

NWS Supplemental Product Generator (SPG)

for the

ARSR-4 and ASR-11 Radars

Product Specification & Interface Control Document

**National Oceanic and Atmospheric Administration
National Weather Service
Office of Science & Technology Systems Engineering Center**

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ARSR-4 Technical Details

The Air Route Surveillance Radar, Model 4 (ARSR-4) is a joint FAA and DoD initiative whose mission is to provide aircraft position information to the FAA, Air Force, Navy and Customs Service. The system is used simultaneously for national defense early warning, drug smuggling interdiction, and air traffic control. There are 43 ARSR-4 units located in the U.S. and other U. S. territories.

The ARSR-4 uses phased array technology. One volume scan is accumulated each 36 seconds. Its frequency is in the L Band (21.4 – 24.7 cm) and utilizes both linear and circular polarization. Doppler data are acquired by the system but are not made available to the NWS. Weather data are generated by switching at set ranges to lower beams at longer ranges. The beam width is 1.41 degrees azimuth by 2.2 degrees elevation. Weather data are provided as NWS 6-level DVIP values. For any given range, only 5 weather levels are available. For the first (closest in) beam, weather levels 1 through 5 are processed. Beyond the first beam, only levels 2 through 6 are processed. Three full 12-second scans are collected and smoothed before transmitting a single 36-second weather map.

ASR-11 Technical Details

The Airport Surveillance Radar, Model 11 (ASR-11) is a next-generation solid-state terminal area air traffic control radar. Both the FAA and the DoD have used the ASR-11 to replace aging analog systems at 213 military and civilian airfields across the country.

The ASR-11 utilizes a fan beam configuration with a width of 1.41 degrees and a height of 4.8 degrees. The maximum antenna rotation rate is 12 RPM. The transmitting frequency is in the S band (10.3 - 11.1 cm). Weather data are provided as NWS 6-level DVIP values.

2. Product Specifications Document Modifications

2.1 REFLECTIVITY (R)

SSS Product Description

"This product shall provide the reflectivity data displayable as an image¹ and formatted as a data array. The product shall provide areas of coverage and display resolutions. The product shall be generated based on user requirements. Each scan shall be updated once per volume scan time.² Each product shall be available for 8 reflectivity data levels. Each product shall include annotations for the product name, radar ID, time and date of scan, data level code, elevation angle, maximum data value (dBZ), radar position, radar elevation above MSL, and radar operational mode.

¹Defines the form of presentation on a graphic display; not necessarily the form of transmission."

²Defined in Appendix B"

2.2 Display Format

The product is displayable in full- or quarter-screen format (see Appendix B).

2.2.1 Data Levels

The range of data level values (dBZ) varies with area climatology and season. The range of reflectivity supported by the ARSR and ASR RDA is 18 to 57 dBZe.

2.2.2 Color Level Code Tables

The color level code used for display of the image version of reflectivity is NEXRAD system adaptation data. With the exception of the end points, the lower value of the range is assigned to the individual colors displayed. The range of values for each is also indicated.

Precipitation Mode and Clear Air Mode

8-Level Code	Display dBZ	Range dBZ	Color Levels Code	Color
0	ND	SNR<TH or dBZ<5	(00 00 00)	black
1	blank	N/A		
2	18	18≤dBZ<30	(C9 70 70)	dark pink
3	30	30≤dBZ<41	(00 BB 00)	medium green
4	41	41≤dBZ<46	(FF FF 70)	light yellow
5	46	46≤dBZ<50	(DA 00 00)	medium red
6	50	50≤dBZ<57	(00 00 FF)	blue
7	57	57≤dBZ	(FF FF FF)	white

2.2.3 Range/Data Resolution

The products will be available for the range/resolution combinations as indicated.

Product	Coverage Area (nmi Radius)	Resolution (nmi x deg)	Product Center
ARSR-4 REFL	0 to 250	0.25 x 1.41	Radar location
ASR-11 REFL	0 to 60	0.5x 1.41	Radar location

2.3 Annotations

2.3.1 Alphanumeric

Standard Annotations (Appendix A, I(A))

Elevation Angle

Data Level Code

Maximum Data Value Detected

2.3.2 Special Symbols

None defined

2.4 Product Interaction

All overlay products are displayable on this product:

None defined

~~—Combined Shear Contour~~

~~—Hail Index~~

~~—Mesocyclone~~

~~—Severe Weather Probability~~

~~—Storm Tracking Information~~

~~—Tornado Vortex Signature~~

Class I, Interface Control Document (ICD) Modifications

This portion of the document highlights changes that will be required to properly format AWIPS-compatible radar products using ARSR-4 and ASR-11 data at the resolutions selected by the NWS HQ Systems Engineering Center.

