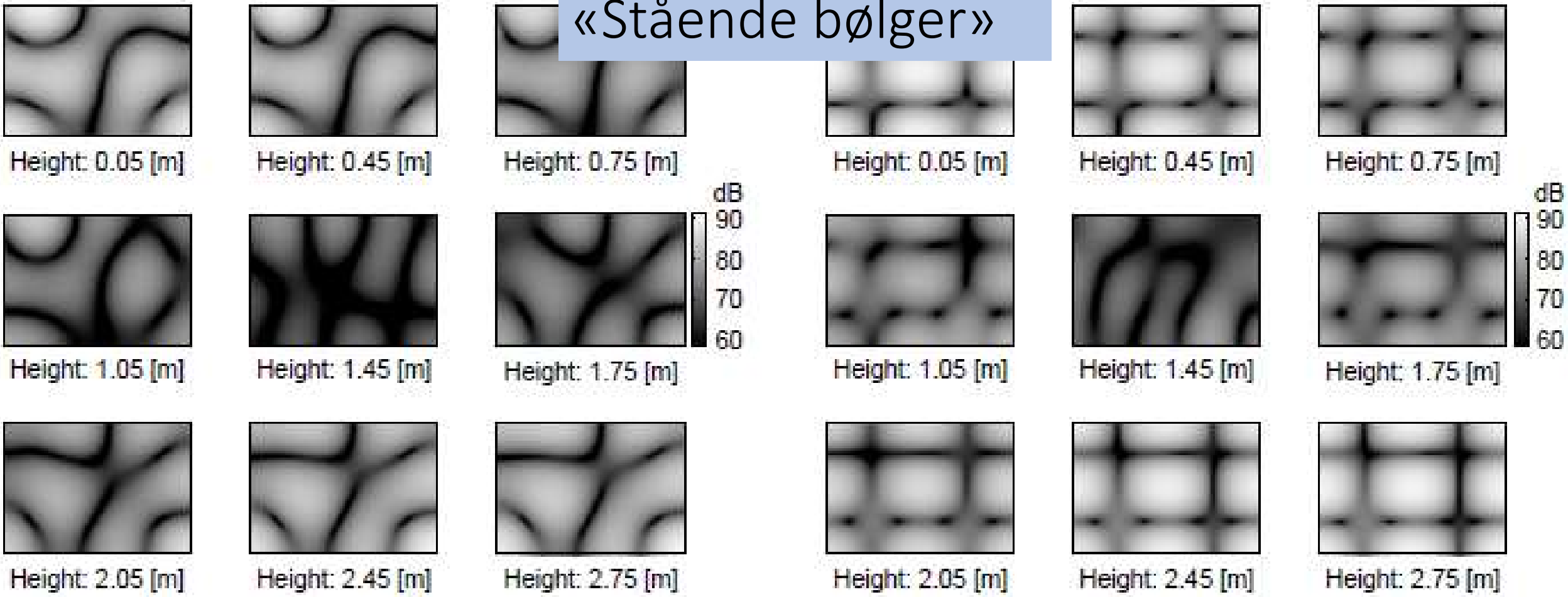
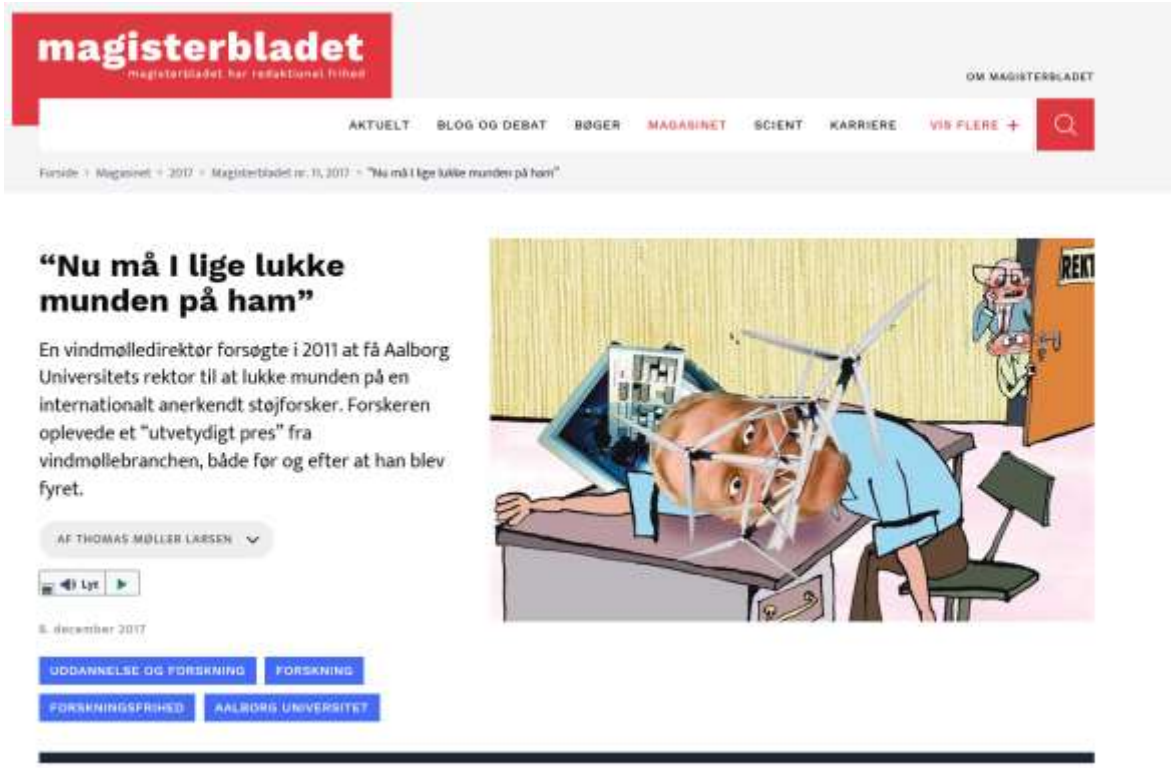


