



Wind Farms and Weather Surveillance Radars

NEXRAD Technical Advisory Committee

Presented by

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Background....1

- Competing National Priorities
 - White House's Advanced Energy Initiative....American wind farms should be able to supply fully 20% of the nation's electricity consumption (currently 1%)
 - Protection of: airspace, national security/readiness, radar (long & short range, weather), land use, cultural resources, rural economies, wildlife and habitat
- Proliferation of wind turbine installations
 - 2004....2,500 turbines
 - 2005....5,600 turbines
 - July 2006....7,200 turbines
 - December 2006....12,000 turbines
 - Future....350,000 turbines



Background....2

- Federal agencies currently lack a comprehensive understanding of all the permitting and approval requirements involved in the wind siting process
 - A variety of different approaches by Federal agencies to addressing wind siting issues
 - Absence of an integrated process and lack of early consultations; causing delays and financial impacts to wind energy companies, and impacts to Federal missions



Background....3

- Federal government has no regulatory authority over wind turbine construction on 'private' property
 - FAA notified of structures over 200 ft tall; determines if hazard to aviation via Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) process; if 'yes', difficult for builder to obtain financing, insurance or permits
 - Inter-department Radio Advisory Committee (IRAC) receives some voluntary notifications from wind energy developers
 - FCC can only say 'no' to interfering signal transmissions from a structure



Background....4

- Permitting (where required) generally done at ‘county’ level
- DOD tasked by Congress to determine impact of wind turbine installations on military readiness and air surveillance radars....a.k.a. Section 358 Report
 - Released 28 Sep 06: *primary finding—to preclude adverse impacts on defense radars, avoid locating turbines in radar line of sight; achieved by distance, terrain masking or terrain relief; requires case-by-case analysis*
 - Deferred to NWS for impacts to weather radars
 - Urgency due to expiration of Production Tax Credit in December 2007