Changes and additions to the Class 1 ICD are noted below.

Table 4 – ARSR-4 and ASR-11 product ranges and resolutions

Product Type	Range Resolution	Maximum Range	#bins used	Azimuth Resolution
ARSR-4 Reflectivity	0.25 nmi (463 m)	250 nmi (463 km)	1000 bins	1.41 deg
ASR-11 Reflectivity	0.5 nmi (926 m)	60 nmi (111 km)	120 bins	1.41 deg

Table 5 –Message Codes for Products

CODE	NTR	PRODUCT NAME	RESOLUTION	RANGE	DATA LEVEL	MESSAGE FORMAT
500	1	ARSR-4 Reflectivity	.25 x 1.41 Nmi x Deg	250 nmi (463 km)	8	Radial Image
550	1	ASR-11 Reflectivity	.50 x 1.41 Nmi x Deg	60 nmi (111 km)	8	Radial Image

Message Header Block

A new set of source IDs (Appendix A) and product message codes (Table 5) has been established for FAA radars.

Table 6 – Message Header Block

	MSB	HALFWORD	LSB
MESSAGE HEADER BLOCK	MESSAGE CODE		01
	DATE OF MESSAGE		02
	TIME OF MESSAGE (MSW)		03
	TIME OF MESSAGE (LSW)		04
	LENGTH OF MESSAGE (MSW)		05
	LENGTH OF MESSAGE (LSW)		06
	SOURCE ID		07
	DESTINATION ID		08
	NUMBER OF BLOCKS		09

Table 6 (cont) - Message Header Block Description

HALF WORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
01	Message Code	INT*2	N/A	-131 to -16, 0 to +550	N/A	NEXRAD Message Code defined in Table II. See Appendix A
02	Date of Message	INT*2	Julian Date	1 to 32,767	1	Modified Julian Date at time of transmission (number of days since 1 January 1970, where 1=1 January 1970). To obtain actual Julian Date, add 2,440,586.5 to the modified date
03-04	Time of Message	INT*4	Seconds	0 to 86,399	1	Number of seconds after midnight, Greenwich Mean Time (GMT)
05-06	Length of Message	INT*4	N/A	18 to 409856	1	Number of bytes in message including header
07	Source ID	INT*2	N/A	0 to 4399	1	Source (originators') ID of the sender. See Appendix A
08	Destination ID	INT*2	N/A	0 to 999	1	Destination ID (receivers') for message transmission
09	Number Blocks	INT*2	N/A	1 to 51	1	Header Block plus the Product Description Blocks in message

Product Description Block

To properly accommodate ARSR-4 and ASR-11 products, the following modifications are made to the Product Description Block (Table 7):

- a. Halfword 16: Product Code – New product codes for the ASR and ARSR
- b. Halfword 17: Operational Mode – The ARSR and ASR will only provide “Precipitation/Severe Weather” Operational Mode.
- c. Halfword 18: VCP – The ASR and ARSR volume consists of a single elevation scan. VCP number is set to 100 for each.

Table 7 – The Product Description Block

PRODUCT	(-1) BLOCK DIVIDER	
10		
DESCRIPTION	LATITUDE OF RADAR (MSW)	
11		
BLOCK	(LSW)	
12		
13	LONGITUDE OF RADAR (MSW)	
14	(LSW)	
15	HEIGHT OF RADAR	
16	PRODUCT CODE	
17	OPERATIONAL MODE	
18	VOLUME COVERAGE PATTERN	
19	SEQUENCE NUMBER	
20	VOLUME SCAN NUMBER	
21	VOLUME SCAN DATE	
22	VOLUME SCAN START (MSW)	
23	TIME (LSW)	
24	PRODUCT GENERATION DATE	
25	PRODUCT GENERATION (MSW)	
	TIME (LSW)	
27	PRODUCT DEPENDENT (P1)	(SEE TABLE V)
28	PRODUCT DEPENDENT (P2)	(SEE TABLE V)
29	ELEVATION NUMBER	
30	PRODUCT DEPENDENT (P3)	(SEE TABLE V)
31	DATA LEVEL 1 THRESHOLD	(SEE NOTE, SHEET 11)
32	DATA LEVEL 2 THRESHOLD	
33	DATA LEVEL 3 THRESHOLD	
34	DATA LEVEL 4 THRESHOLD	
35	DATA LEVEL 5 THRESHOLD	
36	DATA LEVEL 6 THRESHOLD	
37	DATA LEVEL 7 THRESHOLD	
38	DATA LEVEL 8 THRESHOLD	
39	DATA LEVEL 9 THRESHOLD	
40	DATA LEVEL 10 THRESHOLD	

