NEXRAD Technical Information

The Weather Surveillance Radar, 1988 Doppler (WSR-88D), also known as NEXRAD, is the most advanced operational weather radar in the world. The fleet of 159 WSR-88D radars operate 24/7 to support the weather warning and forecast missions of the National Weather Service, FAA and DoD. Additionally, real-time radar data is made available to the nation's academic and commercial weather enterprise.

Pictured to the left is the tower, which houses the antenna (inside the radome).

There are two major components of the radar (RDA and RPG):

RDA

The RDA (Radar Data Acquisition) samples the atmosphere to produce base moments (reflectivity, velocity, and spectrum width) and Dual Pol variables (differential reflectivity, correlation coefficient and differential phase) representing the radar characteristics of the meteorological and biological return within the radar coverage umbrella. The RDA is composed of four primary components:

Transmitter

Transmitter characteristics-
Type: S-band, coherent chain (STALO/COHO), line modulator, klystron tube amplifier (53 dB gain typical)
Modulation: P0N
Frequency: 2700 to 3000 MHz
Power: 650 to 750 kW Peak at Transmitter measurement port
Transmitter to antenna loss: 1.5 to 2.5 dB depending on tower height (10 to 35 meters)
Average Power: 300 to 1300 watts at Antenna port
Pulse Width Short Pulse: 1.52 to 1.62 microseconds
Pulse Width Long Pulse: 4.61 to 4.81 microseconds
PRF Range Short Pulse: 318 to 1304 Hz
PRF Range Long Pulse: 318 to 452 Hz
Phase Noise: Phase and amplitude stability better than -57 dBc (-60 dBc system goal)
Short Pulse Transmit Spectrum: 40 dBc at bandwidth of +/- 7.26 MHz, 80 dBc bandwidth at +/- 62 MHz (5 RSEC, Criteria D), 80 dBc bandwidth of +/- 19.6 MHz when spectral filter is installed (Spectral filter typically installed in "spectrally congested" areas)

Antenna/Pedestal

Antenna characteristics-
Type: Parabolic dish (8.53 m/28 ft in diameter) with center feedhorn
Polarization: Dual Pol (simultaneous horizontal and vertical transmit/receive - Transmit propagation is elliptical; receive is linear horizontal and linear vertical)
Gain at 2850 MHz: 45.5 dB (including radome loss)
Beamwidth at 2850 MHz: 0.925 deg (Pencil Beam)
Sidelobes: 29 dBc beyond main beam (40 dBc beyond 10 degrees from main beam)
Radome two-way loss: 0.24 dB at 2850 MHz
Height AGL: 10 to 35 meters (Tower plus Pedestal)

Pedestal Characteristics		
Pedestal Function	Azimuth	Elevation
Range	360 deg	-3 to +65 deg
Typical Scan	360 deg	+0.5 to +19.5 deg
Max Rate (Range)	36 deg/sec (Typically 5 to 30 deg/sec)	36 deg/sec
Acceleration	15 to 19 deg/sec^2	15 to 19 deg/sec^2
Positioning Error	+/-0.22 deg	+/-0.22 deg
Pedestal Type: Elevation over Azimuth		

Receiver

Type: Coherent (STALO/COHO)
Detection: Digital Receiver, 16 bits sampled at 93.52 MHz
Digital Matched Filter BW, SP: 636 kHz
Digital Matched Filter BW, LP: 212 kHz
Dynamic Range, minimum: 93 dB
Intermediate Frequency: 57.5491 MHz
System Noise Figure: 2.6 dB (~240 K)
Minimum Discernible Signal, SP: < -112 dBm @ Antenna Port (Typically < -114 dBm, est. by NP = kTBG)
Minimum Discernible Signal, LP: < -116 dBm @ Antenna Port (Typically < -118 dBm, est. by NP = kTBG)
Front-end rejection (BPF): 0.5 dB minimum ± .35 MHz from center frequency (Just prior to TR-Limiter (Receiver Protector) and LNA), 3 dB minimum ± 10 MHz from center frequency, 30 dB minimum ± 25 MHz from center frequency, 60 dB minimum ± 100 MHz from center frequency
Interference-to-Noise (INR) Ratio: -13 dB

Signal Detection Capabilities	
Signal Description	Signal Parameters
Minimum required signal detection, short pulse	-9.5 dBZ$_e$ at 50 km
Minimum required signal detection, long pulse	-19.5 dBZ$_e$ at 50 km
Minimum Point target detection	0.0004 m^2 (4cm^2; -34 dBsm) at 100 km Point Target References: A 0.5 meter sphere has an RCS of 0.785 m^2. Also, point target detection takes into account system characteristics: Bandwidth, Noise Temperature, Noise Figure, etc.

