# OFCM

FEDERAL METEOROLOGICAL HANDBOOK NO. 11

# DOPPLER RADAR METEOROLOGICAL OBSERVATIONS

PART A
SYSTEM CONCEPTS,
RESPONSIBILITIES, AND
PROCEDURES

FCM-H11A-2004

**WSR-88D**

Washington, DC
March 2004

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PART A
SYSTEM CONCEPTS, RESPONSIBILITIES,
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# CHANGE AND REVIEW LOG

Use this page to record changes and notices of reviews.

| Change Number | Page Numbers | Date Posted | Initials |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |

Changes are indicated by a vertical line in the margin next to the change.

| Review Date | Comments | Initials |
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## PREFACE

The Federal Coordinator for Meteorological Services and Supporting Research has the responsibility to maintain and publish Federal Meteorological Handbooks. This series of documents provides standards and procedures to facilitate the efficient collection, sharing, and use of meteorological information by agencies of the federal government and private industry.

Federal Meteorological Handbook, Number 11 (FMH-11), DOPPLER RADAR METEOROLOGICAL OBSERVATIONS, was prepared and published under the auspices of the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) at the request of the Next Generation Weather Radar (NEXRAD) Program Council (NPC) and in coordination with the federal agencies that are represented on the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR). The purpose of FMH-11 is to standardize, insofar as practical, the operation of the Weather Surveillance Radar -1988, Doppler (WSR-88D) systems and the procedures used by personnel of the Departments of Commerce, Defense, and Transportation. By approving publication of this handbook, those agencies have agreed to operate their WSR-88D systems accordingly. Some flexibility under certain meteorological, siting, or mission circumstances is permitted to enhance the quality and utility of some WSR-88D products.

The revision process is dependent on the evolution of WSR-88D subsystems software, and products. Part A has been revised twice to ensure it provides users current operations guidance. Parts B, C, and D are being revised in a separate effort principally through the guidance of the Radar Operations Center (ROC), formerly known as the Operational Support Facility (OSF). All revisions are coordinated among the NEXRAD triagencies, thus they possess the same authority as the initial edition of FMH-11.

The agencies shall review the documents at least annually. The goal is to review/update the handbooks with every WSR-88D software build (6-month release cycle). Suggestions for modifications and additions shall be forwarded through the appropriate channels in each agency for consideration, and issuance, if appropriate. Changes may be issued as write-in corrections, page replacement or additions, or a total reprint when necessary. Each major part of the FMH-11 is designed to stand alone, except where cross references avoid voluminous redundancy. Changes should be annotated in the Change and Review Log near the beginning of each part.

In all, FMH-11 has four parts:

Part A  -  System Concepts, Responsibilities, and Procedures (March 2004)

Part B  -  Doppler Radar Theory and Meteorology (June 1990)

Part C  -  WSR-88D Products and Algorithms (February 1991)

Part D  -  WSR-88D Systems Description and Operational Applications (April 1992)

Part A provides an introduction for the entire Handbook including the restatement of some policy, definitions of terms, and agencies' functions and responsibilities under the WSR-88D System Concept. It provides current listings of the general location of systems; prescribes the relative priorities for product generation, so as to assure availability to all users; and sets requirements for national archiving. Additionally, authority for change to adaptation parameters is established. Familiarity with Part A should aid the user of other parts of FMH-11 and provide a better understanding of the overall WSR-88D system.

Samuel P. Williamson
Federal Coordinator for Meteorological
 Services and Supporting Research

FEDERAL METEOROLOGICAL HANDBOOK NO. 11
DOPPLER RADAR METEOROLOGICAL OBSERVATIONS
PART A
SYSTEM CONCEPTS, RESPONSIBILITIES, AND PROCEDURES

TABLE OF CONTENTS

Page

LIST OF TABLES

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## Definition of Terms

**WSR-88D System.**  A WSR-88D system is composed of a Weather Surveillance Radar - 1988 Doppler, and communications links to distribute products to various agency display systems. The functional designations are: Radar Data Acquisition (RDA) system, Radar Product Generator (RPG), and agency user display systems.

**Agency User Display Systems**.  The agencies have various user display systems with dedicated and/or dial connections to WSR-88Ds.  The current list of systems are:

> **Principal User Processor (PUP)**.  The original display system fielded with the WSR-88D.  Currently only used at some DoD locations.

> **Open Principal User Processor (OPUP)**.  This new DoD display system is fielded in three sizes: small, medium, and large.