41	DATA LEVEL 11 THRESHOLD	
42	DATA LEVEL 12 THRESHOLD	
43	DATA LEVEL 13 THRESHOLD	
44	DATA LEVEL 14 THRESHOLD	(SEE NOTE, SHEET 11)
45	DATA LEVEL 15 THRESHOLD	
46	DATA LEVEL 16 THRESHOLD	
47	PRODUCT DEPENDENT (P4)	(SEE TABLE V)
48	“ (P5)	
49	“ (P6)	
50	“ (P7)	
51	“ (P8)	
52	“ (P9)	
53	“ (P10)	
54	VERSIONS	SPOT BLANK
55	OFFSET TO GRAPHIC (MSW)	
56		(LSW)
57	OFFSET TO GRAPHIC (MSW)	
58		(LSW)
59	OFFSET TO TABULAR (MSW)	
60		(LSW)

Table 7 (cont) - Product Description Block – Field Description

HALFWORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
10	Block Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate the header from the Product Description Block
11 - 12	Latitude of Radar	INT*4	Degrees	-90 to +90	0.001	North (+) or South (-) of the Equator
13 - 14	Longitude of Radar	INT*4	Degrees	-180 to +180	0.001	East (+) or West (-) of the Prime Meridian
15	Height of Radar	INT*2	Feet	-100 to +11000	1	Feet above mean sea level
16	Product Code	INT*2	N/A	16 to 550, -16 to -131	N/A	Internal NEXRAD product code of weather product being transmitted Table 5
17	Operational Mode	INT*2	N/A	0 to 2	N/A	0 = Maintenance 1 = Clean Air 2 = Precipitation/ Severe Weather (only 2)
18	Volume Coverage Pattern	INT*2	N/A	1 to 767	1	RDA volume coverage pattern for the scan strategy being used (ARSR-4 and ASR-11 use VCP = 100)
19	Sequence Number	INT*2	N/A	-13, 0 to 32767	1	Sequence number of the request that generated the product (Refer to Figure 3-4). For products generated by an Alert Condition, sequence number = -13

HALFWORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
20	Volume Scan Number	INT*2	N/A	1 to 80	1	Counter, recycles to one (1) every 80 volume scans
21	Volume Scan Date	INT*2	Julian Date	1 to 32767	1	Modified Julian Date; integer number of days since 1 Jan.
22 - 23	Volume Scan Start Time	INT*4	Seconds GMT	0 to 86399	1	Number of seconds after midnight, Greenwich Mean Time (GMT)
24	Generation Date of Product	INT*2	Julian Date	1 to 32767	1	Modified Julian Date as above
25 - 26	Generation Time of Product	INT*4	Seconds GMT	0 to 86399	1	Number of seconds after midnight, Greenwich Mean Time (GMT)
27 - 28	-----PRODUCT DEPENDENT AS PER TABLE V-----					
29	Elevation Number	INT*2	N/A	0 to 22	1	Elevation number within volume scan for elevation based product 0 for volume based products.
30 - 53	-----PRODUCT DEPENDENT AS PER TABLE V-----					
54	Version	INT*1	N/A	0 to 255	1	If the message is product data, the upper byte is the version number of the product. The original format of a

HALFWORD	FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
						product will be version 0. (Note 2)
54	Spot Blank	INT*1	N/A	0 to 1	1	If the message is product date, the lower byte is: 1 = Spot Blank ON 2 = Spot Blanking if OFF
55 - 56	Offset to Symbology	INT*4	Halfwords	0 to 80000	1	Number of halfwords from the top of message (message code field in header) to the -1 divider of each block listed. If the offset is zero (0), the block is not part of the product in question
57 - 58	Offset to Graphic	INT*4	Halfwords	0 to 80000	1	Same as above to Graphic Block (NOTE: For Product 62, this will point to the Cell Trend data)
59 - 60	Offset to Tabular	INT*4	Halfwords	0 to 80000	1	Same as above to Tabular Block

Product Symbology Block

No modifications are required to support ARSR-4 and ASR-11 products.