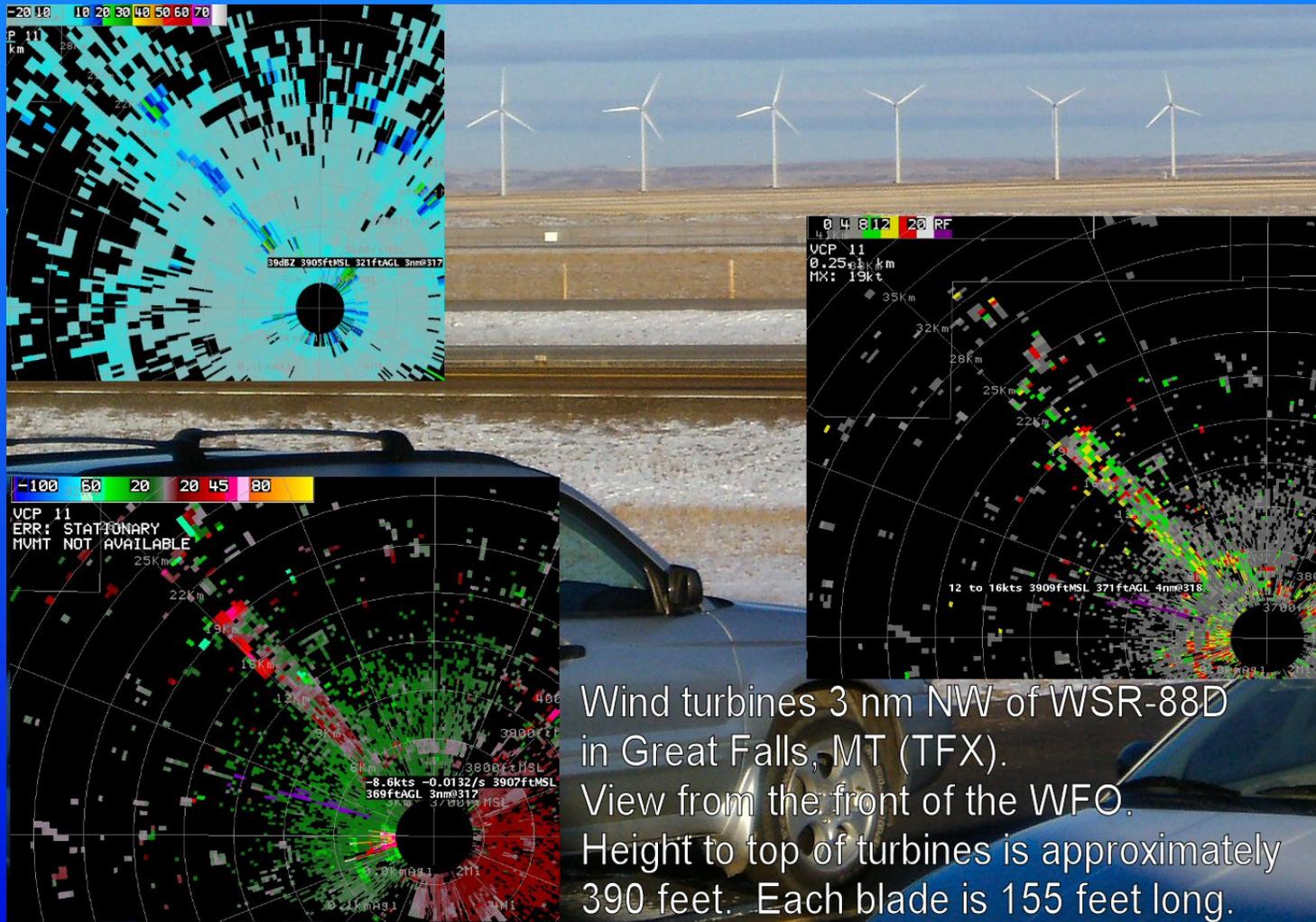


Wind Farm Interference with Weather Radar Data Quality

- Wind farms cause non-stationary clutter returns and wake turbulence-induced radar echoes
- Wind farms may create clutter (reflectivity) and blockage (all moments); and interference (velocity and spectrum width). For example:
 - Mis-identification of thunderstorm features in/near wind farm reflectivity signature
