



# Full Monopile Removal by means of Vibratory Technology

Case study of the Netherlands decommissioning

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**SeeOff** *Development of efficient strategies for offshore wind farm decommissioning*

**DIESEKO GROUP**

## Agenda

- Who is Dieseko



## Agenda

- Decom experience – project Lely Windfarm, the Netherlands
- Fundamentals of Vibro Equipment
- How a Vibratory Hammer works
- Vibrating vs Impact Hammering
- Noise emissions
- Subsea Operations
- Industry Challenges

## 500M dismantling wind park

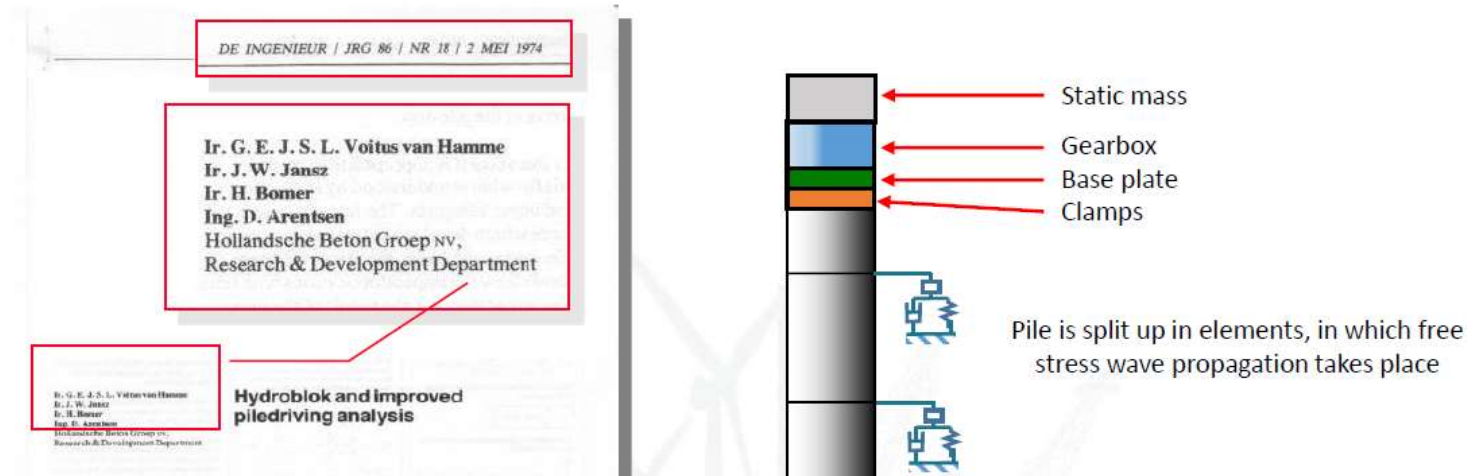


# Fundamentals

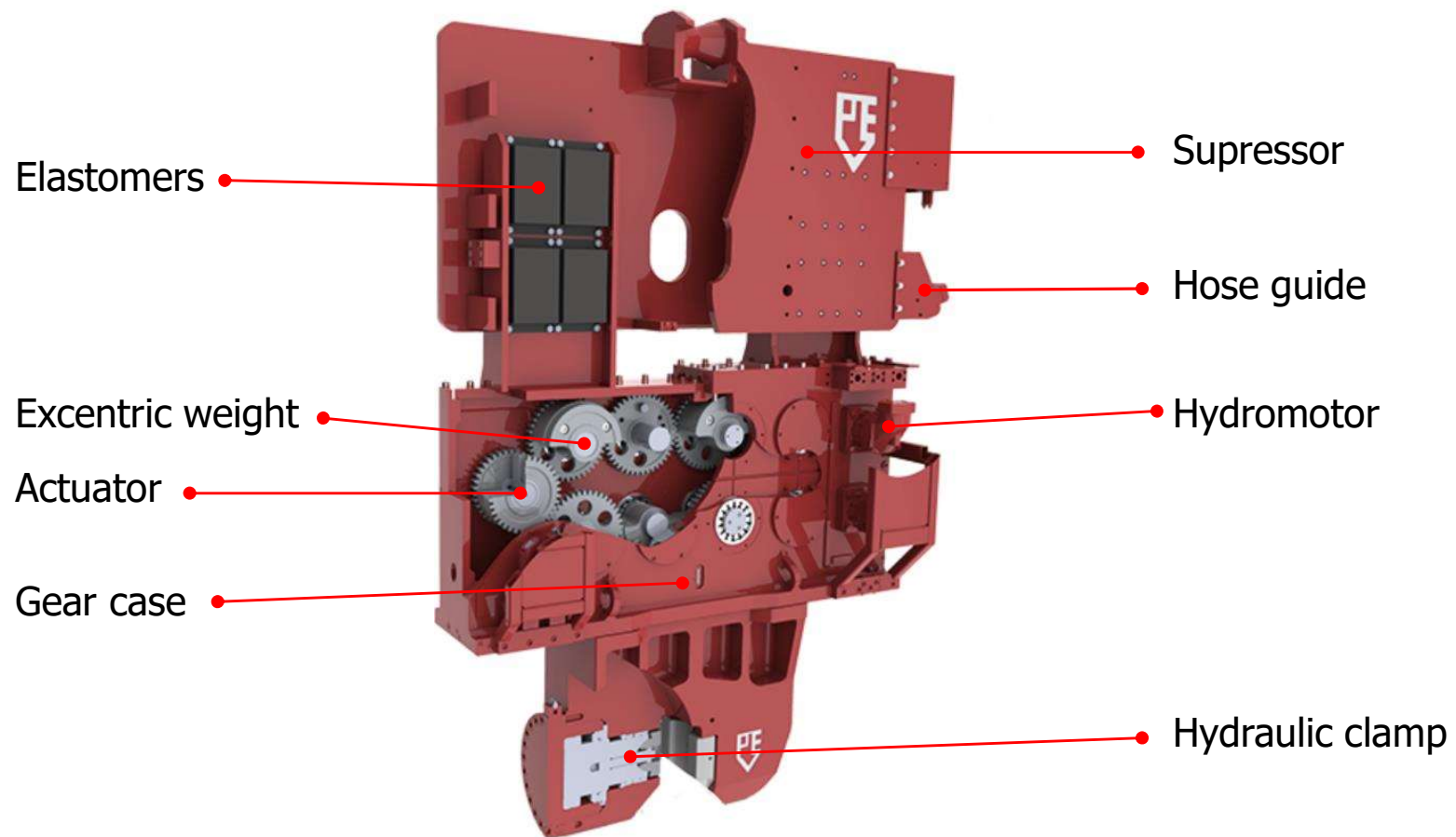
## Vibratory Hammers

- Accurate simulations based on 1974 wave-equation theory
- Soil fatigue caused by repetitive vibro movement reduces friction when driving or extracting
- Pile movement occurs when pile-motion exceeds elastic deformation of soil
- Voitus van Hamme's wave equation is based on pile segments with mass, spring- and damping characteristics