Table 8 – Product Symbology Block

PRODUCT	(-1) BLOCK DIVIDER		
	SYMBOLGY	BLOCK ID (1)	
	BLOCK	LENGTH OF BLOCK (MSW)	
		(LSW)	
	NUMBER OF LAYERS		
	(-1) LAYER DIVIDER		
	LENGTH OF DATA LAYER (MSW)		
	(LSW)		
	DISPLAY DATA PACKETS	SEE FIGURES 3-6 THRU 3-14	
	• • •		
	(-1) LAYER DIVIDER		
	LENGTH OF DATA LAYER (MSW)		
	(LSW)		
	DISPLAY DATA PACKETS	SEE FIGURES 3-6 THRU 3-14	

Table 8 (cont) Product Symbology Block – Field Descriptions

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Block Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate the Product Description from the Product Symbology Block
Block ID	INT*2	N/A	1	N/A	Constant value of 1 which identifies this block
Length of Block	INT*4	Bytes	1 to 80000	1	Length of block in bytes (includes preceding divider and block id)
Number of Layers	INT*2	N/A	1 to 15	1	Number of data layers contained in this block (see Note 2)
Layer Divider	INT*2	N/A	-1	N/A	Integer value of -1 used to delineate one data layer from another
Length of Data Layer	INT*4	N/A	1 to 80000	1	Length of data layer (in bytes) not including layer divider and length field
Display Data Packets	N/A	N/A	N/A	N/A	See Figures 3-6 through 3-14

Data Packets for the ARSR-4 and ASR-11 SPG

16 Level Run Length Encoded Packet AF1F

No modifications are required to support ARSR-4 and ASR-11 products

Table 10 – Radial Packet AF1F (16-level)

		MSB	HALFWORD	LSB		PACKET CODE
		A	F	1	F	
		INDEX OF FIRST RANGE BIN				
		NUMBER OF RANGE BINS				
		I CENTER OF SWEEP				
		J CENTER OF SWEEP				
		SCALE FACTOR (Range of Product(km) / # OF RANGE BINS)				
		NUMBER OF RADIALS				
REPEAT FOR EACH RADIAL	NUMBER OF RLE HALFWORDS IN RADIAL					
	RADIAL START ANGLE					
	RADIAL ANGLE DELTA					
	RUN (0)	COLOR CODE (0)	RUN (1)	COLOR CODE (1)		
	RUN (2)	COLOR CODE (2)	RUN (3)	COLOR CODE (3)		
	• • •					
• • •						
RUN (N)	COLOR CODE (N)	0000	0000			

FIELDNAME	TYPE	UNITS	RANGE	PRECISION/ ACCURACY	REMARKS
Packet Code	INT*2	N/A	AF1F (Hex)	N/A	Packet Type AF1F
Index of First Range Bin	INT*2	N/A	0 to 460	1	Location of first range bin
Number of Range Bins	INT*2	N/A	1 to 1000	1	Number of range bins comprising a radial
I Center of Sweep	INT*2	Km/4	-2048 to +2047	1	I coordinate of center of sweep
J Center of Sweep	INT*2	Km/4	-2048 to +2047	1	J coordinate of center of sweep
Scale Factor	Scaled Integer	Pixels	.001 to 8.000	.001	Number of pixels per range bin
Number of Radials	INT*2	N/A	1 to 400	1	Total number of radials in products
Number of RLE Halfwords in Radial	INT*2	Halfword	1 to 1000	1	Number of RLE (Run Length Encoded) 16-bit halfwords per radial
Radial Start Angle	Scaled Integer	Degrees	0.0 to 359.9	.1	Starting angle at which radial data was collected; Scan is always in Clockwise direction
Radial Angle Delta	Scaled Integer	Degrees	0.0 to 2.0	.1	Radial angle data
Run(0)	4 Bit INT	N/A	0 to 15	1	4-bit run code
Color Code(0)	4 Bit INT	N/A	0 to 15	1	4-bit color level

Appendix

Table A1 – Listing of NWS assigned identifiers for ARSR-4 and ASR-11 radars, their affiliated airports, the ARSR-4/ASR-11 source ID and associated NWS WFO.

Site specific four-character and integer radar IDs and locations are TBD. However, ARSR-4 RPG ID's will be 4000 – 4099, and ASR-11 RPG ID's will be 4100 – 4399.