 - Meteorological algorithm errors
 - False radar estimates of rainfall accumulation
 - False tornado vortex and mesocyclone signatures
 - False storm cell identification and tracking



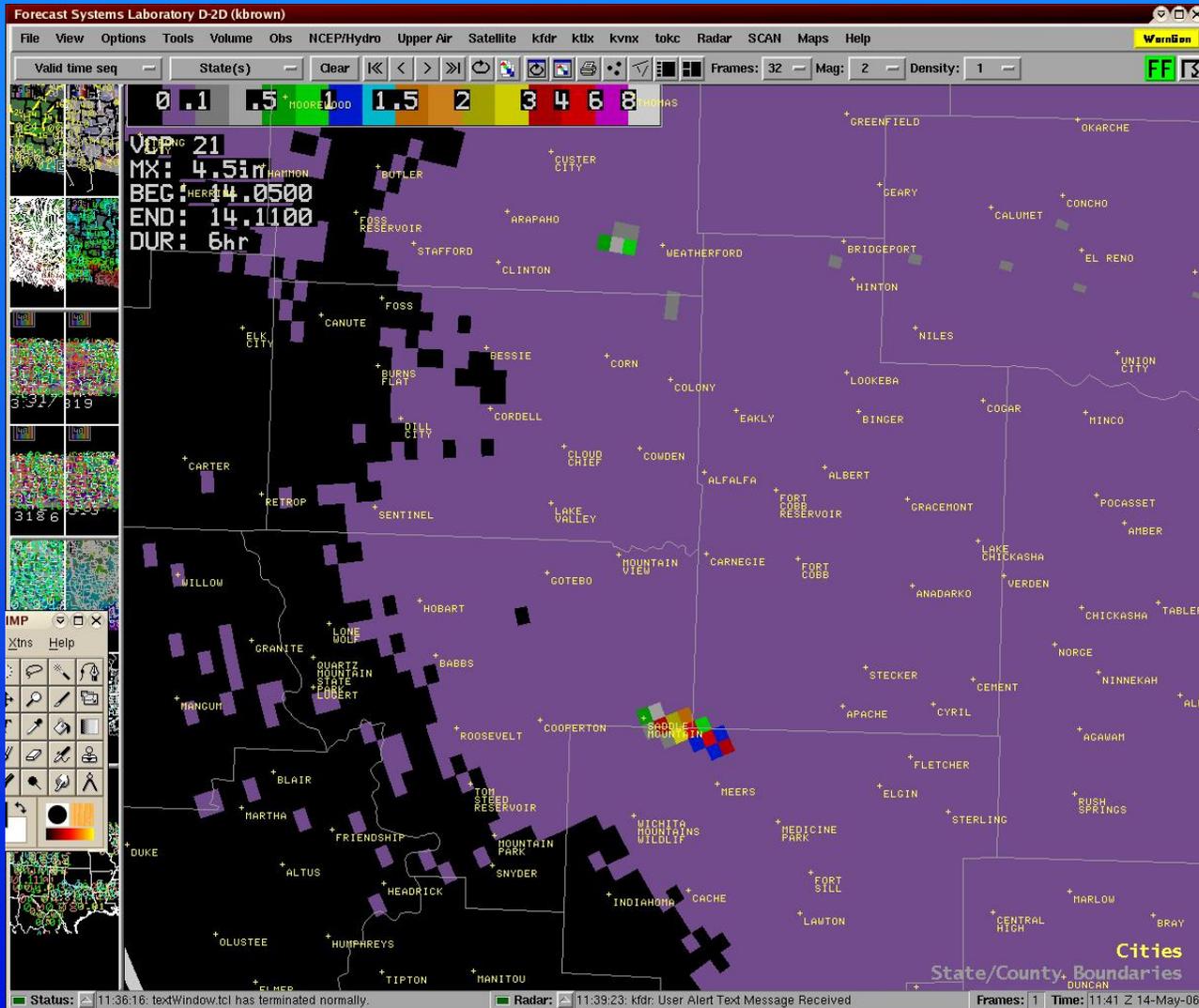
Great Falls, MT



Wind turbines 3 nm NW of WSR-88D
in Great Falls, MT (TFX).
View from the front of the WFO.
Height to top of turbines is approximately
390 feet. Each blade is 155 feet long.

