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ATC-311

Medium Intensity Airport Weather System NEXRAD Selection Recommendations

G. W. Rappa

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Lincoln Laboratory
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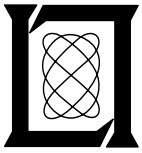

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16. Abstract

In December of 1999, the Federal Aviation Administration (FAA) contracted Lincoln Laboratory to develop and demonstrate a new type of weather alert system. Their objective was to provide air traffic controllers at medium-intensity airports with a real time color display of weather impacting the terminal airspace. The weather data was to come from nearby Doppler weather surveillance radars, called Next Generation Radar (NEXRAD), typically owned and operated by the National Weather Service (NWS). Lincoln Laboratory has been operating prototypes of the Medium Intensity Airport Weather System (MIAWS) since May of 2000 at field sites in Memphis, TN; Jackson, MS; Little Rock, AR; and Springfield, MO. With the success of the MIAWS prototypes and favorable response among air traffic controller users, the FAA is seeking to rapidly deploy MIAWS systems at 40 airports within the National Airspace System (NAS).

This report identifies suitable NEXRAD systems for each of the 40 MIAWS airports and three additional test and/or maintenance FAA facilities. Several other radar selection options are also provided to account for availability and cost-saving contingencies.

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ABSTRACT

Under Federal Aviation Administration (FAA) sponsorship, Lincoln Laboratory has developed a Medium Intensity Airport Weather System (MIAWS). MIAWS provides air traffic controllers at medium-intensity airports a real time color display of weather impacting the terminal airspace. The weather data comes from nearby Doppler weather surveillance radars, called Next Generation Radar (NEXRAD). Lincoln Lab has been operating prototypes of the Medium Intensity Airport Weather System (MIAWS) since May 2000 at field sites in Memphis (TN), Jackson (MS), Little Rock (AR), and Springfield (MO). With the success of the MIAWS prototypes and favorable response among air traffic controller users, the FAA is seeking to rapidly deploy MIAWS systems at forty airports within the National Airspace System (NAS).

This report identifies suitable NEXRAD systems for each of the 40 MIAWS airports and three additional test and/or maintenance FAA facilities. Several other radar selection options are also provided to account for availability and cost-saving contingencies.

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1. INTRODUCTION

In December of 1999, the Federal Aviation Administration (FAA) recognized the need for a real time hazardous weather detection system at medium-intensity airports, that is, airports with moderate levels of air traffic, throughout the United States. The FAA sought the assistance of MIT Lincoln Laboratory (MIT/LL) to develop and demonstrate a prototype of a new type of weather alert system. The Medium Intensity Airport Weather System (MIAWS) [1] was thus established with the following objectives:

1. Provide air traffic controllers and supervisors with a real time depiction of weather using data acquired from one or more nearby Weather Surveillance Radar, also called Next Generation Weather Radar (NEXRAD), typically operated by the National Weather Service (NWS). Provide color displays showing precipitation with a standard NWS intensity scale.

2. Detect and track storm cells of significant intensity (Level 3 and above) and provide controllers with information regarding storm positions, motion, and forecast positions.

3. Detect and report instances of significant precipitation impacting the airport approach and departure corridors. Approach corridors include the runway and three one-mile-square areas leading up to the runway. Departure corridors include the runway and two one-mile-square areas beyond the runway.

Within six months, Lincoln Lab developed and fielded two MIAWS prototypes. One prototype was installed in a field site owned and operated by Lincoln Lab at Memphis (TN). Another prototype was installed in the air traffic control tower at the Jackson International Airport in Jackson, Mississippi. After receiving positive feedback from the Jackson air traffic controllers, the FAA arranged to have two additional MIAWS prototypes installed in Little Rock (AR) and Springfield (MO) air traffic control towers. Both prototypes were installed during the summer of 2002. Once again, the MIAWS prototype was readily accepted and appreciated by the air traffic controllers.

The FAA is currently seeking to rapidly deploy MIAWS systems at 40 airports within the National Airspace System (NAS). Appendix A contains a list of the proposed MIAWS airport names and identifiers. Appendix B contains a list of the available NEXRAD system names and identifiers. This report identifies suitable NEXRAD systems for each of the 40 MIAWS airports and three additional test/maintenance FAA facilities. The information in this report is expected to assist the FAA with preliminary cost estimates and analysis when planning procurements for leased phone lines to NEXRAD systems.

2. MIAWS NEXRAD SELECTION CRITERIA

Early on in the development of the MIAWS prototypes, the FAA contracted Technology Service Corporation (TSC) to analyze the NEXRAD coverage at each proposed MIAWS airport. TSC generated a series of reports [2], for each proposed MIAWS airport[1], in which NEXRAD selection was based on the following criteria:

1. Coverage Volume Analysis
2. Terrain and Line-of-sight Analysis
3. Weather Detection Performance Analysis

The TSC report recommendations, listed in Table 1, were considered along with a number of other selection criteria in order to generate a list of recommended NEXRAD selections for MIAWS airports. The additional NEXRAD selection criteria, listed below, are described in the following subsections:

1. NEXRAD Weather Products and Airport Coverage
2. NEXRAD Storm Coverage
3. Phone Line Leasing Costs
4. NEXRAD Interface Number Restrictions

2.1 NEXRAD WEATHER PRODUCTS AND AIRPORT COVERAGE

The original MIAWS prototypes relied on NEXRAD Composite Reflectivity, a Cartesian grid product that extended 232 km (124 nmi) from the NEXRAD, with 1 kilometer bin-to-bin resolution. The production system MIAWS, however, is expected to use the High-Resolution Vertically Integrated Liquid (HRVIL) product as its source of weather data. The HRVIL is a radial product with a range extent of 464 km (248 nmi) and 1 km range resolution. The MIAWS ingest process converts the HRVIL radial messages into a Cartesian grid product with 1 km bin-to-bin resolution. When compared with Composite Reflectivity, the HRVIL product is expected to offer superior data quality and range extent. However, in order to continue support of Composite Reflectivity, commonly available from all NEXRAD data providers, the 230-kilometer outer radius restriction was imposed in discussions of NEXRAD selection.

