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Description Document
Supplemental Adaptive Intra-Volume Low-Level Scan
(SAILS)

1. **General Description**.

SAILS inserts one supplemental split cut*[1,2] scan (lowest elevation defined in the VCP definition, normally 0.5°) into the existing severe weather VCPs 12 and 212. This new split cut scan is inserted into the "middle" of the volume scan to evenly space, as close as possible, the time intervals between low-level data updates. The "middle" of the volume scan is adaptive and determined on a volume scan-to-volume scan basis based on the termination angle determined by the Automated Volume Scan Evaluation and Termination (AVSET) function (see Table 1 below).

*NOTE *[1] - Split Cut is a term used to describe the technique of scanning a particular elevation two or more times, using a different PRF for each full scan. This technique is used to accurately place targets in range using a low PRF and to collect accurate velocity data using a high PRF.*

*NOTE [*2] - For sites with site-specific scanning strategies, the lowest elevation angle may be other than 0.5°. For purposes of this DAR, it will be assumed the lowest elevation defined in the VCP is 0.5°.*

Split Cut data collection was chosen because it provides the required number of samples to ensure effective clutter filtering, provides range unambiguous reflectivity data which is the basis to range unfold velocity data and supports Super Resolution data processing. Using Split Cut scanning to collect the supplemental low-level scan adds approximately 35 seconds to the volume scan duration. This results in VCP 12 completion times of approximately 285 seconds when AVSET does not terminate the VCP early and a completion time of approximately 225 seconds when AVSET terminates the volume coverage pattern after collection of the 6.4° scan.

The SAILS supplemental scan uses the same antenna rotation rates and data acquisition schemes as defined for the baseline VCP in which it is used. Therefore, the supplemental scan data are processed using the same moment estimation methods and data processing techniques as the standard low-level data for that VCP.

2. **SAILS Data.**

a. Base Products.
   i. The RPG will support generating the base products DR (94), DV (99), SDR (153), SDV (154), and SDW (155) from the SAILS elevation data. These products should be requested by external user with the "All Elevations" elevation parameter request option with the elevation angle specified in the request (i.e., bit 14 set, bit 15 and 13 cleared; bits 0-12 specify the elevation angle*10).
   ii. For products generated from the SAILS supplemental scan data, the start of volume time in the Product Description Block is substituted with the start of elevation time. This is necessary to distinguish the supplemental scan products from the products generated from the first split cut in the VCP.

b. Base Data.
   i. The base moments (Z, V and W) and Dual Pol variables from the SAILS supplemental scan will be included in the Level II base data stream.
   ii. Algorithms MUST be configured via task_attr_table in order to receive SAILS scan base data for processing.*[3]

c. GSM.
   i. Halfword 58, Bit 14 will be used to identify when SAILS is active.
   ii. Bit 14 set when SAILS is enabled and a SAILS VCP is active.
   iii. Bit 14 not set all other times.

NOTE[3] - The SAILS scan data is segregated from the algorithm data processing stream is to ensure the field deployment of SAILS would not be delayed waiting for algorithm development required to incorporate this new data. However, by including this new scan in the Level II data stream algorithm developers can enhance/correct/modify their algorithms, if they wish to use the new data input, without delaying SAILS field implementation. Any algorithm updates and enhancements will be included in future RPG builds.*

3. **SAILS Functional Requirements**.

a. SAILS is only available for execution with VCPs that allow SAILS, as determined by a flag set in the VCP definition (currently only VCP 12 and VCP 212).
b. When active, SAILS inserts one supplemental low-level (lowest elevation defined in the VCP definition, normally 0.5°) split cut scan into the allowed VCPs.
c. SAILS will insert a new split cut scan into the "middle" of the volume scan to evenly space, as close as possible, the time intervals between low-level data updates.