Figure 1: *Sound pressure distribution in a 5.7 m by 3.8 m by 2.8 m (L x W x H) room. Left: Sinusoidal sound wave at 114 Hz. Right: Sinusoidal sound wave at 124 Hz (mode 2,2,1). Sound generated by piston in lower left corner indicated by rectangle. Simulated using FDTD with 0.1 m cell size and 6 kHz sampling frequency.*

https://www.researchgate.net/publication/5327784_Measuring_low-frequency_noise_indoors

Brysom professor som la se ut med vindturbinindustrien



https://www.magisterbladet.dk/magasinet/2017/magisterbladet-nr-11-2017/nu-maa-i-lige-lukke-munden-paa-ham

https://www.information.dk/indland/2014/06/fyret-stoej-professor-valgt-blandt-200-forskere

https://nordjyske.dk/nyheder/aau-fyrer-topforsker/2709b19d-7764-4b75-a3ae-2ef649eb51d7

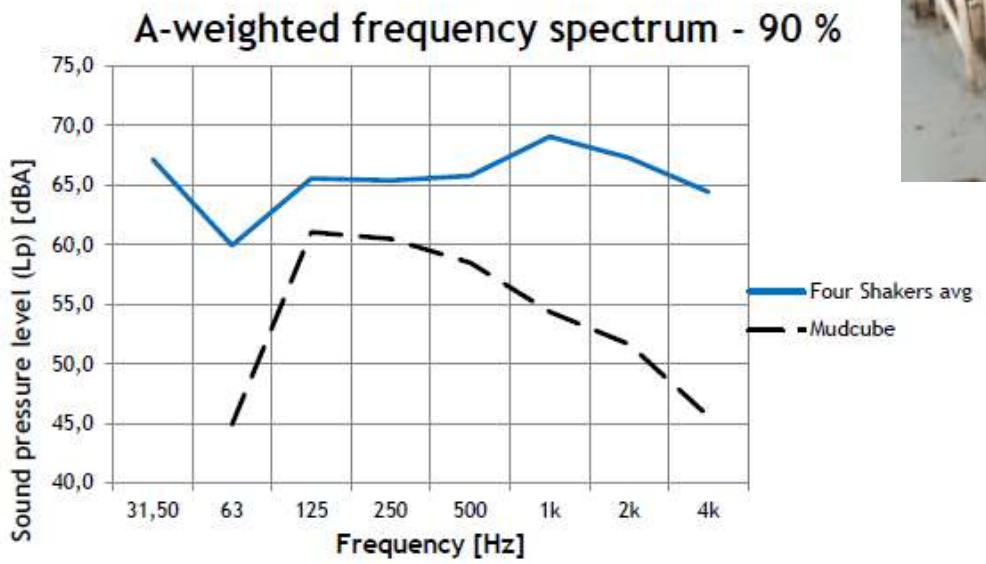
FROKOSTMØTE HØR! MUD CUBE – MINDRE STØY OG LIKE GOD YTELSE SOM VANLIGE «SHAKERE» 15.03.13