> **Advanced Weather Interactive Processing System (AWIPS)**.  The NWS operates AWIPS  at each Weather Forecast Office to integrate and display data and products from all sources.

> **Weather and Radar Processor (WARP)**.  The FAA computer network that places WSR-88D product data on air controllers' displays in Air Route  Traffic Control Centers (ARTCCs).  The WARP also collects, formats, and distributes weather information to Center Weather Service Units at FAA ARTCCs.

> **Integrated Terminal Weather System (ITWS)**.  This FAA system integrates data from the WSR-88D, Terminal Doppler Weather Radar, Airport Surveillance Radar-9 (ASR-9), Low-level Windshear alert systems (LLWAS), Automated Surface Observing Systems (ASOS), and other NWS systems.

> **Medium Intensity Airport Weather System (MIAWS)**.  This FAA system will go into airports that have a medium intensity of aircraft operations.

> **Micro Enroute Air Route Traffic System (Micro-EARTS)**.  This FAA system is located at Combined Center/RAPCON (CERAP) outside the CONUS.

**National Weather Radar Network.**  The national weather radar network consists of sites dispersed throughout the conterminous United States (CONUS).

**Network Site.**  A Network Site is a Department of Commerce WSR-88D site in the CONUS.

**Supplemental Site.**  A Supplemental Site is a Department of Defense site in the CONUS.

**Non-Network Site.**  A non-Network Site is a non-CONUS Department of Defense site or a non-CONUS Department of Transportation site.

**Principal User.**  Principal users are the National Oceanic and Atmospheric Administration (NOAA) National Weather Service, the Air Force, the Naval Meteorology and Oceanography Command, the Marine Corps Weather Service, and the Federal Aviation Administration.

       **Associated Principal User.**  An associated principal user is a principal user linked to a WSR-88D system with a dedicated telecommunication line.

       **Non-Associated Principal User.**  A non-associated principal user is a principal user with access to a WSR-88D system through means of dial telecommunication.

**External User.**  An external user is anyone other than a principal user who is authorized access to WSR-88D data and products, e.g., information service companies, broadcast meteorologists, aviation interests, marine interests, industrial meteorologists, other government agencies, and universities.

**CHAPTER 1**


**BACKGROUND**


**1.1  Introduction.**  The impetus for originally preparing this handbook was the development, acquisition, and deployment of the Weather Surveillance Radar - 1988, Doppler (WSR-88D). The motivation of this update is to reflect the changing operation of the WSR-88D system as it matures.

The Federal Coordinator for Meteorological Services and Supporting Research determined that the preparation of this handbook was required to support triagency utilization of the WSR-88D. Subsequent to coordination within the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR), a Doppler Radar Meteorological Observations Working Group  (WG/DRMO) was formed within the Committee for Basic Services.  The WG/DRMO was charged with the responsibility for preparation of this Federal Meteorological Handbook, Number 11 (FMH-11).

The WG/DRMO was composed of personnel from the National Weather Service within the Department of Commerce, the Air Force Weather Agency and the Naval Meteorology and Oceanography Command within the Department of Defense, and the Federal Aviation Administration within the Department of Transportation.  This version has been coordinated with the triagency WSR-88D focal points and triagency Radar Operations Center personnel.

**1.2   Purpose and Scope.**  This handbook provides information, guidance, and instruction regarding the triagency management and operation of the WSR-88D systems.  The following definitions apply throughout this handbook:

> Shall:  means that a procedure or practice is mandatory.
> Should:  means that a procedure or practice is recommended.
> May:  means that a procedure or practice is optional.
> Will:  means futurity, not a requirement to be applied to a procedure or practice.

**1.3   Policy.**  The WSR-88D systems shall be operated to satisfy the integrated set of federal requirements that emanated primarily from the public charters of the departments represented in the Next Generation Weather Radar (NEXRAD) Program Council (NPC) and the NEXRAD Program Management Committee (NPMC).  This handbook has been developed to establish standards for the triagency operation of the WSR-88D systems and the collection, processing, and dissemination of information to meet those requirements.  As a federal system, it shall be operated to meet as many requirements as possible.  However, this handbook guides operations to fulfill first those fundamental requirements of the agencies that founded the program.  Policy, procedures, and operational concepts, as defined in this handbook, shall be adhered to by the principal user agencies.