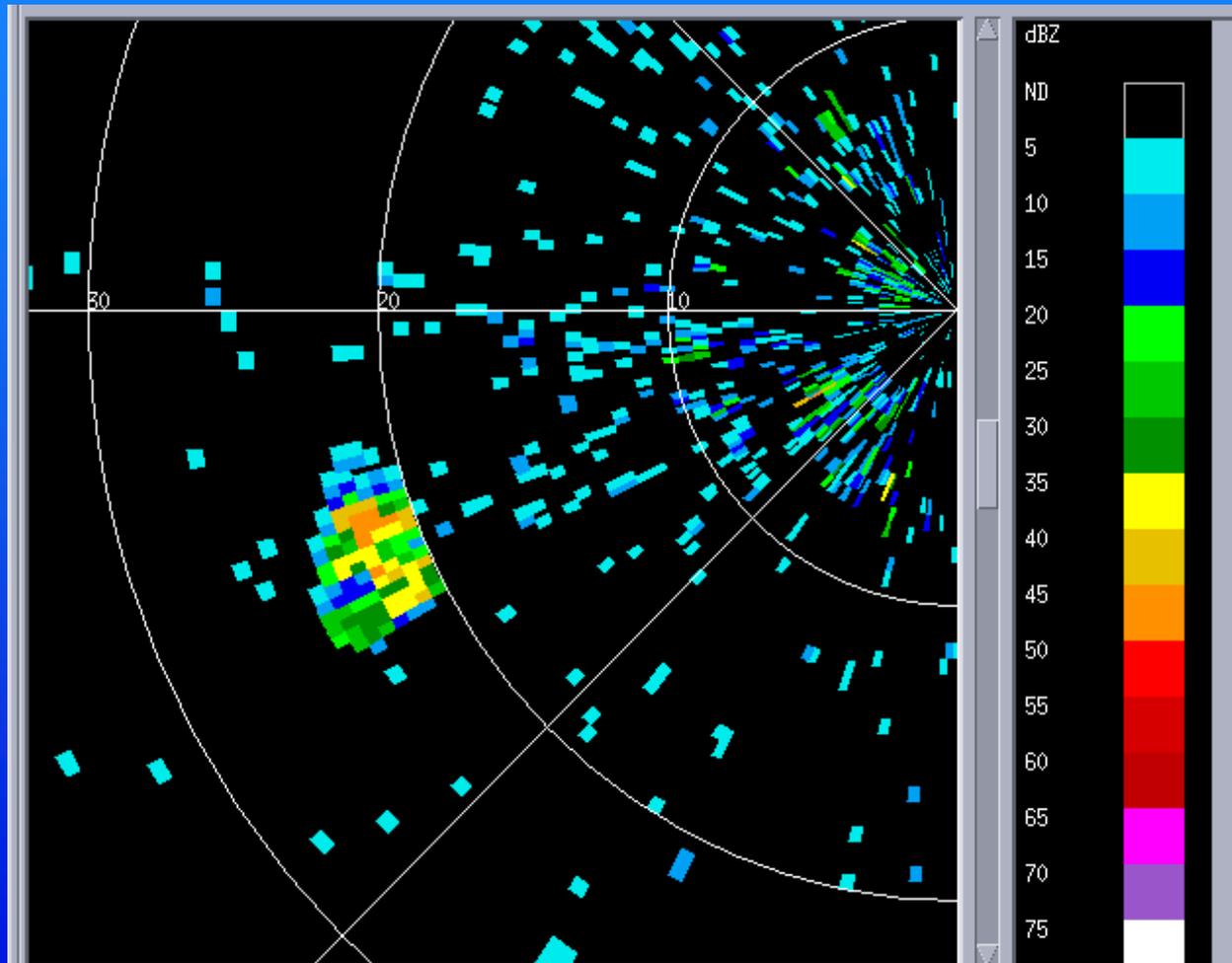


False Radar Rain Accumulations Due To Wind Farms





Wind Farm Reflectivity on Dodge City, KS WSR-88D





Wind Turbine Interference

- Does interference impact the mission?
- Anticipate some wind farms will interfere with NEXRADs sufficiently to impact the ability of users to perform their mission
- Case-by-case assessment needed



