Terminal Doppler Weather Radar and the Supplemental Product Generator

Training Presentation
September 3, 2020
• **Terminal Doppler Weather Radar Basics**

- FAA radar designed to cover only its associated airport
- Radar was developed to automatically alert ATCs to existence and location of low-level wind shear hazards within the terminal area of airports
- Placed close to airports that are vulnerable to and have a history of wind shear conditions
- Sited specifically to scan atmospheric volumes over and around associated airport
TDWR Coverage Below 10,000 Feet AGL

TDWR Hazardous Mode Coverage
- 3,000 ft above ground level
- 5,000 ft above ground level
- 10,000 ft above ground level

*Center of beam height (assuming Standard Atmospheric Refraction)
Terrain Blockage indicated where more than 50% of beam blocked
• Microburst Alert Warning Area (MAWA)
  – Used to automatically determine which of two scanning modes to employ.
  – MAWA is defined as a volume over an airport whose height is 6 km and whose horizontal region includes all of the runways, 3 miles final and 2 miles departure.
  – Maximum vertical spacing between each elevation scan no larger than 1 km within the MAWA.
  – High resolution used to detect the rapid evolution of wind shear.
  – Initially performed “sector scans” over the MAWA but now performs only full, 360 degree volume scans
The MAWA (horizontal view) as depicted around Memphis International Airport
TDWR Characteristics

- **TDWR Basics**
  - C-band radar (5 cm wavelength)
  - 0.55 degree beam sampled every 1.0 degree, azimuthally
  - Spot blanking performed at some sites
  - Clutter filtering performed below approx. 10 degrees elevation
  - Base data is relative to magnetic north
• TDWR observational requirements

  – Must produce a long-range surveillance scan every 6 minutes. The range of this scan is 460 km (248 nm)
  – Provide a short-range, low level “near surface” (under 1 degree) scan every minute to capture the evolution of wind shear during hazardous weather conditions
  – Like the 88D, must perform sector blanking at some sites (e.g., TCLT).
TDWR Mode Control

• Automatically switches from monitor mode to hazardous weather mode when one of the following conditions occurs within the MAWA:

  – A region of 30 dBZ (precipitation level 2) must be located within 45 km from the airport with a nominal extent of 2.4 km² and be at least 2.4 km above ground level, or
  – Hazardous wind condition (such as a wind shear or microburst signature) has been detected.
TDWR Scanning Modes

• TDWR Modes

  – 2 scanning modes – both 6 minutes in duration
    • Monitor Mode and Hazardous Mode
    • Elevation angles are site dependent
      – Base elevation scan ranges from 0.1 to 0.8 degrees
    • First (long-range) cut in each mode is used for range ambiguity mitigation.

  – Occasional non-operational modes
    • Calibration
    • Others?
TDWR Scanning Modes

• Monitor Mode

  – Surveys the weather to determine if criteria for a switch to hazardous mode are met.
  – After a long-range scan at its base elevation, consists of 15 sequential short-range scans ranging from its base elevation, up to a maximum of 60 degrees.
  – Rotation speed is constant rate of 19 deg/sec or 3.2 rpm, clockwise
TDWR Scanning Modes

- Hazardous Mode
  - Optimized to monitor both low and high level conditions over and in proximity to its airport.
  - A base (low elevation) scan is required every minute to monitor for possible low-level wind shear.
  - After a long-range scan at its base elevation, consists of 22 non-sequential scans ranging from its base elevation up to a site dependent maximum that ranges from 20.1 to 55 degrees.
  - Elevation angles can be vastly different for each TDWR due to radar location relative to associated airport.
TDWR Scanning Modes

• Hazardous Mode (continued)

  – In general, the strategy patterns (aloft or low level scans) are the same among all systems.
  – Contains two identical “mini-volumes”, each with a low elevation scan once per minute and aloft scans.
  – Requires just about the same amount of time to complete as monitor mode because it uses a higher antenna rotation rate.
  – Uses a mix of rotation rates from 21.6 deg/sec (3.6 rpm) to 30.0 deg/sec (5 rpm), clockwise
Long Range Scan Characteristics

- **Long-Range Scan – 248 nmi* (460 km*)**
  - Always the first elevation cut of a volume scan
  - Site dependent base-elevation, ranges from 0.1 to 0.8 deg elevation
  - Reflectivity data only
    - Reflectivity data range is -30 to +80 dBZ
  - Low PRF (no range folding)
  - Aggressive clutter filtering performed over full range with clutter residue editing within 70 km
  - 150 meter range resolution close to radar, 300 meter range resolution beyond 135 km
    - NOTE: SPG combines the 150 meter data into 300 meter data by averaging the returned power of every two bins.
  - *LR reflectivity product display range is reduced to 225 nmi (416 km)
  - Data from this long range scan is used by TDWR in all subsequent short range scans of the volume for range ambiguity mitigation.
    - PRF selection
    - Setting of data quality flags
Short Range Scan Characteristics