## Wave equation: Voitus van Hamme



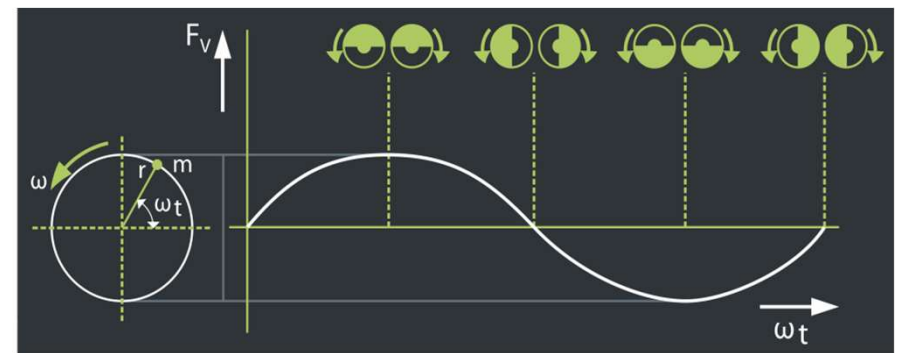
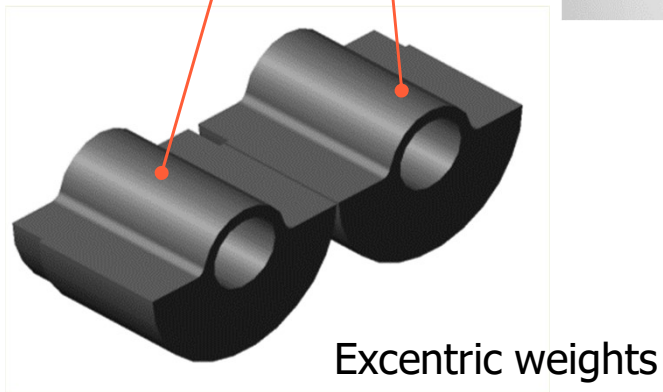
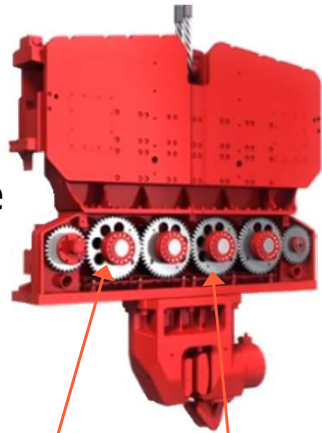
## How a Vibratory Hammer works



## How a Vibratory Hammer works

### Excentric weights

- In pairs
- Create centrifugal force
- Vertical movement



## Challenge of extracting piles vs vibratory driving of piles

Static pull on the suppressor

Exceeds pile & vibratory hammer mass plus soil friction and marine growth

Casus MP weight 1600Te; Vibro equipment mass: 500Te; Soil Friction and Marine growth ?

Required static pull capacity: order of magnitude: 2500Te ?

Design of suppressor and elastomers will be leading

Presently, 2000Te is achievable

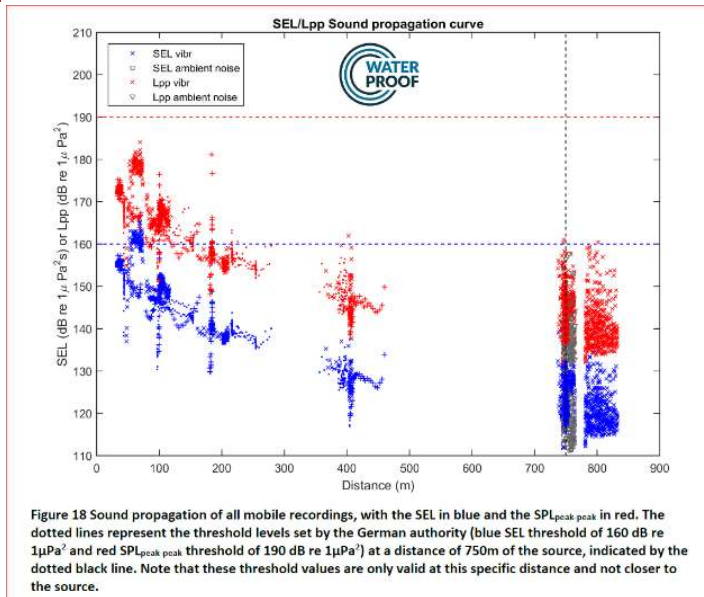
Modern current MP designs call for design change of Vibratory Equipment

# Vibrating vs Hammering Driving





# Noise Reduction



Between 6 and 11 October 2016, 4 monopiles (3200-3700mm dia) were retracted from the seabed at "Windpark Lely" with our PVE 500M vibratory hammer. During the work extensive underwater sound measurements were performed, resulting in positive indications of noise levels compared to "German requirements".