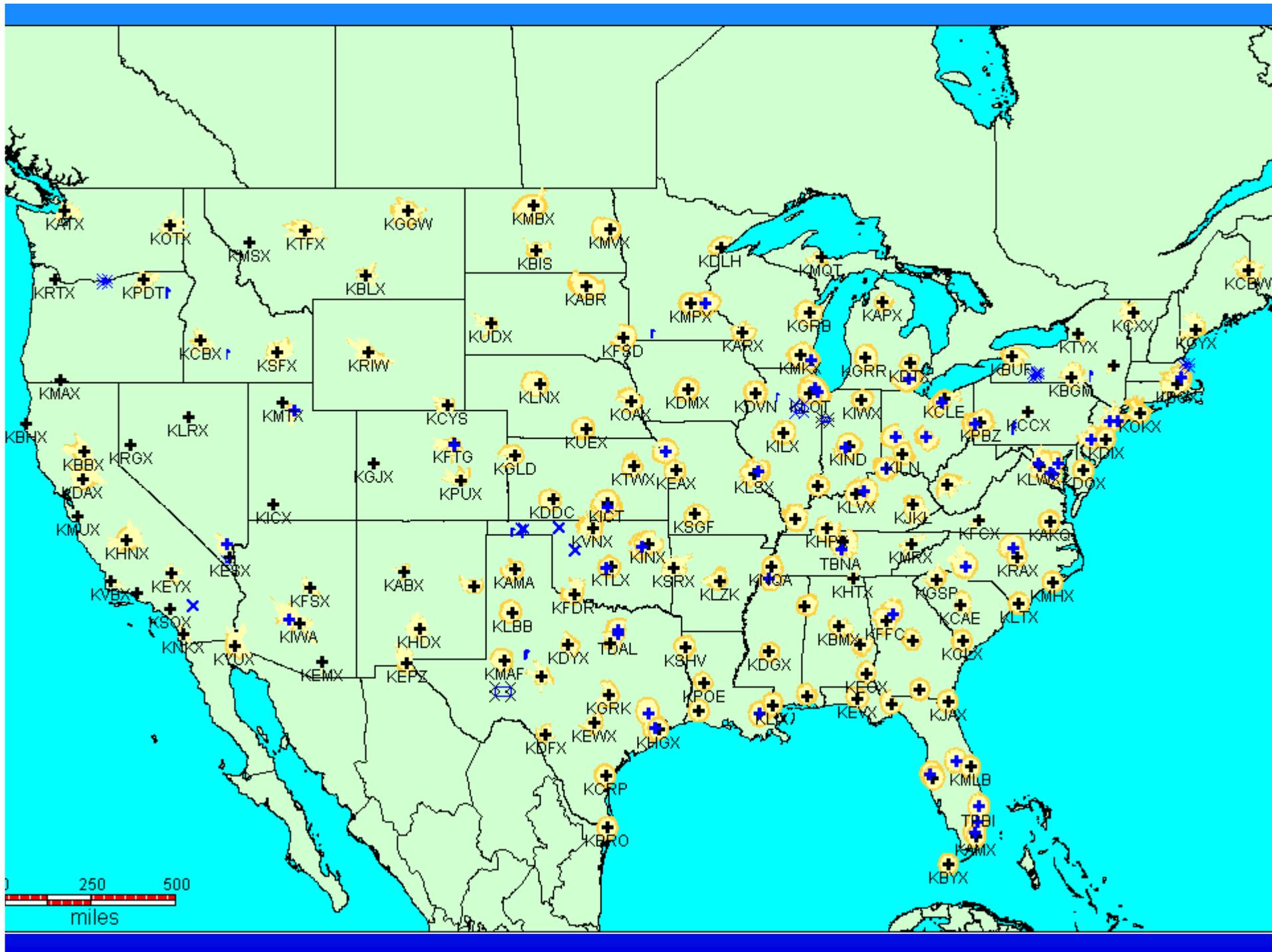
Mitigation Options

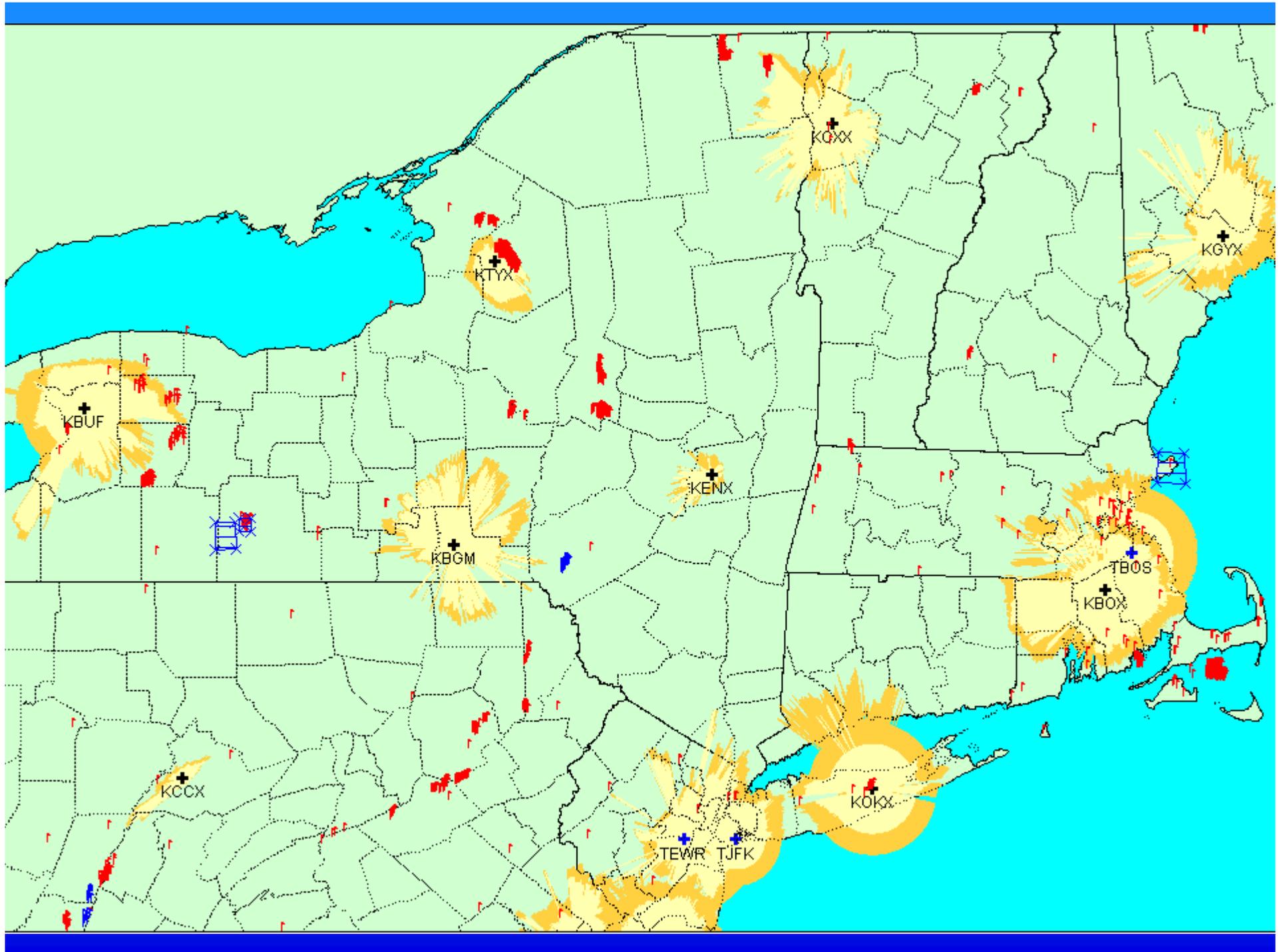
- Meteorologists can establish exclusion zones to limit precipitation over estimation
 - Exclusion zones ignore returns for precipitation estimates
 - Contamination still present in reflectivity base data
- Meteorologists can invoke clutter suppression
 - Only works well to exclude stationary targets; not effective on turbines in motion
 - Results in loss of meaningful weather data
- Meteorologists can use higher antenna elevation angles to “see over” wind farms
 - Loss of important low-altitude weather features
- Additional radars could provide alternate, unobstructed view of weather

