Initial Test – Report of Findings
Multiple Elevation Scan Option for SAILS

Antenna/Pedestal Assembly Performance Specifications:

Maximum Rotation Rate = 36°/second
Maximum Elevation Rate = 36°/second
Maximum Elevation Acceleration/Deceleration Rate = 36°/second/second

SAILS Test VCP (SAILSx3) Performance Characteristics:

Rotation Rate:

Surveillance Rotation Rate = 21.149°/second (same as standard VCP 12)
Doppler Rotation Rate = 24.994°/second (same as standard VCP 12)

Elevation Rate**:

1.4° to 0.5°	Average transition time* = .9297 seconds;	Rate = 0.968°/second
0.5° to 1.9°	Average transition time* = 1.020 seconds;	Rate = 1.373°/second
4.0° to 0.5°	Average transition time* = 2.049 seconds;	Rate = 1.708°/second
0.5° to 5.1°	Average transition time* = 1.710 seconds;	Rate = 2.690°/second
8.0° to 0.5°	Average transition time* = 2.255 seconds;	Rate = 3.326°/second
0.5° to 10.0°	Average transition time* = 3.402 seconds;	Rate = 2.792°/second

Acceleration Rate**:

1.4° to 0.5°	2.78°/second/second	(Deceleration Rate = 8.33°/second/second)
0.5° to 1.9°	3.59°/second/second	(Deceleration Rate = 10.77°/second/second)
4.0° to 0.5°	2.22°/second/second	(Deceleration Rate = 6.67°/second/second)
0.5° to 5.1°	4.20°/second/second	(Deceleration Rate = 12.59°/second/second)
8.0° to 0.5°	3.93°/second/second	(Deceleration Rate = 11.80°/second/second)
0.5° to 10.0°	2.19°/second/second	(Deceleration Rate = 6.57°/second/second)

NOTE: The acceleration/deceleration rates were calculated based on the following assumptions:

- Acceleration/Deceleration is constant
- The antenna/pedestal assembly accelerates 75% of elevation transition time interval and decelerates 25% of the time interval. In other words, it accelerates to some maximum velocity for 75% of elevation transition time interval and decelerates the remainder of elevation transition time interval.
- These acceleration/deceleration percentages (75% and 25%) were chosen to represent a worst case scenario (the calculated deceleration rates are more aggressive than expected operational rates) and are not actual operational percentages.

*Average transition time computed from 6 volume scans using acc1 tool for timing information
**See Attachment 2 for VCP 21 comparison information

Initial Testing - Multiple Elevation Scan Options for SAILS:

The initial test event was conducted on June 25, 2013 and executed the SAILSx2 VCP (See Attachment 1 for VCP definition) for approximately 4-1/2 hours. A ROC electronics maintenance technician, reviewed the SAILSx2 VCP definition and spent a considerable amount of time in the radome observing the behavior of the antenna/pedestal assembly.

During the second test event, June 28, 2013, the SAILSx3 VCP (See Attachment 1 for VCP definition) was executed for approximately 1-1/2 hours on KOUN. For this demonstration, a ROC Radar Hardware Engineer reviewed the SAILSx3 VCP definition and accompanied an electronics maintenance technician into the radome to observe and inspect the antenna/pedestal assembly.

A radar hardware engineer was also briefed on the concept of SAILSx3 and provided a copy of the test SAILSx3 VCP definition for review.

Additionally, a ROC systems engineer was also briefed on the concept of SAILSx3 and provided the elevation transition times collected during the second test event. These elevation transition times were used to calculate the antenna elevation acceleration (provided above) required to position the antenna for execution of the SAILSx3 VCP definition.

Test Observations:

Observing the operation of the antenna/pedestal assembly during the execution of the SAILSx3 VCP, the additional 0.5° elevations were scanned after the 1.3°, 4.0° and 8° elevation cuts. Upon completion of each additional 0.5° scan, the antenna returned to the next elevation in the defined VCP (1.8°, 5.1° and 10°, respectively). Operational rotation speeds and elevation changes were well within operational parameters of the antenna/pedestal drive assembly system.