- Short-Range Scans – 48 nmi (90 km)
  - Used for all but the first elevation cut of a volume scan
  - Elevation angles vary by TDWR site
  - Reflectivity, Velocity and Spectrum Width
    - Reflectivity data range is -30 to +80 dBZ
    - Velocity data range is +/- 156 knots
    - Spectrum width data range is 0 to 10 m/sec
  - High PRF (range folding possible in all moments)
  - Aggressive clutter filtering and clutter residue editing performed over full 90 km range
  - Staggered PRT and other waveforms new in “TDWR Build 2”
    - 150 meter range resolution
  - Data truncated at 70,000 feet above radar level
    - Applicable above approximately 7 degrees elevation
FAA Signal Processing Strategy

- TDWR Build 2 signal processing uses four methods, depending upon elevation angle and weather location.
  - **LP (Long PRI), PRI 3066:** Single Long PRI (Reflectivity only).
    - Used on initial long range scan.
  - **MP (Multi-PRI), aka Block Staggered:** Multiple number of PRIs are block transmitted within the radial (e.g., PRI Set 3, 4, or 5).
    - Used adaptively at surface scan.
    - Good at trip separation even if overlaid powers are strong or spectrally wide, as long as overlaid weather does not span far along radial.
    - Base data is selected and Velocity Dealiasing is performed within each radial using the PRI estimates that are not range folded.
  - **DP (Dual-PRI Phase-Code Mode):** Two PRIs are used, in alternating radials (e.g., PRI 600/836).
    - Used at mid-levels and adaptively at surface scan.
    - Good at trip separation even if overlaid weather has long continuous radial range, as long as the weather is not strong and/or spectrally wide.
    - Dealias Velocity across adjacent radials.
  - **SP (Staggered PRI):** Two PRIs are used in alternating pulses.
    - Used at angles ≥ 11.9° where range folding isn’t an issue.
    - Traditional SPRT Velocity Dealiasing
    - Clutter filtering via [Meymaris et al. 2009](#), where I/Q data is split into two evenly spaced time series with interval PRT1 + PRT2. PRI pairs should be [600, 836] below 15.8 deg and [518, 722] above (e.g., at ORD, the staggered PRT clutter filter Nyquist velocities are 9.3 at 15.2 deg, and 10.8 m/s at 20.1 deg).
FAA Signal Processing Strategy

Multi-PRI Mode  Block Staggered (MP)
FAA Signal Processing Strategy
Dual-PRI Phase Code Mode (DP)
FAA Signal Processing Strategy

Multi-PRI Mode Staggered (SP)

Diagram showing the processing strategy with labeled time series and processing steps.
Two radial header fields indicate the PRI(s) used in the radial: Multi-PRI Flag (MP) and PRI.

- If MP=0, PRI field is actual PRI value (μsec) used for all pulses in radial.
- If MP=1, PRI field contains a code interpreted as below:

<table>
<thead>
<tr>
<th>CODE</th>
<th>MP MODE PRI CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>MP: Block staggered: [600, 670, 740, 810] μs, each PRI repeated L times, L dependent on angular scan rate.</td>
</tr>
<tr>
<td>4</td>
<td>MP: Block staggered: [698, 798, 898, 998] μs, each PRI repeated M times, M dependent on angular scan rate.</td>
</tr>
<tr>
<td>5</td>
<td>MP: Block staggered: [600, 648, 696, 744, 792, 840, 888, 936] μs, each PRI repeated N times, N dependent on angular scan rate.</td>
</tr>
<tr>
<td>6</td>
<td>SP: Staggered: [600, 836] μs (for elevation &lt; 15.8°), PRIs alternate.</td>
</tr>
<tr>
<td>7</td>
<td>SP: Staggered: [518, 722] μs (for elevation ≥ 15.8°), PRIs alternate.</td>
</tr>
</tbody>
</table>
## FAA Signal Processing Strategy

Sample Build 2 VCP 80 volume scan data from 5/8/2016 23:22z (TPSF configured as TOKC)