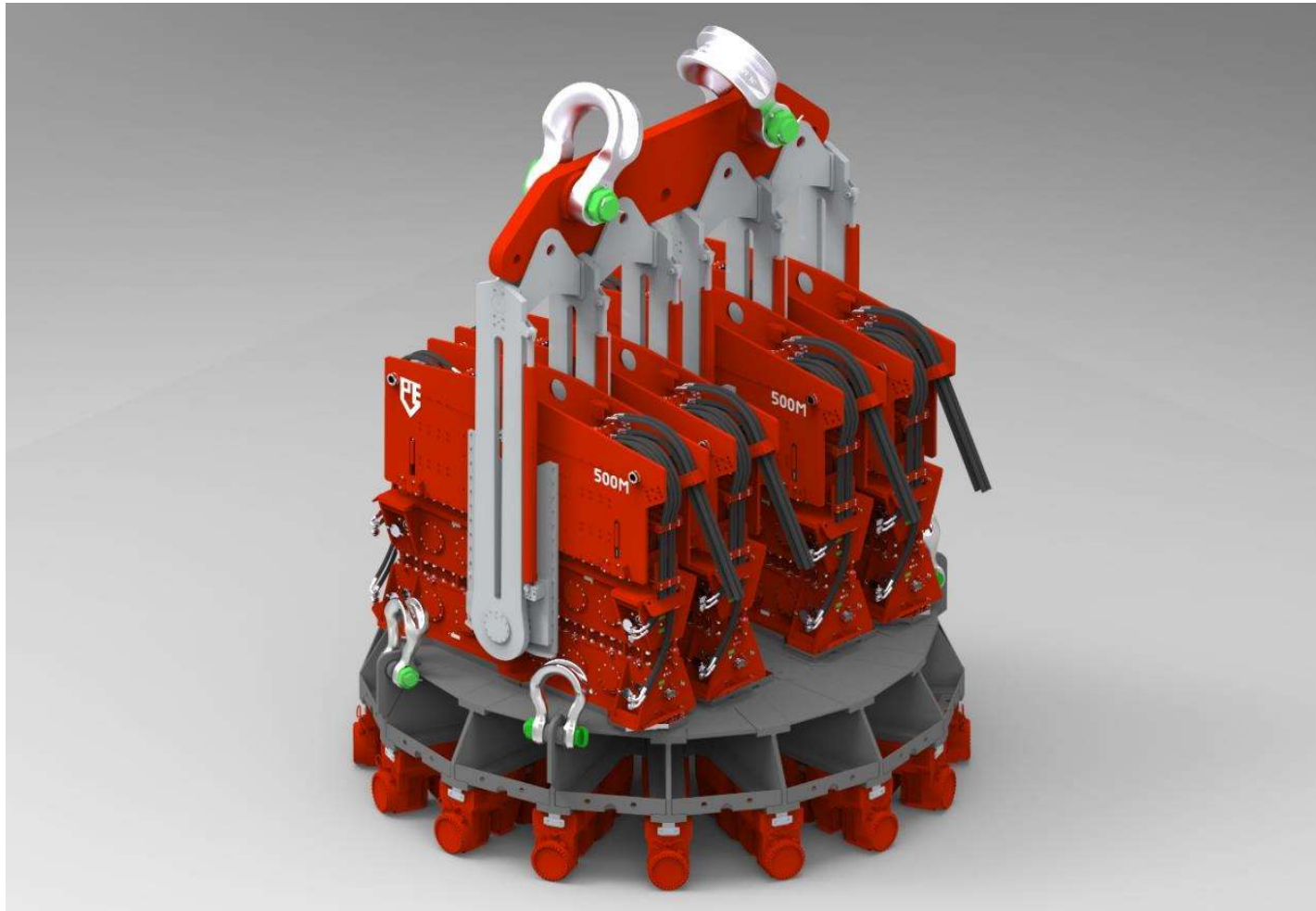
## Conclusions

The measured sound levels of both the Sound Exposure Level (SEL) and the peak-to-peak Sound Pressure Level (SPL<sub>peak-peak</sub>) are substantially lower than the threshold levels that are set by the German authorities (i.e. SEL 160 dB re 1 μPa² and SPL<sub>peak-peak</sub> 190 dB re 1 μPa²) at a distance of 750m from the source. Sound levels are measured without any mitigation measure in force to reduce sound propagation. It is expected that for comparable foundations and vibro-hammer intensities in offshore conditions, the source level will not deviate considerably from the levels measured during this campaign. Therefore, the threshold levels are likely not