[1] Due to funding constraints, TSC was unable to complete MIAWS site reports for the following airports: MGM, OMA, SFO, and TRI.

Table 2 provides a list of all NEXRAD locations that fall within a 230 km radius of each proposed MIAWS airport. Appendix A and B contain MIAWS airport and nationwide NEXRAD names and identifiers.

Implementing all NEXRAD interfaces listed in Table2, defined within a 230 km radius, would result in excessive, costly, and unnecessary coverage for the airports. Thus, the NEXRAD lists of Table 2 should be reduced to a suitable number while maintaining appropriate coverage for each airport. The following subsections discuss criteria that helped reduce each NEXRAD selection list.

2.2 NEXRAD STORM COVERAGE

It is important to consider how much of the vertical airspace above the airport, and associated runway corridors, are radiated and processed by the NEXRAD. During the course of a volume scan, the NEXRAD sweeps through elevation angles from 0.5 degrees up to 19.5 degrees in order to produce a single composite product. For any given distance between a NEXRAD and an airport, the minimum and maximum altitude above the airport scanned by the NEXRAD may be computed (earth curvature must also be considered when evaluating radar beam coverage). When selecting optimal NEXRAD systems for MIAWS, the preferred NEXRAD system volume scan coverage includes airspace above the airport and below 30,000 feet (above ground level). Choosing a NEXRAD too close to an airport may provide suitable low-level coverage but would miss high-altitude storm cell formation above the airport (See Figure 1). Choosing a NEXRAD too far from the airport would provide suitable high-altitude coverage but would miss the low-elevation weather events (See Figure 2).

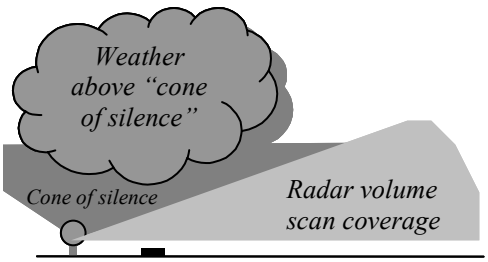

Figure 1. NEXRAD too close to airport.

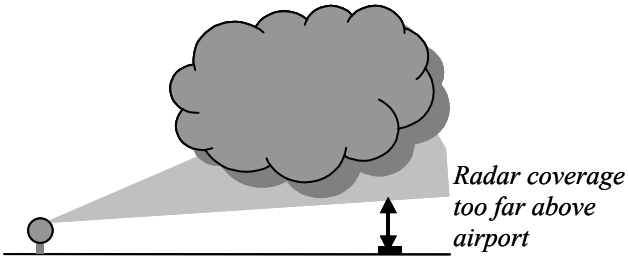

Figure 2. NEXRAD too far from airport

In the TSC report, NEXRAD selections sought to include radars whose low-elevation tilts were above 10,000 feet within the terminal airspace (within 60 nmi of the airport). In several cases, the nearby NEXRAD was rejected, in favor of using a more distant NEXRAD, to ensure more complete volume coverage. Based on operational experience with NEXRAD systems at the MIAWS prototypes, it was observed that the NEXRAD coverage within the TSC minimum range could also provide useful information, regardless of the associated cone of silence. Merging data from two NEXRAD sources, one nearby and one more distant, could provide an improved volumetric coverage of the total airspace. Finding an optimal combination of near and far NEXRAD systems could offer advantages over consistently choosing more distant NEXRAD systems, as recommended in the TSC report. The two MIAWS prototypes installed at Little Rock and Springfield merged weather products from two NEXRAD systems in this fashion (nearby and distant) with favorable results. Not only did dual NEXRAD merging provide more complete volumetric coverage, and improved resolution near the airport, but it also maintained nominal coverage when one radar dropped out due to communication line malfunction or pre-planned radar maintenance.

Another justification for favoring nearby NEXRAD systems, regardless of limitations reported by TSC, involves future NEXRAD product development. Lincoln Lab and the NWS Radar Operations Center (ROC) are working together to add an automatic gust front detection algorithm to the NEXRAD processor. Eventually, MIAWS could receive the gust front detections and provide the associated gust front runway impact alerts to air traffic controllers via the MIAWS Situation Displays. In order to detect gust fronts, a NEXRAD must operate within roughly 55 nmi of the airport in order to have access to surface velocity data.

Table 3 contains a list of suitable NEXRAD selection pairs (nearby and distant) for each MIAWS airport. NEXRAD selections appearing in Table 3 were derived from Table 2 with nearby NEXRAD systems always favored over more distant NEXRAD systems, barring any line-of-sight obscuration indications in the TSC report.

2.3 PHONE LINE LEASING COSTS

A MIAWS interfaces with a NEXRAD through a leased analog data circuit provided by a local telephone line carrier. The circuit baud rates range between 9600 and 14,400 baud. The type of phone line currently used by MIAWS for acquiring weather products from a NEXRAD is gradually becoming obsolete as telephone service providers switch to more modern types of digital telephony, including dedicated digital circuits such as Frame Relay. As a result, the costs associated with analog leased lines have been steadily increasing. Eventually, the phone line costs may be higher than economically practical for a given airport, particularly when spanning a long distance or crossing state boundaries.

In the event prohibitive phone line costs force the FAA to reconsider more distant NEXRAD systems, Table 4 lists the recommended NEXRAD selections, restricted to one NEXRAD per airport and involving the shortest distances.

2.4 NEXRAD INTERFACE NUMBER RESTRICTIONS

The FAA has arranged with the NWS to allocate at least one NEXRAD narrowband port interface for MIAWS airport connections. However, there are instances when one NEXRAD must provide weather data to more than one airport. Fortunately, due to reduced narrowband interface consumption, the NWS has agreed to support multiple MIAWS interfaces. This eliminates the inevitable compromises that would be necessary to resolve NEXRAD selections with interface count restrictions imposed.