<table>
<thead>
<tr>
<th>Elevation Cut</th>
<th>Relative Angle</th>
<th>MP Flag</th>
<th>PRI Value/Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Surface</td>
<td>0</td>
<td>LP: Long PRI, 3066 (360 radials)</td>
</tr>
<tr>
<td>2</td>
<td>Surface</td>
<td>0</td>
<td>DP: Dual-PRI phase-code, radials alternate PRI 600/836 (311 radials)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>MP: Block Staggered, 3 (2 radials); 4 (14 radials); 5 (33 radials)</td>
</tr>
<tr>
<td>3,4,5,7,8</td>
<td>Middle</td>
<td>0</td>
<td>DP: Dual-PRI phase-code, radials alternate PRI 600/836 (360 radials)</td>
</tr>
<tr>
<td>6</td>
<td>Surface</td>
<td>0</td>
<td>DP: Dual-PRI phase-code, radials alternate PRI 600/836 (312 radials)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>MP: Block Staggered, 3 (1 radials); 4 (14 radials); 5 (33 radials)</td>
</tr>
<tr>
<td>9</td>
<td>Mid-High</td>
<td>1</td>
<td>SP: Staggered PRT, 6 (360 radials)</td>
</tr>
<tr>
<td>10</td>
<td>Surface</td>
<td>0</td>
<td>DP: Dual-PRI phase-code, radials alternate PRI 600/836 (313 radials)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>MP: Block Staggered, 3 (2 radials); 4 (12 radials); 5 (33 radials)</td>
</tr>
<tr>
<td>11,12</td>
<td>High</td>
<td>1</td>
<td>SP: Staggered PRT, 7 (360 radials)</td>
</tr>
</tbody>
</table>
FAA Signal Processing Strategy
SPG Overview

• Supplemental Product Generator (SPG)
  – SPG originally based on RPG Build 9
  – HCI modified to remove unused functionality
  – SPG has no control over the TDWR RDA
    • Passive listener on a one-way communications cable
  – Preprocessor Module (PPM) added
    • Creates 88D-like base data radials from TDWR radials
    • Interprets quality flags from TDWR to mark data as range folded or below threshold
    • Handles missing data
  – Performs base data logging for archive and playback
VCP 90 - TDWR Monitor Mode

- VCP90 – Monitor Mode
  - Used when no significant weather is near the associated airport
    - Precipitation Weather Mode (A) - may have weather elsewhere
  - 6-minutes to complete
  - Base-elevation angle varies by site, some as low as 0.1 degree
  - Maximum elevation angle is 60 degrees at all sites
  - After the base-elevation long-range scan, 15 short-range elevation scans are performed in sequence, low to high
VCP 80 - TDWR Monitor Mode

- **VCP80 – Hazardous Mode**
  - Used when significant weather is near the associated airport
    - Precipitation Weather Mode (A)
  - 6-minutes to complete
  - Base-elevation (minimum elevation) angle varies by site with some as low as 0.1 degree
  - Maximum elevation angle varies by site from 55 degrees at Orlando to as low as 20.1 degrees at several sites
  - After the base-elevation long-range scan, 22 short-range elevation scans are performed in a complex sequence:
    - base-elevation short-range scanned once per minute
    - all remaining scans are performed every 3 minutes
  - 3-minute “mini-volume” technique by SPG for some algorithms
TDWR vs. WSR-88D
Volume Scan Coverage
SPG Preprocessor

- SPG’s Preprocessor (PPM) task performs the following:
  - Creates 88D-like base data radials from TDWR radials
  - Base data is relative to magnetic north and adjusted to true north from offset TDWR basedata stream
  - Uses SNR threshold adaptable parameter to set data to below threshold (default 1.0 dB)
  - Interprets quality flags (possible RF) to set moment data to range folded
  - Sets short range scan reflectivity data (possible RF) to below threshold
  - No analogy to WSR-88D; Products sometimes have moving “holes”
  - Velocity is quantized from 0.25 m/s precision to 0.5 or 1.0 m/s by PPM, depending on adaptation data setting
SPG Preprocessor (cont.)

- SPG’s Preprocessor (PPM) task functionality (continued):
  - With FAA’s “TDWR Build 2”, uses TDWR’s dealiased velocity
  - Sector Blanking
    - Sets status to enabled if TDWR base data reports it
    - Resets it to disabled if base data does not report it during a compete volume scan
    - Like RPG, SPG products report spot blanking if enabled
  - Forms RDA Status Message to emulate WSR-88D
    - Becomes TDWR Unit Status display on AWIPS
    - VCP change
    - Calibration Mode
SPG Preprocessor (cont.)

