RAMBOLL
OWNER'S ENGINEERING ON COLD CLIMATE SITES

REFERENCE PROJECTS

OWNER'S ENGINEERING
REFERENCE PROJECT

WIND FARM SIDENSJÖ

TECHNICAL DUE DILIGENCE AND CONSTRUCTION SUPERVISION (OE)

CAPACITY: 144 MW

CLIENT: Stadtwerke München GmbH (Germany)

LOCATION: City of Sidensjö, region Västernorrland, Sweden

PERIOD: 2012 - 2015

SERVICES PROVIDED:
Technical Due Dilugence (TDD) and supervision of the construction process (Owner's Engineer). Review of executive designs and technical lead in the contract negotiations.

OWNER'S ENGINEERING
REFERENCE PROJECT

WIND FARM RASKIFTET

TECHNICAL DUE DILIGENCE AND CONSTRUCTION SUPERVISION (OE)

CAPACITY: 112 MW

CLIENT: Austri Raskiftet SPV Holding

LOCATION: Municipalities of Åmot and Trysil, 200 km northeast of Oslo, Norway

PERIOD: 2016 - ongoing

SERVICES PROVIDED:
Technical Due Diligence (TDD) and supervision of the construction process (Owner's Engineer)

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OWNER'S ENGINEERING
REFERENCE PROJECT

WIND FARM SILOVUORI

TECHNICAL DUE DILIGENCE AND CONSTRUCTION SUPERVISION (OE)

CAPACITY: 26.4 MW

CLIENT: KGAL Investment Management GmbH & Co. KG
LOCATION: Municipalities of Pyhäjoki, 500 km north of Helsinki, Finland

PERIOD: 2015 – 2017

SERVICES PROVIDED:
Technical Due Diligence (TDD) and supervision of the construction process (Owner's Engineer)

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OWNER'S ENGINEERING
KEY ISSUE:

PLANNING

As owners engineer or consultant, we recommend to consider if certain tasks can avoided to be done during the winter time like:

- Turbine foundations (concrete works)
- Earthworks
- Turbine component deliveries & delivery of the heavy electrical components
- Turbine installation

In case, any of these activities must be carried out during the winter time, extra arrangements and precautions have to take a place to avoid errors due to the cold climate influence on works.

FOUNDATION WORKS

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FOUNDATION WORKS

HEATING SYSTEM BELOW CONCRETE

Before pouring concrete a heating system will be installed to avoid smaller cracks due to different temperatures.

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FOUNDATION WORKS

REINFORCEMENT WORKS

After pouring blinding concrete, reinforcement works can start.

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FOUNDATION WORKS

CONCRETE POURING

Pouring concrete in cold climate conditions. Temperature has to be tracked with installed sensors permanently after pouring.

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FOUNDATION WORKS

After CONCRETE POURING

Foundation to be covered and not disturbed (walking on the top of it etc.) for around three weeks.

Heating is also an option if considered beneficial.

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FOUNDATION WORKS

If covering and/or heating of the concrete fails during winter time concreting the top surface of the foundation may not cure and form strength as planned.

Case Example:

Concreting was planned to be done in -5 ° C.

At the end of foundation concreting works the air temperature dropped suddenly down to -20° C against all forecasts.

The surface of the concrete got frozen before it started to cure. The extent and the depth of the frozen concrete was defined by drilling core samples and analysing those in a laboratory.

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FOUNDATION WORKS

In order to make sure that there is no damaged concrete left in the structure the whole top surface of foundation was repaired.

- Frost damaged concrete on the top surface of the foundation was removed by milling (depth 20 mm).
- Areas where concrete frost damage were still detectable milling was continued until undamaged concrete was detected.
- After milling, the top surface of foundation was pressure washed and dried.
- Finally all the areas, where concrete cover for reinforcement was insufficient (under 50mm) were coated with Sikagard-552 W Aquaprimer and Sikagard-550 W Elastic.

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FOUNDATION WORKS

Concrete curing during winter time is sensitive for cracks on the top surface.

