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UK NATS
Wind Farm Study

Phase L4 Analysis Report

H452296

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EXECUTIVE SUMMARY

Under contract to the UK Air Traffic Services Limited (NATS), Raytheon has completed an assessment of the effectiveness of specific processing techniques to mitigate the effects of radar returns from wind turbines on Air Traffic Control (ATC) radars. These effects typically include a substantial increase in false radar tracks over the wind farm region, as well as significant degradation in target detection and tracking capabilities in these areas, compromising flight safety.

The study of mitigation techniques focuses on four primary methods: concurrent use of high and low beam data, maintenance of Doppler-filter-specific clutter maps, enhanced Constant False Alarm Rate (CFAR) detection processing, and enhanced target tracking processing. These enhancements have been incorporated into an operational prototype tested at two installed radar sites, and also modeled in a simulation language for performance evaluation. As demonstrated at site trials, incorporation of these enhancements into a fielded Raytheon S-Band or L-Band ATC radar system involves minimal system modification, minimal time, and presents no risk for the operational site.

This report summarizes the results of the assessment of enhancement performance. The report is based on the captured outputs of enhancements-equipped Raytheon ATC radars installed at active Customer radar sites in the near vicinity of large wind turbine concentrations - an ASR-23 L-Band radar at a NATS radar site at Lowther Hill, Scotland, and an ASR-10 S-Band radar at a Royal Netherlands Air Force (RNLAF) radar site at Soesterberg, Holland.

The report also includes the results of analysis of captured raw (I/Q) and processed (plot/track output) radar data from these sites using detailed radar simulation and performance evaluation analysis tools.

Results of live radar performance demonstration, confirmed by analysis, show a dramatic decrease in false track initiation and propagation when the mitigation techniques are installed and activated, and an equally dramatic increase in the ability to track real targets through wind farm areas. Even with heavy air traffic over dense wind farms, the following was observed with enhancements applied as compared with no enhancements and standard optimization in the very challenging environment at Soesterberg:

- ~ 95% reduction in false track activity over wind farms (without the use of track editing or track initiation inhibiting)
- An increase in target reinforcement rate (a measure of probability of detection) over wind farms from ~ 66% to 90-95% for all targets observed at 0.8 degrees or higher in elevation above the wind turbines

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- An increase in target reinforcement rate for low level targets over wind farms (0.8 degrees or lower in elevation above the wind turbines) from ~37% to ~60%
- Consistently improved tracking performance in wind farm regions, including preservation of track continuity, decrease in track seduction, improved plot association, and increase in track position accuracy
- No observed degradation in performance in areas outside of wind farms

It is emphasized that the results presented in this report have been achieved with live operation over significant time periods at two challenging ATC radar site - an S-Band site and an L-Band site - in the presence of large wind turbine concentrations. Results are corroborated by detailed analysis and simulation using data recorded at site. Demonstrated live operation over extended time periods, together with the high fidelity of simulation modeling using large sample sizes of actual site radar data as input to the model, give credence to these results and clearly confirm the capability to dramatically improve target detection and reduce false tracks in areas of wind farms with the use of the Raytheon wind farm mitigation techniques.