Table 5 is included below as a reference in the event a NEXRAD is unable to provide weather products to multiple MIAWS airports.

TABLE 1
TSC-Recommended NEXRAD Selections

*This table lists identifiers of TSC-recommended NEXRAD systems for each MIAWS airport. NEXRAD systems omitted from this list had issues regarding volume coverage, line of sight, or weather detection. "**None**" indicates that no suitable NEXRAD systems were recommended. "**Unavailable**" indicates that no TSC report was generated for the airport.*

*Three sites will be operated at FAA facilities for testing, training and maintenance: the FAA Technical Center in Atlantic City, NJ (**FAA1**), the FAA Training Academy in Oklahoma City, OK (**FAA2**), and the FAA Program Support Facility in Oklahoma City, OK (**FAA3**).*

1	**FAA1**	**: Unavailable**
2	**FAA2**	**: Unavailable**
3	**FAA3**	**: Unavailable**

1	AGS	: KCAE KJGX	21	MAF	: KMAF KSJT
2	AVL	: KMRX	22	MGM	: **Unavailable**
3	BIL	: **None**	23	MLI	: KDVN KILX
4	BTR	: KLIX	24	MLU	: KSHV KDGX
5	CAE	: KCAE KCLX KGSP	25	MOB	: KMOB KLIX
6	CHA	: KHTX KOHX	26	OMA	: **Unavailable**
7	COS	: KPUX KFTG	27	PIA	: KDVN KLOT
8	CRW	: KRLX KJKL KFCX	28	PNS	: KMOB KEVX
9	CSG	: KEOX KJGX	29	PVD	: KBOX KOKX
10	DAB	: KMLB KJAX	30	ROA	: KFCX KRAX
11	FAY	: KRAX KLTX	31	RST	: KARX KMPX
12	FSD	: **None**	32	RSW	: KTBW KAMX
13	FSM	: KINX KLZK	33	SAV	: KCLX KJAX
14	GRB	: KGRB KMKX	34	SFO	: **Unavailable**
15	GSP	: KGSP KCAE	35	SGF	: KSGF KEAX
16	JAN	: KDGX[2] KLIX	36	SHV	: KSHV KPOE
17	LAN	: KGRR KDTX	37	SPI	: KILX KLSX
18	LEX	: KLVX KJKL	38	SUX	: KOAX KFSD
19	LIT	: KLZK KSRX	39	TLH	: KTLH KVAX
20	LNK	: KOAX KUEX	40	TRI	: **Unavailable**

[2] The Jackson NEXRAD "KJAN" antenna location was moved and renamed after the TSC report publication. The new Jackson NEXRAD is identified as "KDGX" and may be considered to be identical to KJAN with respect to NEXRAD selections.

TABLE 2
Preliminary NEXRAD Selection List

This table lists all NEXRAD systems located within a 230-kilometer radius of each MIAWS airport. NEXRAD identifiers are sorted by increasing distance to the airport.

1	**FAA1**	: KDIX KDOX KOKX
2	**FAA2**	: KCRI KTLX KVNX KFDR KINX
3	**FAA3**	: KCRI KTLX KVNX KFDR KINX

1	AGS	: KCAE KCLX KJGX KGSP
2	AVL	: KGSP KMRX KCAE
3	BIL	: KBLX
4	BTR	: KLIX KPOE KLCH KBIX KJAN KDGX
5	CAE	: KCAE KCLX KGSP
6	CHA	: KHTX KOHX KFFC KMRX
7	COS	: KPUX KFTG
8	CRW	: KRLX KJKL KFCX KILN
9	CSG	: KMXX KFFC KEOX KJGX KBMX
10	DAB	: KMLB KJAX KTBW
11	FAY	: KRAX KLTX KMHX
12	FSD	: KFSD
13	FSM	: KSRX KINX KLZK KSGF
14	GRB	: KGRB KMKX
15	GSP	: KGSP KCAE KMRX
16	JAN	: KJAN KDGX KLIX KBIX
17	LAN	: KGRR KDTX KIWX
18	LEX	: KLVX KJKL KILN
19	LIT	: KLZK KSRX KNQA
20	LNK	: KOAX KUEX KTWX
21	MAF	: KMAF KSJT KLBB
22	MGM	: KMXX KBMX KEOX KEVX KFFC
23	MLI	: KDVN KILX KLOT
24	MLU	: KSHV KPOE KJAN KDGX
25	MOB	: KMOB KBIX KLIX KEVX
26	OMA	: KOAX KDMX
27	PIA	: KILX KDVN KLOT
28	PNS	: KMOB KEVX KBIX KEOX
29	PVD	: KBOX KOKX
30	ROA	: KFCX KRLX KRAX
31	RST	: KARX KMPX
32	RSW	: KTBW KAMX KMLB KBYX
33	SAV	: KCLX KJAX KCAE KJGX KVAX
34	SFO	: KMUX KDAX KBBX
35	SGF	: KSGF KEAX KINX
36	SHV	: KSHV KPOE
37	SPI	: KILX KLSX KDVN
38	SUX	: KOAX KFSD
39	TLH	: KTLH KVAX KEVX KEOX
40	TRI	: KMRX KJKL KGSP KFCX KRLX

TABLE 3
Dual-NEXRAD Selection List (Option 1)

This table lists recommended NEXRAD systems for MIAWS airports, limited to two NEXRAD systems per airport. NEXRAD identifiers appearing in this list were selected using criteria suggested by the TSC reports with the exception that nearby NEXRADs were chosen instead of more distant NEXRADs.