**1.4** **Changes.** All recommendations for modifications of this handbook shall be forwarded to the OFCM for consideration and coordination through the ICMSSR infrastructure. No modification shall be adopted that adversely impacts fulfillment of the integrated requirements that drove the development of the program without the consent of the NPC. (The NPC has delegated this responsibility to the NPMC.)

# CHAPTER 2

# WSR-88D SYSTEM CONCEPT

**2.1** <u>Overview of Agency Functions.</u>  The following sections provide discussions of each principal user agency's functions with regard to WSR-88D system operations.

**2.1.1  Department of Commerce**.  Within the Department of Commerce (DOC), the National Weather Service (NWS) is the civilian meteorological agency of the Federal Government.  As such, it must fill a broad spectrum of meteorological and hydrological requirements in its efforts to protect life and property and support the economy of the United States (U.S.).  Specifically, NWS is responsible for the detection and public warning of hazardous weather such as tornadoes, severe thunderstorms, hurricanes, floods, flash floods, winter storms, damaging tides, and any other meteorological or hydrological event with possible harmful effects.  NWS provides weather information for marine operations covering offshore, coastal, Great Lakes, and river and harbor areas for both commercial and recreational activities. NWS also routinely provides forecasts for civilian aviation, reservoir regulation, wildland fire fighting agencies, and a variety of commercial activities.  To assist in fulfilling these responsibilities, NWS operates the national weather radar network and uses information from Department of Defense (DOD) and Department of Transportation (DOT) WSR-88D systems.

**2.1.2  Department of Defense.**  Within the Department of Defense (DOD), the U.S. Air Force provides worldwide meteorological and aerospace environmental services to the Air Force, Army, and certain other DOD elements; the Naval Meteorology and Oceanography Command provides meteorological and oceanographic support to the Navy and oceanographic support to the DOD; and the Marine Corps Weather Service Units provide environmental support to U.S. Marine Corps activities and operations.  These organizations are responsible for providing and relaying severe weather warnings for the protection of DOD resources and personnel, managing flood control reservoirs (U.S. Army Corps of Engineers), providing meteorological and space environmental information to aid the decision-making process at all levels of command authority, and supporting military aerospace operations.  To meet these responsibilities, DOD operates WSR-88D systems in the United States and overseas and uses information from the DOC and DOT WSR-88D systems.

**2.1.3  Department of Transportation.**  The Department of Transportation (DOT), through the Federal Aviation Administration (FAA), is responsible for the safe and efficient utilization of the National Airspace System.  In meeting this responsibility, DOT disseminates information on the location and intensity of potentially hazardous weather conditions to pilots, air traffic controllers, air traffic flow management, and others concerned with aviation.  DOT obtains and processes data from DOC, DOD, and DOT WSR-88D systems for use by DOT personnel and DOC personnel located in DOT facilities.

**2.2  System Support Management.**  Operational support for the deployed WSR-88D system is provided by the Radar Operations Center (ROC), formerly known as the Operational Support Facility (OSF), located in Norman, Oklahoma.  The ROC provides centralized management, coordination, and control for the comprehensive life cycle support of WSR-88D systems.  The ROC performs systematic and coordinated analyses of the day-to-day operations and maintenance of WSR-88D systems to determine the need for improvement and provides both immediate and long-term support during the WSR-88D life cycle.

**2.3  Memorandum of Agreement for the Interagency Operation of the WSR- 88D.**  Policies, procedures, and operational concepts, as defined in this handbook, have been agreed to by each principal user agency.  Each agency shall endeavor to support, to the highest degree possible and in accordance with the terms of the Memorandum of Agreement (MOA) for the Interagency Operation of the WSR-88D, the data, product, and operational requirements of the other agencies.  This supportive service shall be consistent with the capabilities and mission priorities of the agency that has received the request for support. The MOA also forms the basis for the membership, leadership, and activities of the Unit Radar Committee (URC) that shall be at each WSR-88D site where more than one NEXRAD agency is connected.

**2.4  External User Access to WSR-88D Data and Products.**  Real-time access to data and products can be achieved through two methods.  Products and product data can be obtained through the NWS' Radar Product Central Collection Dissemination Service (RPCCDS).  The Level II data can be obtained through the NWS Level II Data Collection and Distribution Network.

