Radial Recombination

- For ½ deg azimuth resolution only, 2 radials, Radial 1 and Radial 2, are combined when:

  0 <= (Radial 1 Azimuth – INT(Radial 1 Azimuth)) <= 0.5

  and

  0.25 <= (Radial 2 Azimuth – Radial 1 Azimuth) <= 0.75

Rules for Assigning Azimuth Angle

- The following rules assume indexed beams: Radial 1 centered on the 0.25 deg and Radial 2 centered on the 0.75 deg.

  - If Radial 1 is missing and Radial 2 is available, radial azimuth is assigned nearest 0.5 deg counterclockwise to Radial 2.

  - If Radial 1 is available and Radial 2 is missing, radial azimuth is assigned nearest 0.5 deg clockwise from Radial 1.

  - If Radial 1 and Radial 2 are missing, there will be no recombined radial.

  - If Radial 1 and Radial 2 are both available, radial azimuth is assigned nearest 0.5 deg to average of the radial azimuths.

- For non-indexed beams, recombined radial azimuth is assigned the average of the 2 radial azimuths.

  - If Radial 2 is missing, recombined radial azimuth is assigned Radial 1 azimuth + 0.25 deg.

Reflectivity Recombination

- There are different recombination rules depending on reflectivity bin size and radial separation:

Reflectivity recombination rules for 0.25 km reflectivity samples and ½ deg radial separation.

- The recombined reflectivity, Z_r, is the linear average of 8, 0.25 km reflectivity estimates Z_{ij}. Example:

	Radial 1	Radial 2
R_4	Z_{14}	Z_{24}
R_3	Z_{13}	Z_{23}
R_2	Z_{12}	Z_{22}
R_1	Z_{11}	Z_{21}

$$Z_r = (Z_{11} + Z_{12} + Z_{13} + Z_{14} + Z_{21} + Z_{22} + Z_{23} + Z_{24})/8$$

where Z_{ij} and Z_r in mm^6/m^3. That is:

$$Z_{ij} = 10^{(Zij\ (dBZ))/10}$$

The range assigned to Z_r is $(R_2 + R_3)/2$.

Reflectivity recombination rules for 0.25 km reflectivity samples and 1 deg radial separation.

- The recombined reflectivity, Z_r, is the linear average of 4, 0.25 km reflectivity estimates Z_{ij}. Example:

	Radial 1
R_4	Z_{14}
R_3	Z_{13}
R_2	Z_{12}
R_1	Z_{11}

$Z_r = (Z_{11} + Z_{12} + Z_{13} + Z_{14})/4$

The range assigned to Z_r is $(R_2 + R_3)/2$.

Reflectivity recombination rules for 1 km reflectivity samples and 1/2 deg radial separation.

- The recombined reflectivity, Z_r, is the linear average of 2, 1.0 km reflectivity estimates Z_{ij}. Example:

	Radial 1	Radial 2
R_1	Z_{11}	Z_{21}

$Z_r = (Z_{11} + Z_{21})/2$

The range assigned to Z_r is R_1

Rules for Handling Reflectivity Data Below Threshold

- If Z_{ij} has a Noise-like return (Z_{ij} (ICD) = 0), power is estimated:

  $P_{ij} = 0.7 * 10^{(\text{Noise (dB)} + \text{Z SNR Threshold (dB)}/10)}$

- The resulting power is used to replace the Noise-like return:

  Z_{ij} (dBZ) = $10\log(P_{ij}) - Atmos*R_j + 20\log R_j$ + SYSCAL

  $Z_{ij} = 10^{(Zij\ (dBZ)/10)}$

  SYSCAL = dBZ0 – Noise (dB)

- The recombined reflectivity Z_r is censored on Z SNR Threshold:

  $P_r = (10^{(Zr\ (dBZ)\ -\ SYSCAL\ +\ (Rj\ *\ Atmos))/10)})/R^2$

  if($P_r < 10^{(\text{Noise (dB)} + \text{Z SNR Threshold (dB)})/10}$)

  Z_r (ICD) = 0

  else

  Z_r (dBZ) = $10\log Z_r$

  Z_r (ICD) = NINT[2.0 * (Z_r (dBZ) + 32.0)] + 2

- Ensure all above threshold Z_r fall within ICD limits:

  If(Z_r (ICD) < 2)

  Z_r (ICD) = 0

  If(Z_r (ICD) > 255)

  Z_r (ICD) = 255

Velocity Recombination

- Velocity recombination only occurs with ½ deg radial data.