				1	**FAA1**	KDIX KDOX	
				2	**FAA2**	KCRI KTLX	
				3	**FAA3**	KCRI KTLX	
1	AGS	KCAE KJGX			21	MAF	KMAF KSJT
2	AVL	KGSP KMRX			22	MGM	KMXX KBMX
3	BIL	KBLX			23	MLI	KDVN KILX
4	BTR	KLIX KPOE			24	MLU	KSHV KDGX
5	CAE	KCAE KCLX			25	MOB	KMOB KLIX
6	CHA	KHTX KOHX			26	OMA	KOAX KDMX
7	COS	KPUX KFTG			27	PIA	KILX KDVN
8	CRW	KRLX KJKL			28	PNS	KMOB KEVX
9	CSG	KMXX KEOX			29	PVD	KBOX KOKX
10	DAB	KMLB KJAX			30	ROA	KFCX KRAX
11	FAY	KRAX KLTX			31	RST	KARX KMPX
12	FSD	KFSD			32	RSW	KTBW KAMX
13	FSM	KSRX KINX			33	SAV	KCLX KJAX
14	GRB	KGRB KMKX			34	SFO	KMUX KDAX
15	GSP	KGSP KCAE			35	SGF	KSGF KEAX
16	JAN	KDGX KLIX			36	SHV	KSHV KPOE
17	LAN	KGRR KDTX			37	SPI	KILX KLSX
18	LEX	KLVX KJKL			38	SUX	KOAX KFSD
19	LIT	KLZK KSRX			39	TLH	KTLH KVAX
20	LNK	KOAX KUEX			40	TRI	KMRX KJKL

The following list shows the NEXRAD connections associated with the selections listed above.

1	KAMX	RSW	21	KFTG	COS	41	KMRX	AVL TRI
2	KARX	RST	22	KGRB	GRB	42	KMUX	SFO
3	KBLX	BIL	23	KGRR	LAN	43	KMXX	CSG MGM
4	KBMX	MGM	24	KGSP	AVL GSP	44	KOAX	LNK OMA SUX
5	KBOX	PVD	25	KHTX	CHA	45	KOHX	CHA
6	KCAE	AGS CAE GSP	26	KILX	MLI PIA SPI	46	KOKX	PVD
7	KCLX	CAE SAV	27	KINX	FSM	47	KPOE	BTR SHV
8	KCRI	FAA2 FAA3	28	KJAX	DAB SAV	48	KPUX	COS
9	KDAX	SFO	29	KJGX	AGS	49	KRAX	FAY ROA
10	KDGX	JAN MLU	30	KJKL	CRW LEX TRI	50	KRLX	CRW
11	KDIX	FAA1	31	KLIX	BTR JAN MOB	51	KSGF	SGF
12	KDMX	OMA	32	KLSX	SPI	52	KSHV	MLU SHV
13	KDOX	FAA1	33	KLTX	FAY	53	KSJT	MAF
14	KDTX	LAN	34	KLVX	LEX	54	KSRX	FSM LIT
15	KDVN	MLI PIA	35	KLZK	LIT	55	KTBW	RSW
16	KEAX	SGF	36	KMAF	MAF	56	KTLH	TLH
17	KEOX	CSG	37	KMKX	GRB	57	KTLX	FAA2 FAA3
18	KEVX	PNS	38	KMLB	DAB	58	KUEX	LNK
19	KFCX	ROA	39	KMOB	MOB PNS	59	KVAX	TLH
20	KFSD	FSD SUX	40	KMPX	RST			

TABLE 4
Single-NEXRAD Selection List (Option 2)

This table lists recommended NEXRAD systems for MIAWS airports, limited to one NEXRAD (the nearest) system per airport.

1	**FAA1**	KDIX
2	**FAA2**	KCRI
3	**FAA3**	KTLX

1	AGS	KCAE	21	MAF	KMAF
2	AVL	KGSP	22	MGM	KMXX
3	BIL	KBLX	23	MLI	KDVN
4	BTR	KLIX	24	MLU	KSHV
5	CAE	KCAE	25	MOB	KMOB
6	CHA	KHTX	26	OMA	KOAX
7	COS	KPUX	27	PIA	KILX
8	CRW	KRLX	28	PNS	KMOB
9	CSG	KMXX	29	PVD	KBOX
10	DAB	KMLB	30	ROA	KFCX
11	FAY	KRAX	31	RST	KARX
12	FSD	KFSD	32	RSW	KTBW
13	FSM	KSRX	33	SAV	KCLX
14	GRB	KGRB	34	SFO	KMUX
15	GSP	KGSP	35	SGF	KSGF
16	JAN	KDGX	36	SHV	KSHV
17	LAN	KGRR	37	SPI	KILX
18	LEX	KLVX	38	SUX	KOAX
19	LIT	KLZK	39	TLH	KTLH
20	LNK	KOAX	40	TRI	KMRX

The following list shows the NEXRAD connections associated with the selections listed above.

1	KARX	RST	13	KGRR	LAN	25	KMXX	CSG MGM
2	KBLX	BIL	14	KGSP	AVL GSP	26	KOAX	LNK OMA SUX
3	KBOX	PVD	15	KHTX	CHA	27	KPUX	COS
4	KCAE	AGS CAE	16	KILX	PIA SPI	28	KRAX	FAY
5	KCLX	SAV	17	KLIX	BTR	29	KRLX	CRW
6	KCRI	FAA2 FAA3	18	KLVX	LEX	30	KSGF	SGF
7	KDGX	JAN	19	KLZK	LIT	31	KSHV	MLU SHV
8	KDIX	FAA1	20	KMAF	MAF	32	KSRX	FSM
9	KDVN	MLI	21	KMLB	DAB	33	KTBW	RSW
10	KFCX	ROA	22	KMOB	MOB PNS	34	KTLH	TLH
11	KFSD	FSD	23	KMRX	TRI			
12	KGRB	GRB	24	KMUX	SFO			

TABLE 5
Single-Airport NEXRAD Selection List (Option 3)

This table lists recommended NEXRAD systems for MIAWS airports, with each NEXRAD limited to providing data to only one airport. In some cases, airports were forced to select NEXRAD systems further away. Some airports were permitted two NEXRAD sources since the NEXRAD systems did not conflict with the needs of any other airports.

