WIND TURBINE ROBUST RADAR SYSTEMS

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SUBJECTS

› Phenomena
› Radars being covered
› Remedies
› Conclusions
PHENOMENA

- There is an abundance of literature in which adverse effects of wind turbines to both primary and secondary radar are described.

- There have been wind turbine clutter measurements, also well described in the open literature.

PHENOMENA PRIMARY RADAR

- Desensitisation overhead: detection threshold increases due to the reception of wind turbine clutter.
- Shadow: decreased sensitivity behind a wind turbine.
- False tracks, initiated by wind turbines.
- Track seduction: tracks get stuck in wind farms.
- Ghost targets due to reflection against wind turbines.
- Receiver saturation.
- Processor overload.
PHENOMENA SECONDARY RADAR

- Erroneous bearing estimate.
- Ghost targets due to reflection against wind turbines.
- Shadow: decreased sensitivity behind a wind turbine.
PHENOMENA BLADE FLASHES

Taken from QinetiQ

RADARS BEING COVERED

- Radars for the air picture.
- Primary ‘civilian’ ATC radars: approach / en route surveillance radars.
- Monopulse mode-S SSR.
REMEDIES FOR PRIMARY RADARS

1. Desensitisation overhead: detection threshold increases due to the reception of wind turbine clutter.
   - More advanced CFAR filtering, e.g., ordered statistics CFAR.
   - Cluttermap per Doppler filter.
   - Parallel receive beams rather than beamswitching on receive (2D → 3D).
   - Range dependent receive beam adaptation (e.g. ‘nulling’).

2. Shadow: decreased sensitivity behind a wind turbine.
   - Fill-in radar.
   - Sensor fusion.

3. False tracks, initiated by wind turbines.
   - Track Initiation Inhibit (TII).

4. Track seduction: tracks get stuck in wind farms.
   - Range azimuth gating (RAG), may require a wind turbine table.
   - Increased instantaneous bandwidth, e.g. 4 MHz rather than 1 MHz.
   - High range resolution fill-in radar (e.g. X-band)

5. Ghost targets due to reflection against wind turbines.
   - Sensor fusion.

REMEDIES SECONDARY RADARS

1. Erroneous bearing estimate.
   - Sensor fusion

2. Ghost targets due to reflection against wind turbines.
   - Sensor fusion, selective interrogation (mode-S)
CONCLUSIONS

- State-of-the-art radars surveillance radars are significantly more robust than their ancestors.
- Certain techniques are familiar in ‘military’ radar systems.
- The process to modernize the systems took approximately 15 years.
- Sensor fusion is a key component to mitigate adverse effects due to the reception of wind turbine clutter.
- SEAs and DEAs are still necessary.

THANK YOU FOR YOUR ATTENTION

Take a look: TNO.NL/TNO-INSIGHTS