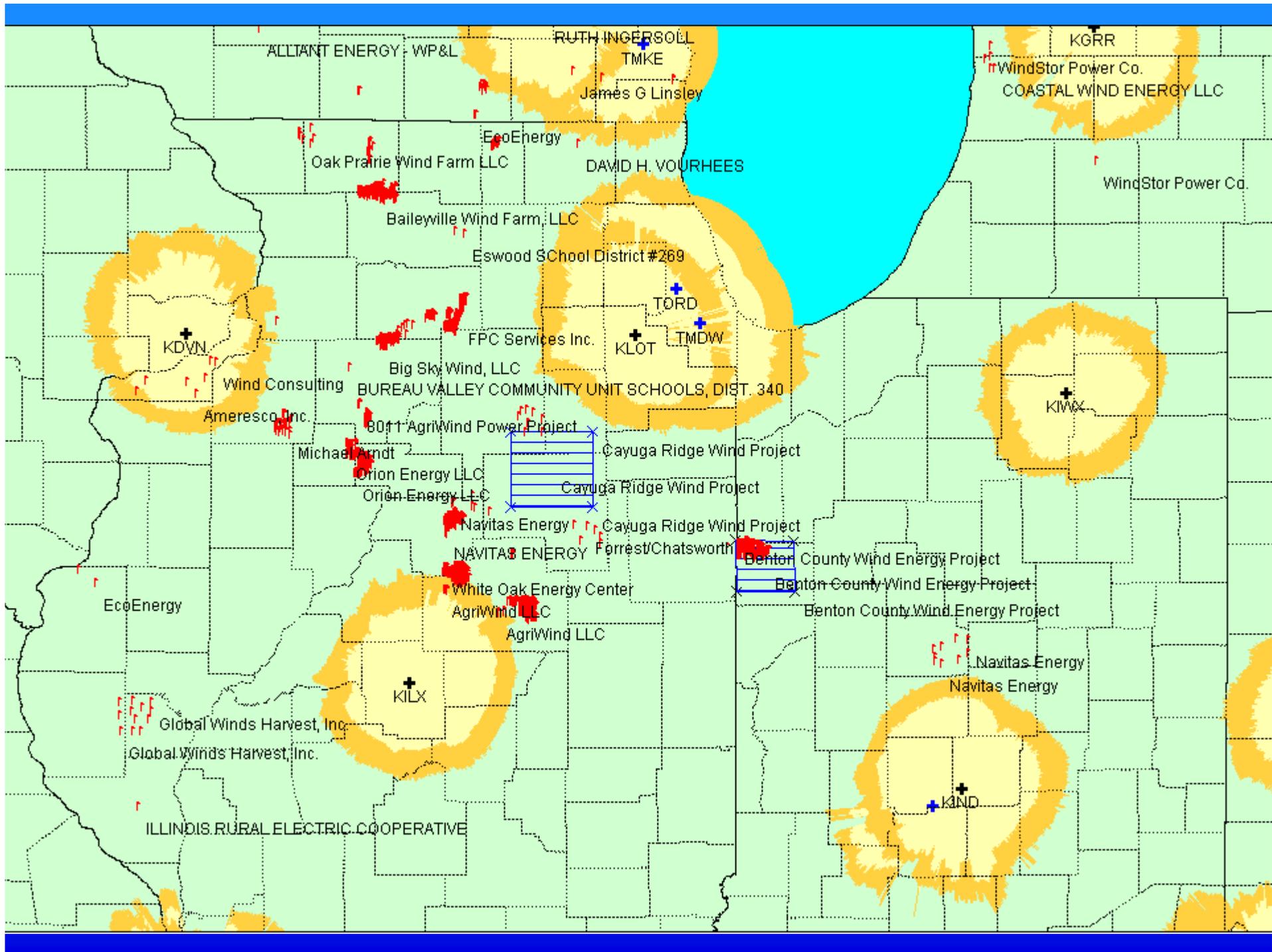


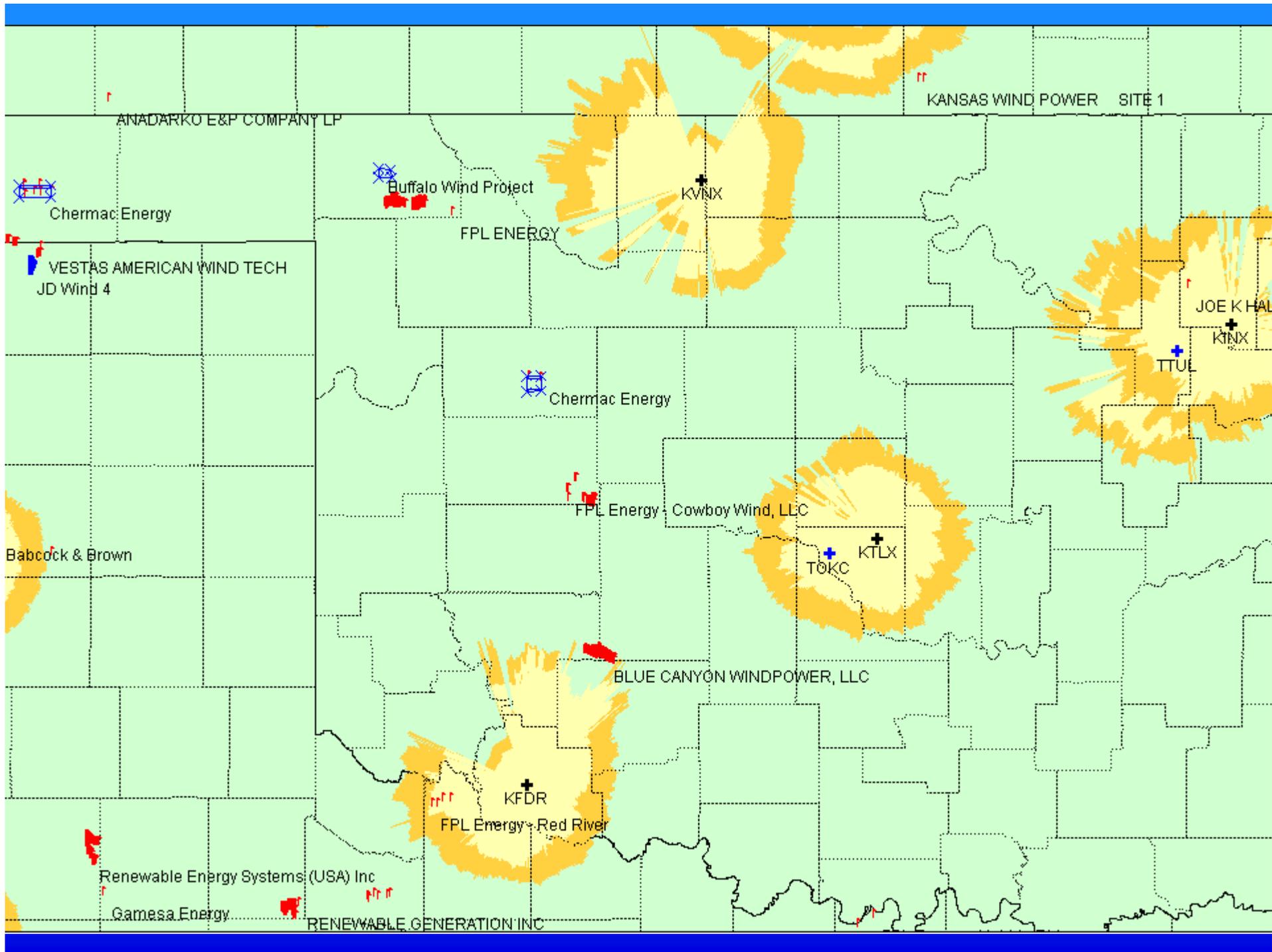
Area of Concern

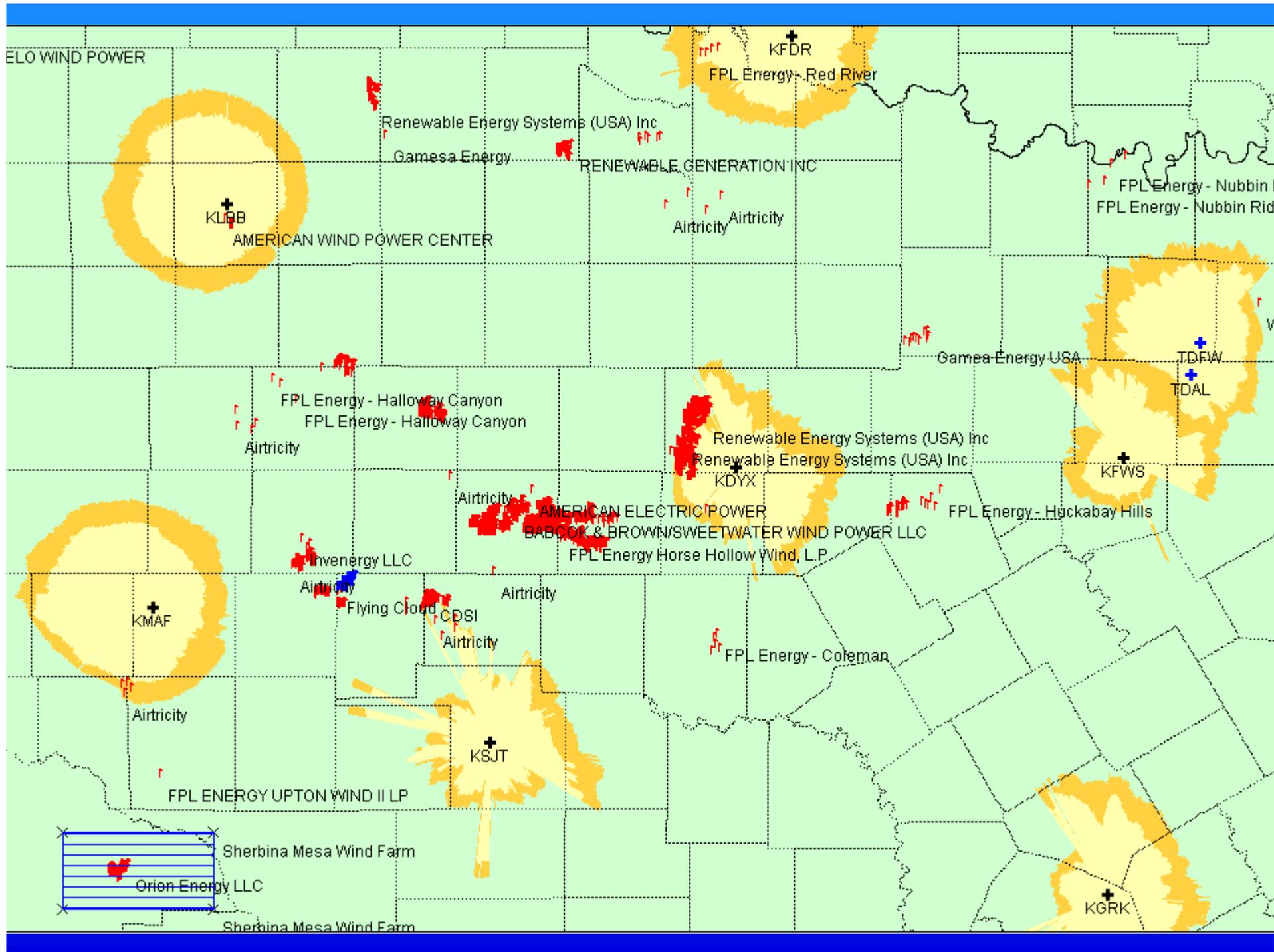
- Ideally, turbines should be at least 25 miles from radar to preclude turbine blades from encroaching into main beam of radar; assuming:
 - WSR-88D tower height of 15 meters (actual sites vary from 5 to 30 meters)
 - 0.5° elevation of radar main beam
 - 1.0° beam width
 - Smooth earth (no terrain features, but curvature)
 - Maximum wind turbine blade height of 130 meters
- Site-by-site analysis required to consider specific radar tower and wind turbine heights, terrain and climatology