1	**FAA1**	KDIX
2	**FAA2**	KCRI
3	**FAA3**	KTLX

1	AGS	KJGX		21	MAF	KMAF	KSJT
2	AVL	KMRX		22	MGM	KBMX	
3	BIL	KBLX		23	MLI	KILX	
4	BTR	KLIX		24	MLU	KSHV	
5	CAE	KCAE		25	MOB	KMOB	
6	CHA	KHTX	KOHX	26	OMA	KDMX	
7	COS	KPUX	KFTG	27	PIA	KDVN	
8	CRW	KRLX		28	PNS	KEVX	
9	CSG	KMXX	KEOX	29	PVD	KBOX	KOKX
10	DAB	KMLB	KJAX	30	ROA	KFCX	
11	FAY	KRAX	KLTX	31	RST	KARX	KMPX
12	FSD	KFSD		32	RSW	KTBW	KAMX
13	FSM	KSRX	KINX	33	SAV	KCLX	
14	GRB	KGRB	KMKX	34	SFO	KMUX	KDAX
15	GSP	KGSP		35	SGF	KSGF	KEAX
16	JAN	KDGX		36	SHV	KPOE	
17	LAN	KGRR	KDTX	37	SPI	KLSX	
18	LEX	KLVX		38	SUX	KOAX	
19	LIT	KLZK		39	TLH	KTLH	KVAX
20	LNK	KUEX		40	TRI	KJKL	

The following list shows the NEXRAD connections associated with the selections listed above.

1	KAMX	RSW		21	KGRB	GRB		41	KMUX	SFO
2	KARX	RST		22	KGRR	LAN		42	KMXX	CSG
3	KBLX	BIL		23	KGSP	GSP		43	KOAX	SUX
4	KBMX	MGM		24	KHTX	CHA		44	KOHX	CHA
5	KBOX	PVD		25	KILX	MLI		45	KOKX	PVD
6	KCAE	CAE		26	KINX	FSM		46	KPOE	SHV
7	KCLX	SAV		27	KJAX	DAB		47	KPUX	COS
8	KCRI	**FAA2**		28	KJGX	AGS		48	KRAX	FAY
9	KDAX	SFO		29	KJKL	TRI		49	KRLX	CRW
10	KDGX	JAN		30	KLIX	BTR		50	KSGF	SGF
11	KDIX	**FAA1**		31	KLSX	SPI		51	KSHV	MLU
12	KDMX	OMA		32	KLTX	FAY		52	KSJT	MAF
13	KDTX	LAN		33	KLVX	LEX		53	KSRX	FSM
14	KDVN	PIA		34	KLZK	LIT		54	KTBW	RSW
15	KEAX	SGF		35	KMAF	MAF		55	KTLH	TLH
16	KEOX	CSG		36	KMKX	GRB		56	KTLX	**FAA3**
17	KEVX	PNS		37	KMLB	DAB		57	KUEX	LNK
18	KFCX	ROA		38	KMOB	MOB		58	KVAX	TLH
19	KFSD	FSD		39	KMPX	RST				
20	KFTG	COS		40	KMRX	AVL				

3. CONCLUSIONS

This report presented a number of NEXRAD selection options for the 40 planned MIAWS airports and three FAA test or maintenance facilities. Table 3 contained the baseline selection list in which airports acquire weather products from at least two NEXRAD systems. Tables 4 and 5 present more limited NEXRAD selection lists under different selection restrictions. In most cases, the recommended NEXRAD selections coincided with those appearing in the TSC reports. However, in some cases, preferring NEXRAD systems within close proximity of the airport produced NEXRAD selections that did not match TSC recommendations. It is expected that upcoming NEXRAD gust front detection capabilities and lower-cost phone lines associated with nearby NEXRAD systems will outweigh the TSC volumetric coverage selection criteria. Table 6 summarizes the three recommended NEXRAD selection options listed in Table 3 (Option 1), Table 4 (Option 2), and Table 5 (Option 3).

	AIRPORT	OPTION 1	OPTION 2	OPTION 3
1	**FAA1**	KDIX KDOX	KDIX	KDIX
2	**FAA2**	KCRI KTLX	KTLX	KCRI
3	**FAA3**	KCRI KTLX	KTLX	KTLX
1	AGS	KCAE KJGX	KCAE	KJGX
2	AVL	KGSP KMRX	KGSP	MKRX
3	BIL	KBLX	KBLX	KBLX
4	BTR	KLIX KPOE	KLIX	KLIX
5	CAE	KCAE KCLX	KCAE	KCAE
6	CHA	KHTX KOHX	KHTX	KHTX KOHX
7	COS	KPUX KFTG	KPUX	KPUX KFTG
8	CRW	KRLX KJKL	KRLX	KRLX
9	CSG	KMXX KEOX	KMXX	KMXX KEOX
10	DAB	KMLB KJAX	KMLB	KMLB KJAX
11	FAY	KRAX KLTX	KRAX	KRAX KLTX
12	FSD	KFSD	KFSD	KFSD
13	FSM	KSRX KINX	KSRX	KSRX KINX
14	GRB	KGRB KMKX	KGRB	KGRB KMKX
15	GSP	KGSP KCAE	KGSP	KGSP
16	HAN	KDGX KLIX	KDGX	KDGX
17	LAN	KGRR KDTX	KGRR	KGRR KDTX
18	LEX	KLVX KJKL	KLVX	KLVX
19	LIT	KLZK KSRX	KLZK	KLZK
20	LNK	KOAX KUEX	KOAX	KEUX
21	MAF	KMAF KSJT	KMAF	KMAF KSJT
22	MGM	KMXX KBMX	KMXX	KBMX
23	MLI	KDVN KILX	KDVN	KILX
24	MLU	KSHV KDGX	KSHV	KSHV
25	MOB	KMOB KLIX	KMOB	KMOB
26	OMA	KOAX KDMX	KOAX	KDMX
27	PIA	KILX KDVN	KILX	KDVN
28	PNS	KMOB KEVX	KMOB	KEVX
29	PVD	KBOX KOKX	KBOX	KBOX KOKX
30	ROA	KFCX KRAX	KFCX	KFCX
31	RST	KARX KMPX	KARX	KARX KMPX
32	RSW	KTBW KAMX	KTBW	KTBW KAMX
33	SAV	KCLX KJAX	KCLX	KCLX
34	SFO	KMUX KDAX	KMUX	KMUX KDAX
35	SGF	KSGF KEAX	KSGF	KSGF KEAX
36	SHV	KSHV KPOE	KSHV	KPOE
37	SPI	KILX KLSX	KILX	KLSX
38	SUX	KOAX KFSD	KOAX	KOAX
39	TLH	KTLH KVAX	KTLH	KTLH KVAX
40	TRI	KMRX KJKL	KMRX	KJKL

