

# Hydrocarbon Background Levels in Denmark: Indoor and Outdoor Air

*Per Loll* ([pl@dmr.dk](mailto:pl@dmr.dk)) (DMR A/S, Denmark)

Per Novrup and Boerge Hvidberg (Central Denmark Region, Denmark)

**Background/Objectives.** Indoor and outdoor air typically contains volatile organic compounds (VOCs) from both outdoor and indoor sources. The VOC levels originating from such sources can be referred to as “background levels”, when assessing the potential for vapor intrusion of VOCs from a subsurface contamination to the indoor air. When measuring VOCs directly in indoor air at contaminated sites, the resulting concentration will contain a contribution from background sources as well as a contribution from the subsurface contamination. When determining whether or not remediation of sub-slab contamination is warranted it is often important to know if the presence of volatile organic compounds (VOCs) in indoor air is primarily from background sources, or primarily from subsurface contamination.

The primary study objective is to produce updated background hydrocarbon levels in both outdoor and indoor air, at non-contaminated Danish homes. Secondary purposes are to investigate if there are significant seasonal variations in the background levels in outdoor or indoor air, and if various factors are consequential in relation to the background levels; e.g. tobacco smoking, wood stove heating, rural/urban areas, town/city size, habits/methods of venting, traffic etc.

**Approach/Activities.** The investigation has been conducted by voluntarily engaged employees of the Central Denmark Region and DMR A/S, as well as their friends and family members. The methods included filling in of a questionnaire concerning all factors that might have an influence on background levels of VOC in indoor and outdoor air. Passive sampling by ORSA-tubes was conducted in a standardized manner in the outdoor and indoor air, and were analyzed by a professional laboratory (TVOC as C6-C35, BTEXN and C9/C10-aromatics). Two sampling rounds were conducted, in November 2015 (131 sites) and May 2016 (142 sites), respectively. Statistical analyses were carried out, identifying statistically significant trends in the collected data.

**Results/Lessons Learned.** In the Danish regulatory framework, the background levels of benzene and TVOC (C6-C35) are the compounds causing difficulties in relation to risk assessment at contaminated sites. More than 99% of all indoor and outdoor measurements of benzene are above the regulatory criteria of  $0,13 \mu\text{g}/\text{m}^3$ . For indoor air, the median values are: May:  $0,44 \mu\text{g}/\text{m}^3$ , Nov.:  $0,66 \mu\text{g}/\text{m}^3$ . For outdoor air the median values are: May:  $0,28 \mu\text{g}/\text{m}^3$ , Nov.:  $0,50 \mu\text{g}/\text{m}^3$ . 29% of all indoor measurements of TVOC (in un-contaminated Danish homes) are above the regulatory criteria of  $100 \mu\text{g}/\text{m}^3$ . Smoking and wood stove burning are identified as major contributors to high background benzene levels in residential areas. Surprisingly, benzene concentration in outdoor air are at the same level in rural and in urban areas.