Radial 1	Radial 2
Z_1, V_1	Z_2, V_2

- Given the reflectivity and velocity at constant range for Radial 1 (Z_1, V_1) and Radial 2 (Z_1, V_2) the recombined velocity V_r is:

  $V_r = (Z_1*V_1 + Z_2*V_2)/(Z_1 + Z_2)$

  where Z_1 and Z_2 are reflectivity estimates, in mm^6/mm^3 and

  $V_j = V_j\ (ICD)\ /2 - 64.5$, j =1,2 (0.5 m/s)

  $V_j = V_j\ (ICD) - 129.0$, j = 1,2 (1.0 m/s)

- If either Z_1 or Z_2 are initially below SNR Threshold, an estimate is derived (See "Rules for Handling Reflectivity Data Below Threshold").

Rules for Handling Anomalies

- The following rules define special cases for velocity recombination:

  - If V_1 (ICD) = 0 and V_2 (ICD) = 0 (Both below V SNR Threshold):

    V_r (ICD) = 0

  - Else if Average power derived From Z_1 and Z_2 Below V SNR Threshold:

    $Z = (Z_1 + Z_2)/2$

    $P_z = Z*10^{(-20\log R - SYSCAL + R*Atmos)/10}$

    if($P_z < 10^{(Noise (dB) + V\ SNR\ Threshold (dB))/10}$)
    V_r (ICD) = 0

  - Else if Either V_1 (ICD) > 1 OR V_2 (ICD) > 1:

    if(V_1 (ICD) <= 1)
    $V_r = V_2$

    if(V_2 (ICD) <= 1)
    $V_r = V_1$

  - Else if (V_1 (ICD) = 1 and V_2 (ICD) = 1) OR
    (V_1 (ICD) = 0 and V_2 (ICD) = 1) OR
    (V_1 (ICD) = 1 and V_2 (ICD) = 0)

    V_r (ICD) = 1

Rules for Handling Anomalies

- Dealiasing attempts to place both V_1 and V_2 in the same Nyquist co-interval

Velocity Dealiasing Rules When V_1 and V_2 Within the Same PRF Sector

- if((V_1 -V_2) > V_Nyquist)
  V_2 = V_2 + 2*V_Nyquist

- if((V_2 – V_1) > V_Nyquist)
  V_1 = V_1 + 2*V_Nyquist

Velocity Dealiasing Rules When V_1 and V_2 Within Different PRF Sectors

- Dealiasing is not attempted in this case. Assume the velocity having the smaller Nyquist velocity is missing.

- Ensure V_r (ICD) is within ICD limits:

  - V_r (ICD) = NINT(Velocity_Reso*V_r + 127.0) + 2

  - if(V_r (ICD) < 2)
    V_r (ICD) = 2

  - if(V_r (ICD) > 255)
    V_r (ICD) = 255

Spectrum Width Recombination

- Spectrum Width recombination only occurs with ½ deg radial data.

Radial 1	Radial 2
Z_1, V_1, W_1	Z_2, V_2, W_2

- Given the reflectivity, velocity and spectrum width at constant range for Radial 1 (Z_1, V_1, W_1) and Radial 2 (Z_1, V_2, W_2) the recombined spectrum width W_r is:

  $$W_r = SQRT((Z_1*[W_1^2 + (V_1-V_r)^2] + Z_2*[W_2^2 + (V_2-V_r)^2])/(Z_1+Z_2))$$

  where Z_1 and Z_2 are reflectivity estimates, in mm^6/mm^3 and $W_j = W_j\ (ICD)/2 - 64.5$, $j = 1,2$.

- If either Z_1 or Z_2 are initially below SNR Threshold, an estimate is derived (See “Rules for Handling Reflectivity Data Below Threshold”).

Rules for Handling Anomalies

- The following rules define special cases for spectrum width recombination:

  - If W_1 (ICD) = 0 and W_2 (ICD) = 0 (Both < W SNR Threshold):

    W_r (ICD) = 0

  - Else if Avg power from Z_1 and Z_2 < W SNR Threshold:

    $Z = (Z_1 + Z_2)/2$

    $P_z = Z*10^{(-20\log R - SYSCAL + R*Atmos)/10}$

    if($P_z < 10^{(Noise (dB) + W SNR Threshold (dB))/10}$)
    W_r (ICD) = 0

  - Else If Either W_1 (ICD) > 1 OR W_2 (ICD) > 1

    if(W_1 (ICD) <= 1)
    $W_r = W_2$

    if(W_2 (ICD) <= 1)
    $W_r = W_1$

  - Else if (W_1 (ICD) = 1 and W_2 (ICD) = 1) OR
    (W_1 (ICD) = 0 and W_2 (ICD) = 1) OR
    (W_1 (ICD) = 1 and W_2 (ICD) = 0)

    W_r (ICD) = 1

- Ensure W_r (ICD) is within ICD limits:

$$W_r (ICD) = NINT(2*W_r + 63.5) + 2$$

$$\text{if}(W_r (ICD) < 2)$$
$$W_r (ICD) = 2$$

$$\text{if}(W_r (ICD) > 255)$$
$$W_r (ICD) = 255$$