TABLE 6
MIAWS NEXRAD Selection Options

This table summarizes the NEXRAD selection lists in Tables 3, 4, and 5.

Option 1
Limit two NEXRAD selections per airport.
Requires connections to 59 NEXRAD systems.

Option 2
Limit one NEXRAD selection per airport.
Requires connections to 34 NEXRAD systems.

Option 3
Limit one airport connection per NEXRAD.
Requires connections to 58 NEXRAD systems.

APPENDIX A
MIAWS AIRPORTS

The following list maps the identifiers of 40 airports scheduled to receive MIAWS with the airport names. In addition, FAA-operated test and maintenance sites are defined for the FAA Program Support Facility in Oklahoma City and the FAA Technical Center in Atlantic City.

1	**FAA1**	FAA TECHNICAL CENTER, ATLANTIC CITY, NJ
2	**FAA2**	FAA TRAINING ACADEMY, OKLAHOMA CITY, OK
3	**FAA3**	FAA PROGRAM SUPPORT FACILITY, OKLAHOMA CITY, OK

1	AGS	AUGUSTA RGNL AT BUSH FIELD AIRPORT, AUGUSTA, GA
2	AVL	ASHEVILLE REGIONAL AIRPORT, ASHEVILLE, NC
3	BIL	BILLINGS LOGAN INTL AIRPORT, BILLINGS, MT
4	BTR	BATON ROUGE METROPOLITAN, RYAN FIELD AIRPORT, BATON ROUGE, LA
5	CAE	COLUMBIA METROPOLITAN AIRPORT, COLUMBIA, SC
6	CHA	LOVELL FIELD AIRPORT, CHATTANOOGA, TN
7	COS	CITY OF COLORADO SPRINGS MUNI AIRPORT, COLORADO SPRINGS, CO
8	CRW	YEAGER AIRPORT, CHARLESTON, WV
9	CSG	COLUMBUS METROPOLITAN AIRPORT, COLUMBUS, GA
10	DAB	DAYTONA BEACH INTL AIRPORT, DAYTONA BEACH, FL
11	FAY	FAYETTEVILLE REGIONAL/GRANNIS FIELD AIRPORT, FAYETTEVILLE, NC
12	FSD	JOE FOSS FIELD AIRPORT, SIOUX FALLS, SD
13	FSM	FORT SMITH REGIONAL AIRPORT, FORT SMITH, AR
14	GRB	AUSTIN STRAUBEL INTERNATIONAL AIRPORT, GREEN BAY, WI
15	GSP	GREENVILLE-SPARTANBURG INTL AIRPORT, GREER, SC
16	JAN	JACKSON INTERNATIONAL AIRPORT, JACKSON, MS
17	LAN	CAPITAL CITY AIRPORT, LANSING, MI
18	LEX	BLUE GRASS AIRPORT, LEXINGTON, KY
19	LIT	ADAMS FIELD AIRPORT, LITTLE ROCK, AR
20	LNK	LINCOLN MUNI AIRPORT, LINCOLN, NE
21	MAF	MIDLAND INTERNATIONAL AIRPORT, MIDLAND, TX
22	MGM	MONTGOMERY RGNL (DANNELLY FIELD) AIRPORT, MONTGOMERY, AL
23	MLI	QUAD CITY INTL AIRPORT, MOLINE, IL
24	MLU	MONROE REGIONAL AIRPORT, MONROE, LA
25	MOB	MOBILE REGIONAL AIRPORT, MOBILE, AL
26	OMA	EPPLEY AIRFIELD AIRPORT, OMAHA, NE
27	PIA	GREATER PEORIA REGIONAL AIRPORT, PEORIA, IL
28	PNS	PENSACOLA REGIONAL AIRPORT, PENSACOLA, FL
29	PVD	THEODORE FRANCIS GREEN STATE AIRPORT, PROVIDENCE, RI
30	ROA	ROANOKE REGIONAL/WOODRUM FIELD AIRPORT, ROANOKE, VA
31	RST	ROCHESTER INTERNATIONAL AIRPORT, ROCHESTER, MN
32	RSW	SOUTHWEST FLORIDA INTL AIRPORT, FORT MYERS, FL
33	SAV	SAVANNAH INTERNATIONAL AIRPORT, SAVANNAH, GA
34	SFO	SAN FRANCISCO INTERNATIONAL AIRPORT, SAN FRANCISCO, CA
35	SGF	SPRINGFIELD-BRANSON REGIONAL AIRPORT, SPRINGFIELD, MO
36	SHV	SHREVEPORT REGIONAL AIRPORT, SHREVEPORT, LA
37	SPI	CAPITAL AIRPORT, SPRINGFIELD, IL
38	SUX	SIOUX GATEWAY AIRPORT, SIOUX CITY, IA
39	TLH	TALLAHASSEE REGIONAL AIRPORT, TALLAHASSEE, FL
40	TRI	TRI-CITIES REGIONAL TN/VA AIRPORT,BRISTOL/JOHNSON/KINGSPORT,TN

APPENDIX B
NATIONWIDE NEXRAD SYSTEMS

The following list maps the identifiers of all United States NEXRAD systems with names and locations.