d. The “middle” of the volume scan is adaptive and determined on a volume scan-to-volume scan basis based on the termination angle determined by AVSET (for examples of VCP 12 insertion points, see the table below).
e. Determining the “Insert Elevation”
    i. Initial Insertion Elevation Point (Assumption: The termination elevation of this volume scan will be the same as the previous volume scan.)
        1. Estimate the volume scan duration of the previous volume scan. Total volume scan duration is the scanning time of each completed elevation scan (*360° divided by the scan rate (identified in the VCP definition) + 0.5, then truncated to the whole second).*
        2. Calculate the SAILS volume scan duration. Add the previous volume scan duration and the supplemental split cut scan duration (for VCP 12, the 0.5 split cut duration is ~ 31 secs (17 sec for the Surveillance scan and 14 sec for the Doppler scan). This is the SAILS scan duration.
        3. Determine the midpoint target of the calculated SAILS volume scan duration. (SAILS scan duration divided by 2).
        4. Calculate running cumulative volume scan duration for each elevation of the baseline VCP (without the SAILS split cut).
        5. Compare the running cumulative volume scan duration for each elevation to the volume scan midpoint target value. Insert the supplemental scan <u>above</u> the elevation that has the smallest Delta between the running cumulative scan duration and the volume scan midpoint target.
        6. Download this new VCP definition to the RDA.
    ii. Final Insertion Elevation Point. At the beginning of the last elevation of the current volume scan, the SAILS function compares the current termination elevation angle to the previous volume scan termination angle.
        1. If the termination angle of the current volume scan is the same as the termination angle of the previous volume scan then the Initial Insertion Elevation Point equals the Final Insertion Elevation Point. No further action is required.
        2. If the termination angle of the current volume scan is NOT the same as the termination angle of the previous volume scan then the SAILS function accomplishes Steps e.i.1 through e.i.6 (above).
f. Table 1 presents an example of the SAILS insertion angle verses termination angle for VCP 12.

Table 1: SAILS Insert Elevation vs: Termination Angle

SAILS 0.5° Elevation Insertion Point Based on VCP Termination Angle							
Elevation Angles (VCP 12)	VCP 12 Elevation Duration	Standard Termination Angle = 19.5	AVSET Termination Angle = 15.6	AVSET Termination Angle = 12.5	AVSET Termination Angle = 10.0	AVSET Termination Angle = 8.0	AVSET Termination Angle = 6.4
0.5°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.9°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
1.3°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
1.8°	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec
0.5°						31 Sec	31 Sec
2.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°				31 Sec	31 Sec		
3.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°		31 Sec	31 Sec				
4.0°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
5.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
6.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
8.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	
10.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec		
12.5°	13 Sec	13 Sec	13 Sec	13 Sec			
15.6°	13 Sec	13 Sec	13 Sec				
19.5°	13 Sec	13 Sec					
Duration	243 Sec	274 Sec	261 Sec	248 Sec	235 Sec	222 Sec	209 Sec
0.5 Elevation Update Times	243 Sec*	136 Sec and 138 Sec *	136 Sec and 125 Sec *	122 Sec and 126 Sec *	122 Sec and 113 Sec *	108 Sec and 114 Sec *	108 Sec and 101 Sec *
Note: These times are estimates. Times will vary slightly based on individual radar performance.							
* Plus Retrace Time							

4. **Dynamic Scanning Benefits.**

SAILS will significantly reduce low level scan update rate, especially when storms are displaced from the RDA location. The Standard VCP 12 scans 0.5° every ~185 to ~250 seconds, depending on the AVSET's VCP termination angle, which provides 14 to 19 updates per hour. VCP 12 with SAILS will scan 0.5° every ~112 to ~142 seconds, depending on AVSET, providing between 24 and 32 low-level scans per hour. See Tables 2 and 3.

Table 2: VCP 12 Dynamic Scanning Benefits

VCP 12	0.5° Base Product Updates per Hour	Volume Product Updates per Hour
Standard Operation	14	14
AVSET	14 - 19	14 - 19
SAILS	24	12
AVSET and SAILS	24 - 32	12 - 16

Table 3: VCP 212 Dynamic Scanning Benefits

VCP 212	0.5° Base Product Updates per Hour	Volume Product Updates per Hour
Standard Operation	13	13
AVSET	13 - 17	13 - 17
SAILS	22	11
AVSET and SAILS	22 - 28	11 - 14

NOTE: AVSET and SAILS are independent functions and may be executed separately.

AVSET – Automated Volume Scan Evaluation and Termination

SAILS – Supplemental Adaptive Intra-Volume Low-Level Scan

5. **Summary.**

SAILS can provide almost twice as many low-level base products for a given period than the current severe weather VCPs 12 and 212 without impacting the quality of the base data estimates. These additional low-level "looks" during severe weather operations will significantly enhance WSR-88D forecast and warning support, while not impacting WSR-88D data quality or hardware operations.