Støy fra shaker og MudCube

Norsk olje&gass

Shakerrom preges av mye lavfrekvent støy
Siktene drives av eksentermasse med frekvens ca 30Hz.

Mye av støydata er oppgitt som A-veidenivåer:
Tradisjonelle shaker 75-80dBA ved 1m 90% kapasitet
MudCube 68dBA ved 1m 90% kapasitet
Begge fritt felt – ingen refleksjoner fra rommet, kun 1 enhet



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https://www.norskoljeoggass.no/drift/arbeidsmiljo/stoy/moter-seminarer-mm/mudcube/

NORSOK S-002N Støydatablad

Krever ikke data på infralyd

D.5 Støydatablad

STØYDATABLAD (NDS) Side: av Dato: Rev.:

Dokumentnr:

Merkenr: Plassering/modul
Enhet Antall
Funksjon Forespørselsnr.
Størrelse og type Tilbudsnr.
Leverandør Ordrenr.
Produsent Jobbnr.
Modell Serienr.

KONSTRUKSJONSDATA

Utstyrsstørrelse (l x b x h)	m	Beregnet ΔL = Lw - Lp		dB
Effekt	kW	Virkningsgrad		%
Kapasitet		Motortype		
Utløpstrykk	bar	Motorhastighet		rpm
Innløpstrykk	bar	Rotasjonshastighet for utstyr		rpm
Utstyrsvekt	kg	Girtann kontaktfrekvens		rpm
		Strømningsfrekvens for blader/viftehjul		Hz
		Forholdet mellom antall statorer/rotorskovler		

SELSKAPSSPESIFIKKE DATA		Senterfrekvens i oktavbånd, Hz / uveid nivå, dB								
Støynivågrenser [1]	A-veid	31,5	63	125	250	500	1000	2000	4000	8000
Lw komplett maskin										
$Lp_{average}$ @ 1m / L'p										
Lp_{max} @1m dist. & 1,6m over gulv										

Spesielle krav

Krav til støyprøving Ja O Nei O Valgfritt O

LEVERANDØRDATA		Senterfrekvens i oktavbånd, Hz / uveid nivå, dB								
Deklarerte og/eller garanterte nivåer [1]	A-veid	31,5	63	125	250	500	1000	2000	4000	8000
Lw komplett maskin										
$Lp_{average}$ @ 1m / L'p										
Lp_{max} @1m dist. & 1,6m over gulv										
Beregnet eller deklarert K										

Smalbåndskomponent Ja O Nei O Frekvens/oktavbånd: Hz
C-veid nivå > 130 dB(C) PEAK: Ja O Nei O
Metode for støynivåprøving
Beskrivelse av iverksatte tiltak for støykontroll / annen informasjon

SOM BYGD-STØYDATA		Senterfrekvens i oktavbånd, Hz / uveid nivå, dB								
Målte støynivåer [1]	A-veid	31,5	63	125	250	500	1000	2000	4000	8000
Lw komplett maskin										
$Lp_{average}$ @ 1m / L'p										
Lp_{max} @1m dist. & 1,6m over gulv										
K for som bygd-måling										

Metode for støynivåprøving
Spesiell informasjon

Merknad 1 Lp: Lydtrykknivå ved 1 m avstand frifeltforhold over en reflekterende flate (dB re. 20 µPa)
Lw: Lydeffektnivå (dB re. 1 pW) L'p: Lydeffektnivå målei felt (dB re. 20 µPa)
K: Måleusikkerhet