- SPG’s Preprocessor (PPM) task functionality (continued):
  - Fills missing and “fat” radials caused by:
    - Missing: UDP packet loss
      - Poor quality FAA/WFO communication
      - SPG hardware glitch
      - Unusual SPG activity (e.g., base data compress & burn DVD)
    - Fat: Large delta azimuth, without packet loss
  - Cases
    - Single radials or sectors within an elevation.
    - Crossed elevation: PPM forms End-of-Elevation and Beg-of-Elevation
    - Skipped elevation: Lets downstream task PBD abort the volume scan
  - Mitigation to minimize volume scan aborts
    - PPM formed radial is blank except for bins at max range
    - Informs user of missing data and to distinguish from typical radar data problems (strobes, blockage, spot blanking, glitches)
SPG Products: Status

- SPG Status Products
  - General Status Message
  - Free Text Message
  - Archived Status Product
  - GSM, FTM, ASP
    - Product formats, generation method and frequency are identical to WSR-88D versions
SPG Products: Base Data

- SPG Base Products
  - Reflectivity
    - 256 data level, 300 meter resolution, 225 nmi range
    - 256 data level, 150 meter resolution, 48 nmi range
  - Velocity
    - 256 data level, 150 meter resolution, 48 nmi range
  - Spectrum Width
    - 256 data level, 150 meter resolution, 48 nmi range
SPG Products: Derived

- SPG Derived Products
  - Composite Reflectivity
  - VIL
  - Echo Tops
  - CR, VIL and ET
    - Products formats identical to WSR-88D except data range is 48 nmi
    - VCP90: 6-minute updates; includes all elevations
    - VCP80: 3-minute updates; includes all elevations in each mini-volume
SPG Products: Storm Overlay

- SPG Storm Attribute Overlay Products
  - Storm Tracking Information
  - Hail Index
  - Mesocyclone Detection
  - Tornadic Vortex Signature
  - STI, HI, MD, DMD and TVS
    - All product formats identical to WSR-88D versions except range is 48 nmi
    - VCP90: 6-minute updates; includes elevations below configurable elevation number
    - VCP80: 3-minute updates; includes elevations below configurable elevation number in each mini-volume
SPG Products: Wind Profile

- SPG Wind Profile Products
  - Velocity Azimuth Display
  - VAD Wind Profile
  - VAD, VWP
    - Product formats identical to WSR-88D versions
    - VCP90: 6-minute updates; includes all elevations
    - VCP80: 6-minute updates; includes the last cut of each short range angle
TDWR SPG (Build 10)
Product / Algorithm Processing

Algorithms/Products run on scans as indicated by cell side boarder (1 per 6 minute PPS, ULR, VWP), top (derived mini-vol), and patterns (storm analysis mini-volume).

- PPS: Long Range Cut
- VWP: Last Cut of Each Short Range Angle
- ULR: Every Cut
- STI, HI, MD, TVS, cat: Cut #’s as noted
- CR, VIL, ET: Cut #’s as noted & reuse Long Range cut

Product Times (top) of Base Product Elevation Cuts indicated by cell color

rev2 3/23/2016 istok
VIL/ET (SPG-SW-20-00015: eDAR Apr 3, 2020)

- No longer use long range reflectivity cut (#1) because all products from viletalg (VIL, ET) have a max range of 90 km.
- No longer use repeat 0.5 degree cuts (#6, #10, #18 and #22)
- No longer copy cut #3 into the second mini-volume
- Change VCP80 first mini-volume time stamp to time of 2nd elevation cut
- Correct beam depth calculation to account for modified TDWR Build 2 VCP 80 change
- These changes combine to make VIL values slightly lower, more so in the second mini-volume
- Negligible impact seen on ET products
SPG Build 11 Software CCRs

• **STI** (SPG-SW-20-0021: eDAR Apr 3, 2020)
  – No longer use repeat low elevation cuts in second mini-volume of VCP 80.
  – Impacts storm identification and tracking but changes are not statistically significant.

• **CR** (SPG-SW-20-0023: eDAR Apr 3, 2020)
  – No longer use long range reflectivity cut
  – No longer repeat 3rd cut in second mini-volume of VCP 80.
  – Removes subtle false increase in echo coverage in second mini-volume.