"The crack rule of thumb"

When using Ramboll ruler it is likely that Cracks fitting to the scale on the…

- right side do not require corrective actions
- left side will require corrective actions

It is still recommended that all the defects on the surface are assessed by a specialist.

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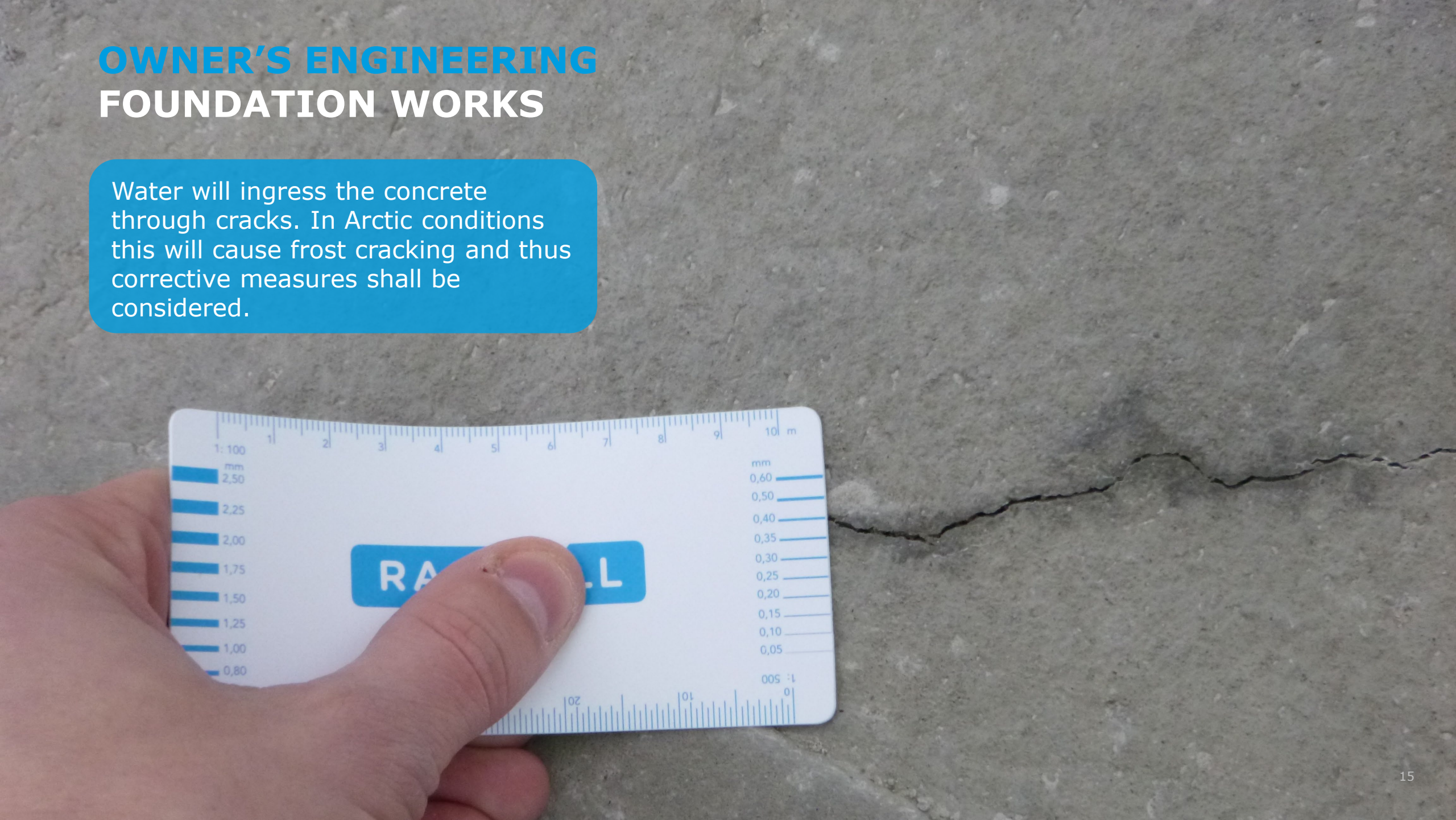
FOUNDATION WORKS

Water will ingress the concrete through cracks. In Arctic conditions this will cause frost cracking and thus corrective measures shall be considered.