Figur D.1 — Støydatablad

Laveste C på et piano 32 Hz

Utstyrsvekt kg Forholdet mellom antall statorer/rotorskovler

SELSKAPSSPESIFIKKE DATA		Senterfrekvens i oktavbånd, Hz / uveid nivå, dB								
Støynivågrenser [1]	A-veid	31,5	63	125	250	500	1000	2000	4000	8000
Lw komplett maskin										
$Lp_{average}$ @ 1m / L'p										
Lp_{max} @1m dist. & 1,6m over gulv										

Spesielle krav

Krav til støyprøving Ja O Nei O Valgfritt O

LEVERANDØRDATA		Senterfrekvens i oktavbånd, Hz / uveid nivå, dB								
Deklarerte og/eller garanterte nivåer [1]	A-veid	31,5	63	125	250	500	1000	2000	4000	8000
Lw komplett maskin										
$Lp_{average}$ @ 1m / L'p										
Lp_{max} @1m dist. & 1,6m over gulv										
Beregnet eller deklarert K										

Smalbåndskomponent Ja O Nei O Frekvens/oktavbånd: Hz
C-veid nivå > 130 dB(C) PEAK: Ja O Nei O
Metode for støynivåprøving
Beskrivelse av iverksatte tiltak for støykontroll / annen informasjon

31,5 Hz

SOM BYGD-STØYDATA		Senterfrekvens i oktavbånd, Hz / uveid nivå, dB								
Målte støynivåer [1]	A-veid	31,5	63	125	250	500	1000	2000	4000	8000
Lw komplett maskin										
$Lp_{average}$ @ 1m / L'p										
Lp_{max} @1m dist. & 1,6m over gulv										
K for som bygd-måling										

Metode for støynivåprøving
Spesiell informasjon

Merknad 1 Lp: Lydtrykknivå ved 1 m avstand frifeltforhold over en reflekterende flate (dB re. 20 µPa)
Lw: Lydeffektnivå (dB re. 1 pW) L'p: Lydeffektnivå målei felt (dB re. 20 µPa)
K: Måleusikkerhet

NORSOK S-002 N:2018 **Standard**

Arbeidsmiljø. Utgave 5, 2018

Språk: Utgave: **5** (2018-03-19)

Produktinformasjon Overvåk standarden

NOK **1 441,00** (eks. mva)

Skriv ut på papir

Trykket og innbunde

https://www.standard.no/no/Nettbutikk/produktkatalogen/Produktpresentasjon/?ProductID=968037

The Problems With “Noise Numbers” for Wind Farm Noise Assessment

Abstract

Human perception responds primarily to sound character rather than sound level. Wind farms are unique sound sources and exhibit special audible and inaudible characteristics that can be described as modulating sound or as a tonal complex.

Wind farm compliance measures based on a specified noise number alone will fail to address problems with noise nuisance.

The character of wind farm sound, noise emissions from wind farms, noise prediction at residences, and systemic failures in assessment processes are examined.