• **TVS** (SPG-SW-20-00033)
  – Filter TVS features that are too far from a SCIT cell centroid (same as WSR-88D)
Remove Rainfall Products (SPG-SW-18-00035 & 37, SPG-SW-19-00015)
- One-Hour Precipitation
- Three-Hour Precipitation
- Storm Total Precipitation
- User Selectable Precipitation
- Hybrid Scan Reflectivity
- Digital Precipitation Array
- Supplemental Precipitation Data
- OHP, THP, STP, USP, DHR, HSR, DPA, SPD
  - All product formats are identical to WSR-88D versions
  - VCP90: 6-minute updates; includes only the first elevation
  - VCP80: 6-minute updates; includes only the first elevation
  - Data is power averaged from 300 meter to 1 km resolution
  - No blockage file used
  - Will use gage-bias if provided by AWIPS
### TDWR SPG (Build 11)
#### Product / Algorithm Processing

<table>
<thead>
<tr>
<th>Bin</th>
<th>Angle</th>
<th>VCP</th>
<th>TDWR SPG (Product Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>Angle</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>27</td>
<td>60.0</td>
<td>57.6</td>
<td>62.5</td>
</tr>
<tr>
<td>26</td>
<td>55.0</td>
<td>52.6</td>
<td>57.5</td>
</tr>
<tr>
<td>25</td>
<td>50.0</td>
<td>47.6</td>
<td>52.5</td>
</tr>
<tr>
<td>24</td>
<td>45.0</td>
<td>42.6</td>
<td>47.5</td>
</tr>
<tr>
<td>23</td>
<td>40.0</td>
<td>37.6</td>
<td>42.5</td>
</tr>
<tr>
<td>22</td>
<td>35.0</td>
<td>32.6</td>
<td>37.5</td>
</tr>
<tr>
<td>21</td>
<td>30.0</td>
<td>27.6</td>
<td>32.5</td>
</tr>
<tr>
<td>20</td>
<td>25.0</td>
<td>22.1</td>
<td>27.5</td>
</tr>
<tr>
<td>19</td>
<td>19.5</td>
<td>18.0</td>
<td>22.0</td>
</tr>
<tr>
<td>17</td>
<td>14.0</td>
<td>13.1</td>
<td>15.6</td>
</tr>
<tr>
<td>15</td>
<td>10.0</td>
<td>9.6</td>
<td>11.0</td>
</tr>
<tr>
<td>12</td>
<td>6.0</td>
<td>5.7</td>
<td>6.6</td>
</tr>
<tr>
<td>9</td>
<td>3.4</td>
<td>2.7</td>
<td>3.6</td>
</tr>
<tr>
<td>5</td>
<td>0.9</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
<td>0.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**AWIPS Binning Scheme**
- **bwi**
- **tbwi example**

**Mini-Vol 1**

**Mini-Vol 2**

Algorithms/Products run on scans as indicated by cell side boarder (1 per 6 minute PPS, VWP), top (derived mini-vol), and patterns (storm analysis mini-volume).

- **VWP:** Last Cut of Each Short Range Angle
- **STI, HI, MD, TVS, cat:** Cut #’s as noted in mini-vol 1 & 2
- **CR(side), VIL/ET(top):** Cut #’s as noted.

Product Times (top) of Base & Derived Product Elevation Cuts indicated by cell color

**rev4 3/23/2021 istok**
TDWR SPG Base Data
Logging, Playback, Archive

- SPG maintains 8 day circular log of TDWR native format base data radials (not UDP packet format)
- SPG utility “tdwr2dvd” to compress data and burn to CD or DVD
  - Each DVD can hold about 24 hours.
  - Compression/DVD burning load can induce live UDP packet loss
- SPG playback utility “tpump”
  - As collected (date/time/data/elevations)
  - Set date/time to current time (for better AWIPS compatibility)
  - Emulate another sites elevations (support AWIPS localization)
  - Alter data to test patterns
  - Continuous playback loop mode
TDWR SPG Level II Data, Archive, and Playback

- TDWR SPG Level 2 Data
  - FAA native format converted to NEXRAD Message 31
  - Central collection and NCEI archive began SPG Build 10
  - Play_A2 updated to replay data
    - As collected (date/time/data/elevations)
    - Set date/time to current time (for better AWIPS compatibility)
    - Emulate another sites elevations (support AWIPS localization)

- Can create Level II data files via SPG “tpump” utility
AWIPS Considerations

• RPS
  – One vs All Cuts, Mini-volume scan products (since 2004)
  – With SPG Build 10 and AWIPS 20.2.1 (DCS 21371)
    • One, All Cuts, All elevations, All at or Below, All at or Below/All cuts,
      Lowest N, Lowest N/All Cuts.