Signal Processor

Signal processor is PC based, with a Linux operating system
Clutter Filter: Spectral notch filter
SZ-2: Phase shifts on transmit pulse; changes scanning rate of Doppler scans (Used in all VCPs but 31, 34*, and 12)
*Added with RDA/RPG Build 23.0
Range increment, short pulse: 250 m
Range Increment, long pulse: 500 m
Azimuth increment: 1 deg (Signal processing techniques allow 0.5-degree increments)

The WSR-88D RDA transmits short bursts (pulses) of electromagnetic energy focused into a 1 degree beam by the antenna. During normal operation, the antenna and thus the beam rotate continuously according to a prescribed scanning program, or “volume coverage pattern (VCP).” The VCP directs the beam through 360 degrees in azimuth about a vertical axis, and range from 0.5 to 19.5 degrees (0.2 to 19.5 degrees at a single coastal location) above horizontal.

RPG

The RDA sends the base data moments (reflectivity, velocity, and spectrum width) and Dual Pol variables (differential reflectivity, correlation coefficient and differential phase) to the Radar Product Generator (RPG). The RPG processes these data to produce base products and executes resident algorithms to generate real-time, user-requested meteorological and hydrological products. The RPG also manages all WSR-88D communications, as well as, product and data distribution.

To optimize the WSR-88D RDA operations and data collection, RPG algorithms analyze radar data strength, coverage and location to dynamically modify the active scanning routines and data collection schemes. Additionally, the RPG provides the human computer interface for WSR-88D command, control and status monitoring.

RPG Characteristics	
RPG Algorithm	Major Characteristics
AVSET	Automated Volume Scan Early Termination - Ends the "precipitation" VCP at an elevation of 6.4 degrees if minimal thresholds for Reflectivity are not met; will allow additional elevations as thresholds are met per the VCP definition up to the 19.5 degree limit
SAILS	Supplemental Adaptive Intra-Volume Low-Level Scans - Adds up to three (3) supplemental 0.5 degree elevation scans -- or whatever the lowest elevation is for the particular site uses -- in the middle of the VCP
MRLE	Mid-Volume Rescan of Low Level Elevations - Similar to SAILS; however, inserts -- at most -- the four lowest elevations in the middle of the VCP (MRLE x1 is identical to SAILS x1)
Auto-PRF	Changes the PRF to reduce range folding or prevent range folding on storms of interest
Automatic Mode Selection	Selection of "clear-air" or "precipitation" VCPs based on Reflectivity threshold and areal coverage

VCPs

The WSR-88D supports the execution of a variety of VCPs. Each VCP is designed to optimize the likelihood of sampling particular meteorological phenomena. Execution of a VCP is determined by the observed or expected meteorological conditions, desired elevation density and data quality expectations for the base data moments.

VCP Characteristics		
VCP	Major Characteristics	Algorithms allowed/Notes
31	Original long pulse VCP used for "clear-air, apprxomimately 10 minutes with 5 elevations from 0.5 to 4.5 degrees	
34	Long pulse VCP used for "clear-air" with similar elevations as VCP 35, approximately 11 minutes with 10 elevations from 0.5 to 4.5 degrees	SAILSx1
35	Default "clear-air" VCP, approximately 7 minutes with 9 elevations from 0.5 to 6.4 degrees	SAILSx1, SZ-2
12	"Precipitation" VCP used for rapidly evolving events (i.e. supercells, squall lines), approximately 4.3 minutes with 14 elevations from 0.5 to 19.5 degrees	SAILSx3, AVSET, MRLEx4
112	"Precipitation" VCP used for large-scale systems with high velocity (i.e. hurricanes, long squall lines), approximately 5.5 minutes with 14 elevations from 0.5 to 19.5 degrees	SAILSx1, AVSET, SZ-2
212	"Precipitation" VCP used for rapidly evolving events (i.e. supercells, squall lines), approximately 4.6 minutes with 14 elevations from 0.5 to 19.5 degrees	SAILSx3, AVSET, MRLEx4, SZ-2
215	Default "precipitation" VCP with lower SNR compared to other "precipitation" VCPs and better vertical coverage at the expense of scan time, approximately 6 minutes with 15 elevations from 0.5 to 19.5 degrees	SAILSx1, AVSET, MRLEx4, SZ-2

*Lowest elevation can be below 0.5 at certain sites