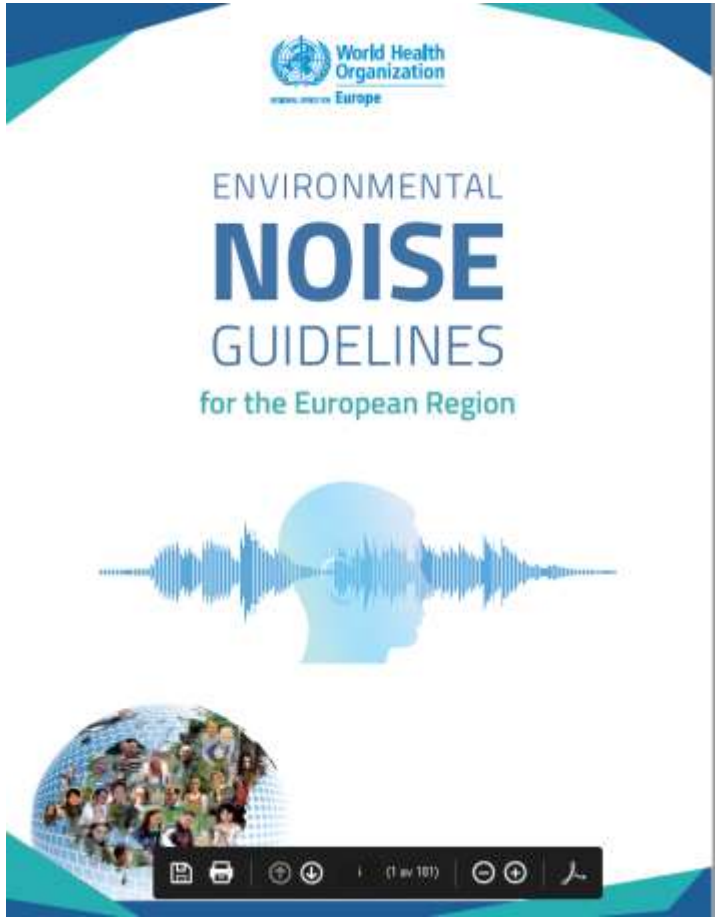
Human perception of wind farm sound is compared with noise assessment measures and complaint histories. The adverse effects on health of persons susceptible to noise from wind farms are examined and a hypothesis, the concept of heightened noise zones (pressure variations), as a marker for cause and effect is advanced.

A sound level of LAeq 32 dB outside a residence and above an individual’s threshold of hearing inside the home are identified as markers for serious adverse health effects affecting susceptible individuals.

The article is referenced to the author’s research, measurements, and observations at different wind farms in New Zealand and Victoria, Australia.

https://stopthesethings.files.wordpress.com/2014/12/bull-sci-technol-soc-2011-thorne-262-90.pdf

WHO Environmental Noise Guideline, 2018



Contents

http://www.euro.who.int/__data/assets/pdf_file/0008/383921/noise-guidelines-eng.pdf?ua=1

Overstyrer vindturbinindustrien hensynet til enkeltmennesker, miljø og arbeidsmiljø?

- Produksjon av vindturbiner krever bruk av store mengder sjeldne jordmetaller.
- Vindturbiner krever store inngrep i nature
- Vindturbiner avgir kraftig lavfrekvent støy.
- De helsemessige effektene av lavfrekvent støy blir fortsatt ikke tatt på alvor i norsk industri

«Det grønne skiftet» må inkludere hensynet til Helse, Miljø og Sikkerhet!

Den lavfrekvente støyen
må bli tatt hensyn til

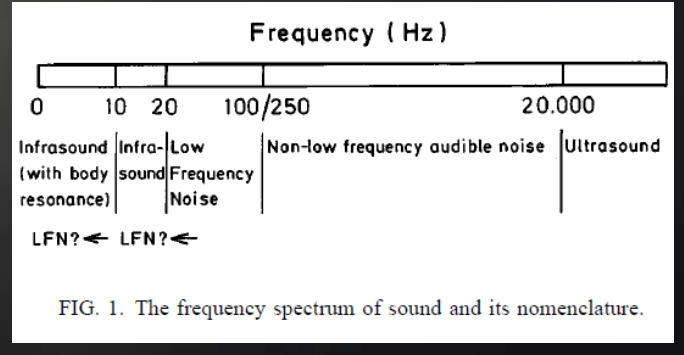


FIG. 1. The frequency spectrum of sound and its nomenclature.

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SAFE www.safe.no

31 års kamp for rettferdighet (2019) “Fullt forsvarlig”.

Asymmetrisk fordeling av risiko. Om å leve med en yrkessykdom hvor selskapet ikke erkjenner ansvar.

Harry Stiegler Brevik med appell til konsernsjef Eldar Sætre, Equinor

https://www.youtube.com/watch?v=FVp2F179-j4&feature=youtu.be

20 års kamp for rettferdighet (2008) ”Åpent lende”

https://safe.no/hms/apent-lende/

https://www.safemagasinet.no/wp-content/uploads/2016/06/SAFE-Magasinet-2012-Nr-04.pdf

25 års kamp for rettferdighet (2013) ”Ta ansvar!”

https://safe.no/ta-ansvar-safes-hms-konferanse-22-23-mai/

Foto: Halvor Erikstein