• OTR
  – All Cuts set to ‘One’ by default (otherwise receive 6 copies of 1\textsuperscript{st} cut)

• Requests for Long Range Reflectivity scan
  – Site specific elevation angle 0.1 to 0.8 deg and resolution 0.3 km

• AWIPS sends part of the RAP model output to the SPG
  – Used to help the NEXRAD hail algorithm in SPG

• AWIPS centrally collects Level III (RPCCDS, NOAAPORT, NCEI)
  – PPS removed in 2019, returned at some sites, but AWIPS 20.2.1 will fix
AWIPS RPS Product Request

- **Cuts: All vs. One**
  - RPS distributes repeated elevations cuts
- **Mini-Volume products**
  - Under the hood (automatic)
- **All at or below/All Cuts**
  - SPG Build 10 and AWIPS 20.2.1 (Oct 2020)
## TDWR SPG Site IDs, Associations, and RPCCDS Directories

<p>| WFO # | SPG @ wfo | Sending WFO ID | TDWR SPG ID | TDWR Site ID | Radar FTP Site directory | SPG # | | WFO # | SPG @ wfo | Sending WFO ID | TDWR SPG ID | TDWR Site ID | Radar FTP Site directory | SPG # |
|-------|------------|----------------|-------------|--------------|--------------------------|-------| | | | | | | | | |
| 1 | 1 | KBOU | DEN | 3013 | Slt.tden | 1 | | 17 | 4 | KLWX | ADW | 3001 | Slt.tadw | 22 |
| 2 | 1 | KBOX | BOS | 3004 | Slt.tbos | 2 | | | | | | | | |
| 3 | 1 | KCLE | LVE | 3006 | Slt.tlve | 3 | | 18 | 1 | KMKG | MEM | 3028 | Slt.tmeg | 26 |
| 4 | 1 | KOTX | DTW | 3015 | Slt.tdtw | 4 | | 19 | 3 | KMFL | MIA | 3029 | Slt.tmia | 28 |
| 5 | 1 | KEAX | MCI | 3025 | Slt.tmci | 5 | | | | | | | | |
| 6 | 1 | KuFC | ATL | 3002 | Slt.tafl | 6 | | 20 | 1 | KMKX | MKE | 3030 | Slt.tmke | 30 |
| 7 | 2 | KFWD | DAL | 3010 | Slt.tdal | 7 | | 21 | 1 | KMLB | MCO | 3026 | Slt.tmco | 31 |
| 8 | 1 | KGSP | CLT | 3007 | Slt.tctl | 9 | | 22 | 1 | KMPX | MSP | 3031 | Slt.tmnp | 32 |
| 9 | 2 | KHGX | HOU | 3018 | Slt.thou | 10 | | | | | | | | |
| 10 | 1 | KICT | ICH | 3021 | Slt.tich | 12 | | 23 | 1 | KOH | BNA | 3003 | Slt.tbna | 33 |
| 11 | 3 | KILN | CMH | 3008 | Slt.tcmh | 13 | | 24 | 2 | Kok | EWR | 3016 | Slt.tewr | 34 |
| | | KILN | CVG | 3009 | Slt.tcvg | 14 | | | | | | | | |
| | | KILN | DAY | 3011 | Slt.tday | 15 | | 25 | 1 | KOUN | OKC | 3033 | Slt.tokc | 36 |
| 12 | 1 | KIND | IDS | 3022 | Slt.tids | 16 | | 26 | 1 | KPBJ | PIT | 3038 | Slt.tpit | 37 |
| 13 | 1 | KLIX | MSY | 3032 | Slt.tmsy | 17 | | 27 | 1 | KPHI | PHL | 3036 | Slt.tplh | 38 |
| 14 | 1 | KLMK | SDF | 3040 | Slt.tsdf | 18 | | 28 | 1 | KPJR | PHX | 3037 | Slt.tphx | 39 |
| 15 | 2 | KLOT | MDW | 3027 | Slt.tmdw | 19 | | 29 | 1 | KRAH | RDU | 3039 | Slt.trdu | 40 |
| | | KLOT | ORD | 3034 | Slt.tord | 20 | | 30 | 1 | KSLC | SLC | 3042 | Slt.tscl | 41 |
| 16 | 1 | KLSX | STL | 3043 | Slt.tstl | 21 | | 31 | 1 | KTBW | TPA | 3044 | Slt.ttpa | 42 |
| 32 | 1 | KTSX | TUL | 3045 | Slt.tttl | 43 | | 33 | 1 | KVEF | LAS | 3024 | Slt.tlas | 44 |
| 34 | 1 | TJSJ | SJU | 3041 | Sl.tsiu | 45 | | | | | | | | |</p>
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>PRODUCT HEADERS</th>
<th>ELEVATION ANGLES (DEGREES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Status Message</td>
<td>2/GSM</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Long Range Reflectivity – 225 nmi Range</td>
<td>186/DR SDU51 cccc TZ0 xxx</td>
<td>RDA v2: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8</td>
</tr>
<tr>
<td>Base Reflectivity – 48 nmi Range</td>
<td>180/DR SDU51 cccc TZ1 xxx</td>
<td>0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8</td>
</tr>
<tr>
<td></td>
<td>180/DR SDU52 cccc TZ2 xxx</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>180/DR SDU51 cccc TV0 xxx</td>
<td>1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 3.1, 3.3, 3.4, 3.7</td>
</tr>
<tr>
<td>Base Radial Velocity - 48 nmi Range</td>
<td>182/DV SDU51 cccc TV1 xxx</td>
<td>0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8</td>
</tr>
<tr>
<td></td>
<td>182/DV SDU51 cccc TV2 xxx</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>182/DV SDU51 cccc NCR xxx</td>
<td>1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 3.1, 3.3, 3.4, 3.7</td>
</tr>
<tr>
<td>Composite Reflectivity 16 Data Levels – 124 nmi Range</td>
<td>37/CR SDU51 cccc NCR xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Echo Tops</td>
<td>41/ET SDU51 cccc NET xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Velocity Azimuth Display Wind Profile</td>
<td>48/VWP SDU51 cccc NVW xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Vertical Integrated Liquid</td>
<td>57/VIL SDU51 cccc NVL xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Storm Tracking Information</td>
<td>58/STI SDU51 cccc NST xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Hail Index</td>
<td>59/HI SDU51 cccc NHI xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Mesocyclone</td>
<td>141/MD SDU51 cccc NMD xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Tornadic Vortex Signature</td>
<td>61/TVS SDU51 cccc NTV xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Free Text Message</td>
<td>75/FTM NOUS51 cccc FTM xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
<tr>
<td>Archive III Status Product</td>
<td>152/ASP SDU51 cccc RSL xxx</td>
<td>Elevation Angle Not Applicable</td>
</tr>
</tbody>
</table>
RPCCDS Throughput