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FOUNDATION WORKS

Repairing cracks on concrete surface:

- Make angle grinded V-shaped groove at the root of the crack.
- Inject with epoxy.

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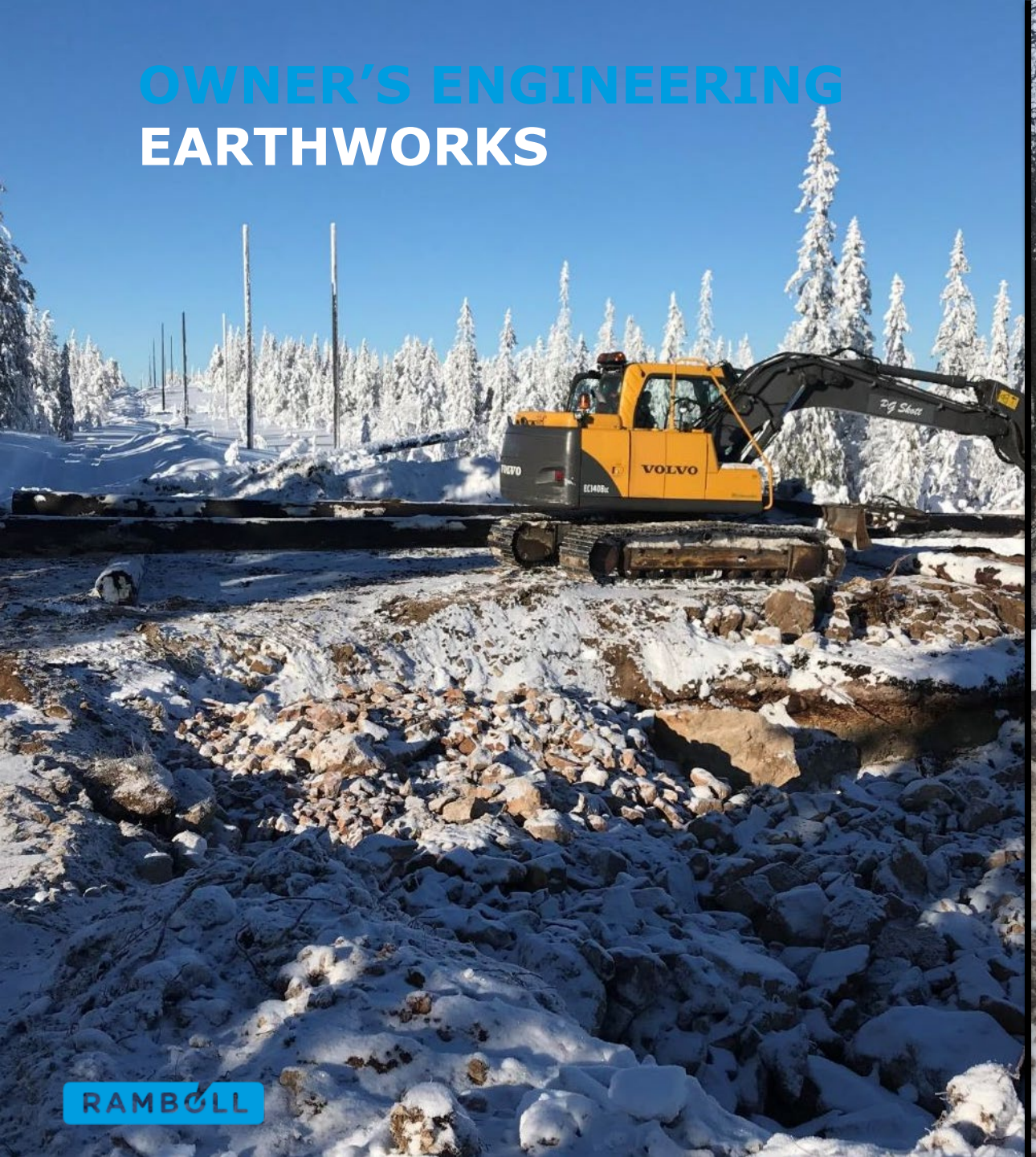
EARTHWORKS