      **2.4.1  Products and Product Data**.  The RPCCDS replaced the NEXRAD Information Dissemination Service (NIDS) agreement in January 2001.  The RPCCDS makes a predefined subset of all WSR-88D products available in near real time from every WSR-88D in the CONUS and all but four remote DOD non-CONUS locations available to external users.  Users will be able to connect to the RPCCDS via a dedicated connection or file transfer protocol (FTP).  Local NWS weather forecast offices will provide a predetermined subset of the images available from their WSR-88D on their WEB site.  In addition, a predetermined set of products will be provided to NOAAPORT users.

      **2.4.2  Wideband Access.**  The principal user agencies offer wideband access on a limited basis to support government operations at sites where the required interface hardware is installed.  Non-NEXRAD agency connections to individual radar sites will not be permitted.  Only certified systems will be permitted to connect to radars.

The NWS has established a WSR-88D Level II Data Collection And Distribution Network.  The network initially (March 2004) includes all NWS radars (121) and 3 CONUS DOD radars.  By March 2005 the remaining 18 CONUS DOD radars will be added to the network.  These data are available in near real time from many sources and can be used or redistributed without any restriction.  Information on the network is available at: http://www.roc.noaa.gov/NWS_Level_2/.

**2.5  National Centers' Applications.**  The national centers of the NWS, Air Force, and FAA have agency-specific display platforms to acquire and display real-time WSR-88D data for their agency-specific applications.  Several dial ports per RPG are allocated for national centers'

access.  National centers may require information to suit a wide range of missions that assist decision making in support of critical operations and exercises.  The FAA's center has access to Doppler weather radar information from a variety of sources to support its management of aviation traffic flow.    The national centers are: Storm Prediction Center (SPC), Tropical Prediction Center (TPC),  Marine Prediction Center (MPC), Aviation Weather Center (AWC), Hydrometeorological Prediction Center (HPC), Air Force CONUS and Pacific Operational Weather Squadrons (OWSs), River Forecast Centers (RFC), and Air Traffic Control Systems Command Center (ATCSCC).

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# CHAPTER 3

## SITE RESPONSIBILITIES

**3.1  Introduction.**  The WSR-88D system is vital to the operation of each principal user agency. Therefore, WSR-88D systems shall be operated to satisfy the integrated needs of all three agencies.  Each agency shall endeavor to support, to the maximum extent possible, the data, products, and operational requirements of the others, consistent with the capabilities and mission priorities of that agency.  The units shall be operated in accordance with the procedures described in this handbook and as agreed to by the URC within the terms of the MOA for the Interagency Operation of the WSR-88D.

WSR-88D sites are categorized as Network, Supplemental, or non-Network. Tables 3-1 through 3-4 list the metropolitan areas served by each system. In addition, the WSR-88D system four-letter International Civil Aviation Organization (ICAO) identifier; name of RDA system location; and RDA antenna elevation in feet above mean sea level (MSL); are specified for each system.  Table 3-5 shows how the antenna elevation above MSL is computed.

**3.2  Network Site Responsibilities.**  A WSR-88D Network Site (Table 3-1) shall:

C   Operate continuously, 24 hours per day, and collect, collate and make available via narrowband communications, radar data and products in support of the national weather radar network.  This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D.  A copy of the MOA may be obtained at the following URL: http://www.roc.noaa.gov/MOA.pdf.

C   Use one of the operational modes and volume coverage patterns agreed to by the URC.

C   Generate and distribute WSR-88D products as specified by *WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG*.  The handbook can be obtained at the following URL: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.

C   Use appropriate levels of clutter filtering to reduce ground clutter and anomalous propagation.

**3.3  Supplemental Site Responsibilities.**  A WSR-88D Supplemental Site (Table 3-2) shall:

C   Operate continuously, 24 hours per day, and collect, collate, and make available via narrowband communications, radar data and products in support of the DOD.  This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D.  A copy of the MOA may be obtained at the following URL: http://www.roc.noaa.gov/MOA.pdf.

C   Use one of the operational modes and volume coverage patterns agreed to by the URC.

C    Provide assistance to NWS forecast offices and the FAA by providing access to weather radar data to reduce gaps in the national weather radar network. Ensure the provision of radar data is consistent with responsibilities stated in the MOA for Interagency Operation of the WSR-88D.

C    Generate and distribute WSR-88D products as specified by *WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG*. The handbook can be obtained at the following URL: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.

C    Use appropriate levels of clutter filtering to reduce ground clutter and anomalous propagation.

### 3.4  Non-Network Site Responsibilities.

A DOT non-CONUS Site (Table 3-3) shall:

C    Operate continuously, 24 hours per day, and collect, collate, and make available via narrowband communications, radar data and products in support of FAA's enroute weather radar coverage, DOD and NWS's operations. This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D. A copy of the MOA may be obtained at the following URL: http://www.roc.noaa.gov/MOA.pdf.