Level 3 Product Central Collection Throughput - 6/13 to 6/20 2019

Hourly Throughput (kbps)

Hourly Product Count (#)

Time (mDDYY-hh)

KTLX

KMHX

tokc
SPG Training - Level II
TBWI August 4, 2020 0.5 deg @ 1329Z
Tropical Storm Isaias
SPG Training - Level II
TDAL October 21, 2019
Dallas Tornado
TDWR SPG Data Quality Considerations

- TDWR Data Quality Issues
  - Data availability
  - Range unfolding
  - Clutter filter effects
  - Interference
  - Attenuation
  - Elevation-dependent noise correction
Missing radials filled with blank radials and marked by several filled bins at the maximum range.
Range-folded obscuration

Note sharp transition to “no data”
Clutter Filter Effects

Zero Isodop

TORD 10aug2020 2101Z 8.7 deg

Note: Velocity > ~85 knots (44 to 48 m/s) marked RF
Clutter Filter Effects
Zero Isodop(s)

TORD 10aug2020 2101Z 15.2 deg
TSJU Interference and Sea Clutter
Attenuation – Impacting Supercell
TDWR Elevation-Dependent Noise Correction

tbwi 0.5 degrees

tbwi 1.0 degrees
TDWR Elevation-Dependent Noise Correction
Bad noise correction TBWI
KLWX same time as TBWI

Images on previous slide
SPG Data Loss Status

- SPG System Status Log Messages
  - Missing Radials
  - Fat Radials
  - Displayed as elevation index/count
  - May result in a volume scan restart/task cleanup

Oct 6,08 [00:16:52] >> Fat Radial: Total 5 (EI/CNT) 1/1 3/1 8/2 13/1
Oct 6,08 [00:16:52] >> Unexpected Start of Volume Scan 43
Oct 6,08 [00:16:52] >> RPG Task Cleanup For Volume Scan 42
Oct 6,08 [00:16:52] >> Vol: 43 (Seq: 29803) RDA Clock:10/06/08 00:16:52 VCP: 90
TDWR SPG
Data Loss Impact

• Impact could be ranked on a scale 1 to 10
  – 1: none,
  – 2: insignificant,
  – 3: occasional nuisance,
  – 4: frequent nuisance,
  – 5: occasional moderate impact,
  – 6: frequent moderate impact,
  – 7: continuous moderate impact,
  – 8: frequent severe impact,
  – 9: unusable,
  – 10: complete loss of operations.