1	KABR	ABERDEEN, SD / ABERDEEN
2	KABX	ALBUQUERQUE, NM / ALBUQUERQUE
3	KAKQ	NORFOLK, VA / WAKEFIELD
4	KAMA	AMARILLO, TX / AMARILLO
5	KAMX	MIAMI, FL / RICHMOND HEIGHTS
6	KAPX	NCL MICHIGAN, MI / GAYLORD
7	KARX	LA CROSSE, WI / LA CROSSE
8	KATX	SEATTLE, WA / STANDWOOD
9	KBBX	BEALE AFB, CA / OROVILLE
10	KBGM	BINGHAMTON, NY / JOHNSON CITY
11	KBHX	EUREKA / BUNKER HILL), CA / EUREKA
12	KBIS	BISMARCK, ND / BISMARCK
13	KBIX	KEESLER AFB OPS TRNG, MS / D'IBERVILLE
14	KBLX	BILLINGS, MT / BILLINGS
15	KBMX	BIRMINGHAM, AL / CALERA
16	KBOX	BOSTON, MA / TAUNTON
17	KBRO	BROWNSVILLE, TX / BROWNSVILLE
18	KBUF	BUFFALO, NY / CHEEKTOWAGA
19	KBYX	KEY WEST, FL / KEY WEST
20	KCAE	COLUMBIA, SC / WEST COLUMBIA
21	KCBW	CARIBOU, ME / HOULTON
22	KCBX	BOISE, ID / BOISE
23	KCCX	STATE COLLEGE, PA / STATE COLLEGE
24	KCLE	CLEVELAND, OH / CLEVELAND
25	KCLX	CHARLESTON, SC / CHARLESTON
26	KCRI	OSF REDUNDANT (R), OK / NORMAN
27	KCRP	CORPUS CHRISTI, TX / CORPUS CHRISTI
28	KCXX	BURLINGTON, VT / COLCHESTER
29	KCYS	CHEYENNE, WY / CHEYENNE
30	KDAX	SACRAMENTO, CA / SACRAMENTO
31	KDDC	DODGE CITY, KS / DODGE CITY
32	KDFX	LAUGHLIN AFB, TX / BRACKETVILLE
33	KDGX	BRANSON, MS / BRANSON
34	KDIX	PHILADELPHIA, PA / PHILADELPHIA
35	KDLH	DULUTH, MN / DULUTH
36	KDMX	DES MOINES, IA / JOHNSTON
37	KDOX	DOVER AFB, DE / ELLENDALE STATE FOREST
38	KDTX	DETROIT, MI / DETROIT
39	KDVN	QUAD CITIES, IA / DAVENPORT
40	KDYX	DYESS AFB, TX / MORAN
41	KEAX	PLEASANT HILL, MO / PLEASANT HILL
42	KEMX	TUCSON, AZ / EMPIRE MOUNTAIN
43	KENX	ALBANY, NY / ALBANY
44	KEOX	FT RUCKER, AL / ECHO

45	KEPZ	EL PASO, NM / SANTA TERESA
46	KESX	LAS VEGAS, NV / LAS VEGAS
47	KEVX	EGLIN AFB, FL / RED BAY
48	KEWX	AUSTIN/SAN ANTONIO, TX / NEW BRAUNFELS
49	KEYX	EDWARDS AFB, CA / BORON
50	KFCX	ROANOKE, VA / COLES KNOB
51	KFDR	ALTUS AFB, OK / FREDERICK
52	KFDX	CANNON AFB, NM / FIELD
53	KFFC	ATLANTA, GA / PEACHTREE CITY
54	KFSD	SIOUX FALLS, SD / SIOUX FALLS
55	KFSX	FLAGSTAFF (R), AZ / FLAGSTAFF
56	KFTG	DENVER, CO / FRONT RANGE AP
57	KFWS	DALLAS/FT WORTH, TX / FORT WORTH
58	KGGW	GLASGOW, MT / GLASGOW
59	KGJX	GRAND JUNCTION (R), CO / GRAND JUNCTION
60	KGLD	GOODLAND, KS / GOODLAND
61	KGRB	GREEN BAY, WI / GREEN BAY
62	KGRK	FT HOOD, TX / GRANGER
63	KGRR	GRAND RAPPIDS, MI / GRAND RAPIDS
64	KGSP	GREER , SC / GREENVILLE/SPARTANBURG
65	KGWX	COLUMBUS AFB, MS / GREENWOOD
66	KGYX	PORTLAND, ME / GRAY
67	KHDX	HOLLOMAN AFB, NM / RUIDOSO
68	KHGX	HOUSTON, TX / HOUSTON
69	KHNX	SAN JOAQUIN VALY, CA / HANFORD
70	KHPX	FT CAMPBELL, KY / TRENTON
71	KHTX	NORTHEAST ALABAMA, AL / NE ALABAMA
72	KICT	WICHITA, KS / WICHITA
73	KICX	CEDAR CITY (R), UT / CEDAR CITY
74	KILN	CINCINNATI, OH / WILMINGTON
75	KILX	LINCOLN, IL / LINCOLN
76	KIND	INDIANAPOLIS, IN / INDIANAPOLIS
77	KINX	TULSA, OK / INOLA
78	KIWA	PHOENIX, AZ / WILLIAMS AFB
79	KIWX	NORTHERN INDIANA, IN / SYRACUSE
80	KJAN	JACKSON, MS / JACKSON
81	KJAX	JACKSONVILLE, FL / JACKSONVILLE
82	KJGX	ROBINS AFB, GA / JEFFERSONVILLE
83	KJKL	JACKSON, KY / JACKSON
84	KLBB	LUBBOCK, TX / LUBBOCK
85	KLCH	LAKE CHARLES, LA / LAKE CHARLES
86	KLIX	SLIDELL, LA / SLIDELL
87	KLNX	NORTH PLATTE, NE / NORTH PLATTE
88	KLOT	CHICAGO, IL / CHICAGO
89	KLRX	ELKO (R), NV / ELKO
90	KLSX	ST LOIS, MO / ST LOUIS
91	KLTX	WILMINGTON, NC / SHALLOTTE
92	KLVX	LOUISVILLE, KY / FORT KNOX
93	KLWX	STERLING, VA / STERLING
94	KLZK	LITTLE ROCK, AR / LITTLE ROCK