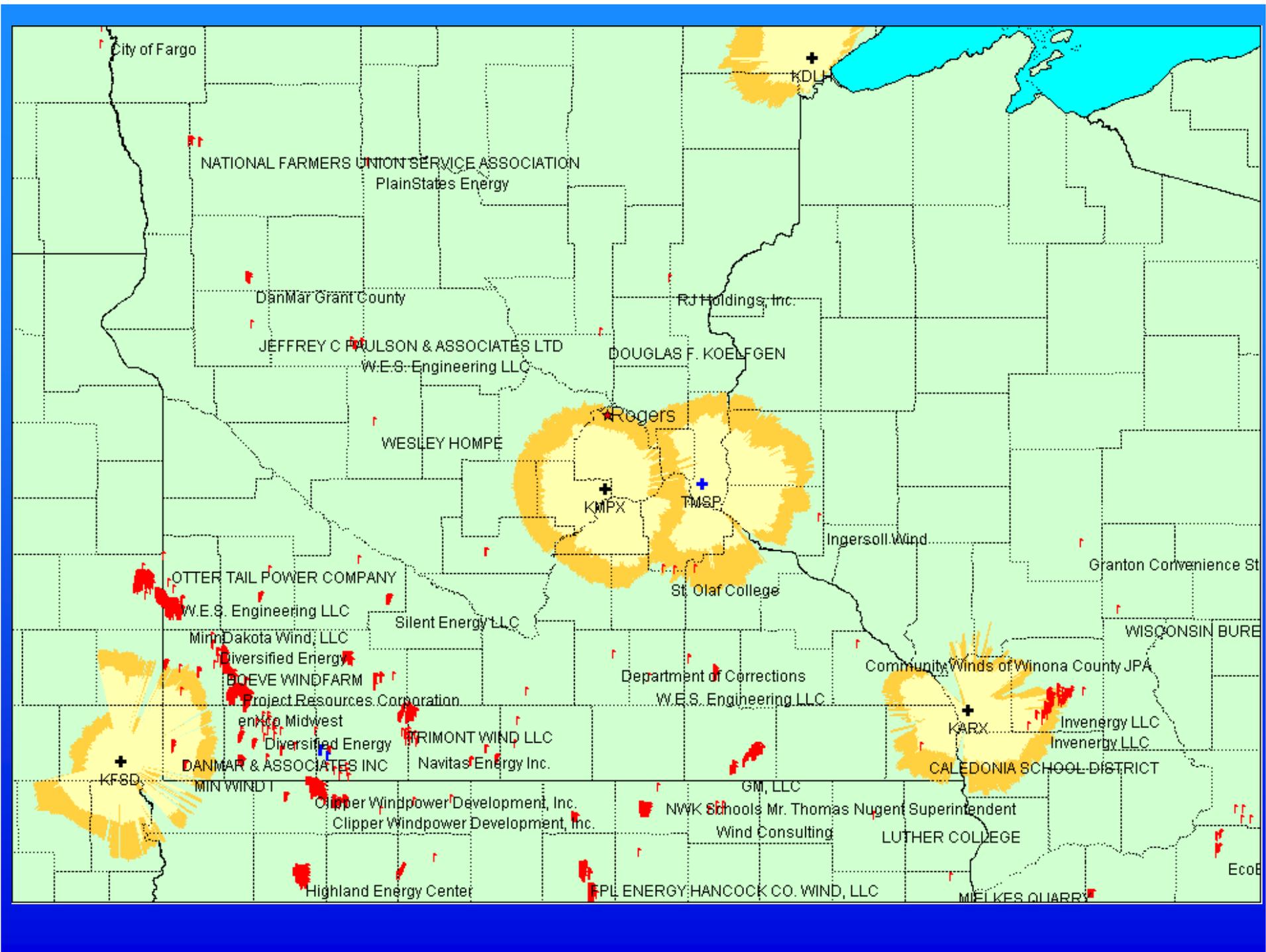














What We Are Doing....1

- Receiving notices from FAA and IRAC; occasional inquiries from military bases, forecast offices, industry
- Assessing impact of proposed wind farms
 - Plot turbine locations using terrain mapping software
 - Determine radar line of site; If radar beam intersects turbine structure/blades, determine beam blockage in dB
 - Estimate operational impacts based on blockage, location of wind farm, climatology, and operational experience
- Developing graphic depiction of “clear zones” where wind farms and weather radars can co-exist with minimal interference
 - Present at American Wind Energy Association’s WINDPOWER 2007, June 2007



What We Are Doing....2

- ROC-OU-WFO team conducting study to quantify mission impact at Dodge City WFO (only site with multi-year experience with turbines in radar beam)
 - Characterize actual radar interference signatures in a variety of weather scenarios
 - Identify potential vs actual mitigation actions taken by radar operators
 - Evaluate WFO severe weather warning verification statistics
- ROC sponsoring OU study of advanced signal processing
 - Goal: recognize/discount wind turbine signatures while recovering weather signatures (tough challenge)



What We Are Doing....3

- Participating on new Federal Interagency Wind Siting Working Group, and Technical Subgroup
 - Primary forum for aligning and coordinating the Federal government's activities and priorities
 - Through Executive Steering Committee, coordinate policies and national direction for wind energy developments across agencies
 - Chaired by DOE and DOT/FAA representatives
 - NOAA/NWS representatives....Mark Paese on Working Group; Richard Vogt on Technical Subgroup
- Working with FAA to see if ROC can be included in OE/AAA process for structures over 200 ft tall



What NEXRAD Agencies and Radar Operators/Users Can Do

- Inform ROC of:
 - Any suspected wind turbine interference to weather radars
 - Any planned or under-construction wind turbines
 - Any mission impacts caused by suspected wind turbine interference
- Inform local county permitting authorities and emergency managers of wind turbine interference potential for new construction under consideration



Summary

- More and larger wind turbines expected
- Wind farms can effect NEXRAD data quality
 - May impact forecast/warning operations (needs more analysis to confirm extent of mission impact)
 - Confusing to non-meteorologist users
- Interagency collaboration essential for notification and prescreening of proposed wind farms
 - Goal: coexist with minimal interference
- Federal policy and prescreening processes now address both air surveillance and weather radars