• Interim SPG Status Web page
  – Data loss, volume aborts, ASP

• Status Log
  – Lost radial patterns
    • Few every volume
    • Many every volume
  – Volume Scan aborts
    • Few per 8 hours
    • Many aborts
    • Few or no completions
  – Complete loss
    • Comms discontinuity alarm (wideband failure)
    • HCI data flow icon stops

• Products
  – Few wedges
  – Many wedges
  – No volume products
  – No products of any kind
### NWS SPG TDWR Operational Status as of Tue Oct 14 12:59:52 UTC 2008

**Radar Sites - Last receipt of OTR data - Requested 1/hour**

- **Green = normal, Time is Product Volume Scan Time;**
- **Yellow = SPG OTR Responding, Time is Age of Old Product (Radar Likely Not Transmitting Base Data);**
- **Yellow GSM Date = Only GSM Received (SPG Operating, Radar Likely Not Transmitting Base Data);**
- **Orange = 8 Hour Radial Data Loss >= 1%, or 8 Hour Volume Aborts >= 25% (possible communications problems)**
- **Red = SPG Missing or Not Operational.**

### Operational Field SPGs Status:

<table>
<thead>
<tr>
<th>SPG</th>
<th>Date</th>
<th>Time</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>tadw</td>
<td>Oct 14 12:31</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tatl</td>
<td>Oct 14 12:29</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tbna</td>
<td>Oct 14 12:25</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tbos</td>
<td>Oct 14 12:26</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tbwi</td>
<td>Oct 14 12:24</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tclt</td>
<td>Oct 14 12:24</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tcmh</td>
<td>Oct 14 12:29</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tcvg</td>
<td>Oct 14 12:29</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tdal</td>
<td>Oct 14 12:23</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tday</td>
<td>Oct 14 12:24</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tden</td>
<td>Oct 14 12:31</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tdfw</td>
<td>Oct 14 12:22</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tdtw</td>
<td>Oct 14 12:25</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tewr</td>
<td>Oct 14 12:29</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tfll</td>
<td>Oct 14 12:23</td>
<td>Bld 30 VCP 80</td>
<td>Green</td>
</tr>
<tr>
<td>thou</td>
<td>Oct 14 12:25</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tiad</td>
<td>Oct 14 12:28</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tiah</td>
<td>Oct 14 12:28</td>
<td>Bld 30 VCP 80</td>
<td>Green</td>
</tr>
<tr>
<td>tich</td>
<td>Oct 14 12:21</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tids</td>
<td>Oct 14 12:28</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tjfk</td>
<td>Oct 14 12:34</td>
<td>Bld 30 VCP 80</td>
<td>Green</td>
</tr>
<tr>
<td>tias</td>
<td>Oct 14 12:25</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tive</td>
<td>Oct 14 12:30</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tmci</td>
<td>Oct 14 12:25</td>
<td>Bld 30 VCP 80</td>
<td>Green</td>
</tr>
<tr>
<td>tmco</td>
<td>Oct 14 12:19</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tmdw</td>
<td>Oct 14 12:28</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tmem</td>
<td>Oct 14 12:27</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tmia</td>
<td>Oct 14 11:52</td>
<td>Bld 30 VCP 80</td>
<td>Yellow</td>
</tr>
<tr>
<td>tmke</td>
<td>Oct 14 12:27</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tmsp</td>
<td>Oct 14 12:23</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tmsy</td>
<td>Oct 14 12:22</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tokc</td>
<td>Oct 14 12:22</td>
<td>Bld 30 VCP 80</td>
<td>Green</td>
</tr>
<tr>
<td>tord</td>
<td>Oct 14 12:30</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tpbi</td>
<td>Oct 14 12:18</td>
<td>Bld 30 VCP 80</td>
<td>Green</td>
</tr>
<tr>
<td>tphl</td>
<td>Oct 14 12:28</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tphx</td>
<td>Oct 14 12:23</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tpit</td>
<td>Oct 14 12:23</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>trdu</td>
<td>Oct 14 12:24</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tsdf</td>
<td>Oct 14 12:28</td>
<td>Bld 30 VCP 80</td>
<td>Green</td>
</tr>
<tr>
<td>tsju</td>
<td>Oct 14 12:28</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tsic</td>
<td>Oct 14 12:22</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>tstl</td>
<td>Oct 14 12:29</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
<tr>
<td>ttpa</td>
<td>Oct 14 12:29</td>
<td>Bld 19790 min old</td>
<td>Yellow</td>
</tr>
<tr>
<td>ttul</td>
<td>Oct 14 12:25</td>
<td>Bld 30 VCP 90</td>
<td>Green</td>
</tr>
</tbody>
</table>