to be exceeded at the specified distance of 750m. It is recommended to validate this by actual measurements under representative offshore conditions to provide solid proof.

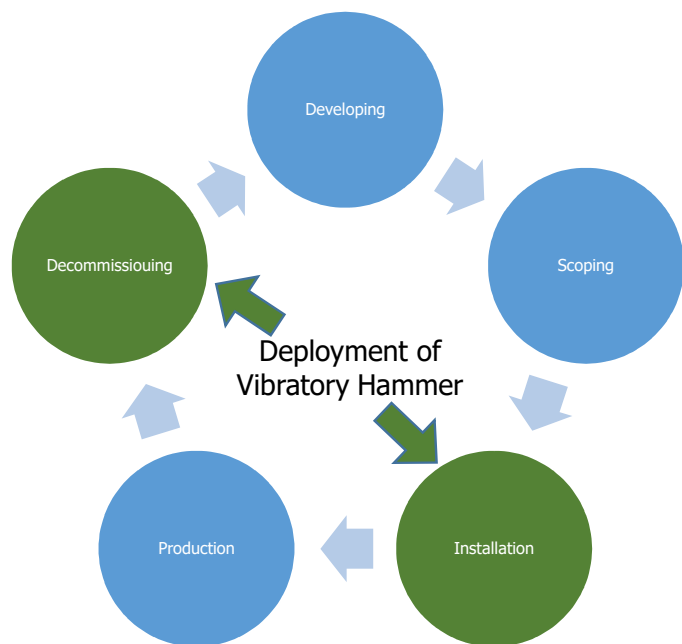
# Subsea Operations



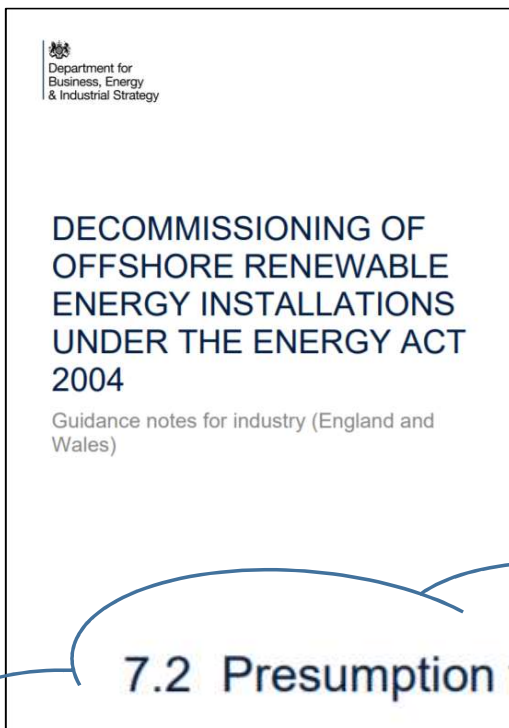
## 2000 GIANT – Specially designed for OWF



# Vibratory Hammer in OWF life cycle and requirements for removal of foundations



Life cycle OWF



## Industry Challenges

Drive for efficient decomm operations may lead to the formation of a dedicated decomm supply chain with own equipment, vessels, operating methodologies with high deployment rate

# How to realize ?



# Thank you

## Q & A

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