95	KMAF	MIDLAND/ODESSA, TX / MIDLAND
96	KMAX	MEDFORD (R), OR / MEDFORD
97	KMBX	MINOT AFB, ND / DEERING
98	KMHX	MOREHEAD CITY, NC / NEWPORT
99	KMKX	MILWAUKEE, WI / DOUSMAN
100	KMLB	MELBOURNE, FL / MELBOURNE
101	KMOB	MOBILE, AL / MOBILE
102	KMPX	MINNEAPOLIS, MN / CHANHASSEN
103	KMQT	MARQUETTE, MI / NEGAUNEE
104	KMRX	KNOXVILLE, TN / MORRISTOWN
105	KMSX	MISSOULA (R), MT / MISSOULA
106	KMTX	SALT LAKE CITY (R), UT / SALT LAKE CITY
107	KMUX	SAN FRANCISCO, CA / MCQUEEN'S RIDGE
108	KMVX	FARGO/GRAND FORKS, ND / GRAND FORKS
109	KMXX	MAXWELL AFB, AL / CARRVILLE
110	KNKX	SAN DIEGO, CA / SAN DIEGO
111	KNQA	MEMPHIS, TN / MILLINGTON NAS
112	KOAX	OMAHA, NE / VALLEY
113	KOHX	NASHVILLE, TN / OLD HICKORY
114	KOKX	BROOKHAVEN, NY / UPTON
115	KOTX	SPOKANE, WA / SPOKANE
116	KPAH	PADUCAH, KY / WEST PEDUCAH
117	KPBZ	PITTSBURGH, PA / MOON TOWNSHIP
118	KPDT	PENDLETON, OR / PENDLETON
119	KPOE	FT POLK, LA / FT POLK
120	KPUX	PUEBLO, CO / PUEBLO
121	KRAX	RALEIGH/DURHAM, NC / RALEIGH/DURHAM
122	KRGX	RENO (R), NV / RENO
123	KRIW	RIVERTON/LANDER, WY / RIVERTON
124	KRLX	CHARLESTON, WV / CHARLESTON
125	KRTX	PORTLAND, OR / PORTLAND
126	KSFX	POCATELLO, ID / POCATELLO
127	KSGF	SPRINGFIELD, MO / SPRINGFIELD
128	KSHV	SHREVEPORT, LA / SHREVEPORT
129	KSJT	SAN ANGELO, TX / SAN ANGELO
130	KSOX	SANTA ANA MTS, CA / SANTA ANA MOUNTAINS
131	KSRX	WESTERN ARKANSAS, AR / WESTERN ARKANSAS
132	KTBW	TAMPA, FL / TAMPA BAY AREA
133	KTFX	GREAT FALLS, MT / GREAT FALLS
134	KTLH	TALLAHASSEE, FL / TALLAHASSEE
135	KTLX	NORMAN, OK / OKLAHOMA CITY
136	KTWX	TOPEKA, KS / WABAUNSEE COUNTY
137	KTYX	FT DRUM, NY / MONTAGUE
138	KUDX	RAPID CITY, SD / RAPID CITY
139	KUEX	GRAND ISLAND, NE / WEBSTER CNTY NR BLUE HILL
140	KVAX	MOODY AFB, GA / SOUTH STOCKTON
141	KVBX	VANDENBERG AFB, CA / ORCUTT
142	KVNX	VANCE AFB, OK / CHEROKEE
143	KVTX	ANGELES, CA / OXNARD
144	KYUX	YUMA (R), AZ / YUMA

145	LPLA	LAJES AB, AZR / SANTA BARBARA
146	PABC	BETHEL FAA (R), AK / BETHEL
147	PACG	SITKA FAA (R), AK / BIORKA ISLAND
148	PAEC	NOME FAA (R), AK / NOME
149	PAHG	ANCHORAGE FAA (R), AK / KENAI
150	PAIH	MIDDLETON ISLAND (R), AK / MIDDLETON ISLAND
151	PAKC	KING SALMON FAA (R), AK / KING SALMON
152	PAPD	FAIRBANKS FAA (R), AK / FAIRBANKS
153	PGUA	ANDERSEN AFB, GU / ANDERSEN AFB
154	PHKI	SOUTH KAUAI FAA (R), HI / KAUAI
155	PHKM	KAMUELA/KOHALA APT (R), HI / KAMUELA
156	PHMO	MOLOKAI FAA (R), HI / MOLOKAI
157	PHWA	SOUTH SHORE FAA (R), HI / NAALEHU
158	RKJK	KUNSAN AB, KO / KUNSAN AB
159	RKSG	CAMP HUMPHREYS, KO / CAMP HUMPHREYS
160	RODN	KADENA AB, JA / KADENA AB
161	TJUA	SAN JUAN FAA (R), PR / SAN JUAN

GLOSSARY

FAA	Federal Aviation Administration
HRVIL	High Resolution Vertically Integrated Liquid
MIAWS	Medium Intensity Airport Weather System
MIT/LL	MIT Lincoln Laboratory
NAS	National Airspace System
NEXRAD	Next Generation Weather Radar
NMI	Nautical Miles
NWS	National Weather Service
ROC	Radar Operations Center
TSC	Technology Service Corporation

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