During controlled operation of the antenna/pedestal (executing VCPs), operational parameters are monitored and maintained by the control software. (Note: the antenna/pedestal assembly is controlled by the Digital Control Unit). When the antenna/pedestal assembly is under software control, all movement is considered to cause nominal wear of the electromechanical components.

Test Findings:

The experts involved in this testing all agreed that the small antenna elevation transitions (~10°) required to execute the additional SAILS elevations are well within the design and performance specifications of the antenna/pedestal assembly and will not cause any excessive wear and tear on the system.

Attachment 1

SAILS Test VCP Definitions

Elevation Angles (VCP 12)	VCP 12 Elevation Duration	SAILS	SAILSx2	SAILSx3
0.5°	31 Sec	31 Sec	31 Sec	31 Sec
0.9°	31 Sec	31 Sec	31 Sec	31 Sec
1.3°	31 Sec	31 Sec	31 Sec	31 Sec
0.5°				31 Sec
1.8°	15 Sec	15 Sec	15 Sec	15 Sec
0.5°			31 Sec	
2.4°	14 Sec	14 Sec	14 Sec	14 Sec
3.1°	14 Sec	14 Sec	14 Sec	14 Sec
0.5°		31 Sec		
4.0°	14 Sec	14 Sec	14 Sec	14 Sec
0.5°				31 Sec
5.1°	14 Sec	14 Sec	14 Sec	14 Sec
6.4°	14 Sec	14 Sec	14 Sec	14 Sec
0.5°			31 Sec	
8.0°	13 Sec	13 Sec	13 Sec	13 Sec
0.5°				31 Sec
10.0°	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	13 Sec
19.5°	13 Sec	13 Sec	13 Sec	13 Sec
Duration	243 Sec	274 Sec	305 Sec	336 Sec
0.5 Elevation Update Times	253 Sec*	136 Sec, and 148 Sec*	108 Sec, 101 Sec and 106 Sec*	93 Sec, 88 Sec, 72 Sec and 93 Sec*
		Avg 147** Sec	Avg 108** Sec	Avg 89** Sec
* 10 Sec added to account for Retrace Time ** Avg estimate includes 20 Sec to account for Retrace and Elevation Transitions				

Note: The SAILSx2 and SAILSx3 VCPs were designed to emulate the two proposed SAILS options, respectively.

Attachment 2

Comparison Information.

KINX VCP 21 Performance Characteristics.

Elevation Rate:

4.3° to 6.0°	Average transition time* = 1.230 seconds; Rate = 1.382°/second
6.0° to 9.9°	Average transition time* = 1.665 seconds; Rate = 2.343°/second
9.9° to 14.6°	Average transition time* = 2.132 seconds; Rate = 2.205°/second
14.6° to 19.5°	Average transition time* = 1.646 seconds; Rate = 2.976°/second

Acceleration Rate:

4.3° to 6.0°	3.00°/second/second	(Deceleration Rate = 8.99°/second/second)
6.0° to 9.9°	3.75°/second/second	(Deceleration Rate = 11.25°/second/second)
9.9° to 14.6°	2.76°/second/second	(Deceleration Rate = 8.27°/second/second)
14.6° to 19.5°	3.60°/second/second	(Deceleration Rate = 10.79°/second/second)

NOTE: The acceleration/deceleration rates were calculated based on the following assumptions:

- Acceleration/Deceleration is constant
- The antenna/pedestal assembly accelerates 75% of elevation transition time interval and decelerates 25% of the time interval. In other words, it accelerates to some maximum velocity for 75% of elevation transition time interval and decelerates the remainder of elevation transition time interval.
- These acceleration/deceleration percentages (75% and 25%) were chosen to represent a worst case scenario (the calculated deceleration rates are more aggressive than expected operational rates) and are not actual operational percentages.

*Average of 5 volume scans (July 17, 2013 0933-0956Z) computed using acc1 tool for timing information