OWNER'S ENGINEERING
EARTHWORKS



Extra care have to be taken when building roads and crane pads or making any compaction of material to use material without snow and ice.

Bearing capacity to be tested only after thaw period.

Challenges with machinery -> delays (hydraulics)

Also melting water is a challenge on cold climate sites. In the arctic parts of the Nordics the peak flood is not usually caused by storm water but melting snow in the spring time.

TRANSPORTATION

OWNER'S ENGINEERING
COMPONENTS DELIVERY

Road markings, snow cleaning and additional road maintenance, pulling assistance and careful planning based on weather forecast… all of these things have to be taken into account before and during heavy transportation.

TURBINE INSTALLATION

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TURBINE INSTALLATION

Turbine installation during the winter brings additional challenges especially in regards to HSE and planning. Icing and ice throw need to be considered as well.

CABLE LAYING

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CABLE LAYING

Also cable works have to be planned according to the climate conditions.

- Choosing the correct cable type for the climate
- Avoiding coldest periods for installation
- Considering the min. installation temperature
- Storing the cables in warmer conditions than site conditions 24h before installation (48 hours for large drums), consider pre-heating by heating mats

HEALTH AND SAFETY

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HSE

Zero tolerance policy regarding HSE.
HSE involvement in early planning phase.
Regularly safety inductions and safety walks, refreshing with safety trainings. Early involvement of local fire department, invitation to site and clear definition of rescue plan and meeting points: the y need to find there way even if dark and snowing!
Thinks to check in particular:

- Ice fall
- Clear signages/ signs / route indications
- Warm up periods for personnel, and heated shelters/ cars close to working places
- Thermal working clothes

CONCLUSIONS

- Construction in winter time is possible but requires special measures
- Weather related risks needs to be recognized and mitigated – check high resolution weather forecast at least (!) once a day
- Be always prepared for the worst case – procure for redundancies where reasonably possible
- Increase your CAPEX for “construction reserve” - it is always more expensive to construct in winter
- Zero tolerance policy in relation to HSE on site! Increase on-site checks

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RAMBOLL WIND POWER EXPERTISE FOR ARCTIC CONDITIONS

Owner's Engineering

- Design reviews
- Document Management
- Contract Management
- Construction supervision
- Acceptance inspections (WTG, civil, electrical)
- HSE
- Site management

Foundations

- Design
- Construction supervision
- Acceptance inspections

Roads and lifting zones

- Geotechnics
- Design
- Construction supervision
- Acceptance inspections

Operation and maintenance

- Long and wide experience concerning practical issues and technical solutions

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CONTACT

Joachim Binotsch

Business Development Manager |
Onshore Wind

Ramboll - BBB

Mobil: +49 173 28 12660
Mail: joachim.binotsch@ramboll.com

Ramboll Energy

Ramboll Wind & Towers:
Stadtdeich 7, 20097 Hamburg

Tel: +49 40 30 20 20-10
E-Mail: info@ramboll.de
www.ramboll.de/energie

Ramboll - BBB

Head office:
Munscheidstr. 14, 45886 Gelsenkirchen

Tel: +49 209.167 2550
E-Mail: onshore-wind@ramboll.com
www.ramboll.com/services-and-sectors/energy/wind-energy

Ramboll - CUBE

Head office:
Breitscheidstr. 6, 34119 Kassel

Tel: +49 561.28 85 73 – 0
E-Mail: onshore-wind@ramboll.com
www.ramboll.com/services-and-sectors/energy/wind-energy