C    Use one of the operational modes and volume coverage patterns agreed to by the URC.

C    Generate and distribute WSR-88D products as specified by *WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG*. The handbook can be obtained at the following URL: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.

C    Use appropriate levels of clutter filtering to reduce ground clutter and anomalous propagation.

A DOD non-CONUS Site (Table 3-4) shall:

C    Operate continuously, 24 hours per day, and collect, collate, and make available via narrowband communications, radar data and products in support of the DOD. This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D. A copy of the MOA may be obtained at the following URL: http://www.roc.noaa.gov/MOA.pdf.

C    Use one of the operational modes and volume coverage patterns agreed to by the URC.

C    Generate and distribute WSR-88D products as specified by WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG. The handbook can be obtained at the following URL: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.

C    Use appropriate levels of clutter filtering to reduce ground clutter and anomalous propagation.

## TABLE 3-1
## NETWORK SITES

| Metropolitan Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| AL,  Birmingham | KBMX | Alabaster, AL | 759 |
| AL,  Mobile | KMOB | Mobile Regional Airport | 289 |
| AL,  Northeast AL | KHTX | Hytop, AL | 1,860 |
| AR, Western AR | KSRX | Chaffee Ridge, AR | 721 |
| AR,  Little Rock | KLZK | N. Little Rock Municipal Airport | 649 |
| AZ,  Flagstaff | KFSX * | Flagstaff, AZ | 7,515 |
| AZ,  Phoenix | KIWA | Phoenix, AZ | 1,418 |
| AZ,  Tucson | KEMX | Tucson, AZ | 5,319 |
| AZ,  Yuma | KYUX * | Yuma, AZ | 237 |
| CA, Santa Ana Mts. | KSOX | Santa Ana Mtns: Beeks Place | 3,092 |
| CA,  Eureka | KBHX | Bunker Hill:  Humboldt Cnty | 2,516 |
| CA,  Los Angeles | KVTX | Sulphur Mtn.: Ventura Cnty | 2,807 |
| CA,  Sacramento | KDAX | USAF Davis: Sacramento, CA | 144 |
| CA,  San Diego | KNKX | Miramar  Naval Air Station | 1,052 |
| CA,  San Francisco | KMUX | Los Gatos,CA | 3,550 |
| CA,  San Joaquin | KHNX | Hanford  Municipal Airport | 341 |
| CO,  Denver | KFTG | Front Range Airport | 5,611 |
| CO,  Grand Junction | KGJX* | Grand Mesa:  Mesa,  CO | 10,056 |
| CO,  Pueblo | KPUX | Pueblo, CO | 5,314 |
| FL,  Jacksonville | KJAX | Jacksonville Intl. Airport | 130 |
| FL,  Key West | KBYX | Boca Chica Key, FL | 89 |
| FL,  Melbourne | KMLB | Melbourne Regional Airport | 116 |
| FL,  Miami | KAMX | Richmond Heights | 112 |
| FL,  Tallahassee | KTLH | Tallahassee Regional Airport | 177 |
| FL, Tampa Bay Area | KTBW | Ruskin, FL | 122 |

Updates for site information, along with other site data, can be found at: www.roc.noaa.gov/ssb/srchmain.asp
* - Redundant RDA

# TABLE 3-1
# NETWORK SITES

| Metropolitan Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| GA,  Atlanta | KFFC | Peachtree City, GA | 972 |
| IA,  Des Moines | KDMX | Johnston, IA | 1,095 |
| IA,  Quad Cities | KDVN | Davenport Municipal Airport | 851 |
| ID,  Boise | KCBX | Wild Horse Corral, Ada City | 3,142 |
| ID,  Pocatello | KSFX | Springfield, ID | 4,539 |
| IL, Lincoln | KILX | Logan County Airport: Lincoln, IL | 696 |
| IL,  Chicago | KLOT | Romeoville, IL | 760 |
| IN, Evansville | KVWX | Owensville, IN | 624 |
| IN,  Indianapolis | KIND | Indianapolis Intl. Airport | 887 |
| IN,  Northern IN | KIWX | North Webster, IN | 1,056 |
| KS,  Dodge City | KDDC | Dodge County Regional Airport | 2,671 |
| KS,  Goodland | KGLD | Goodland, KS | 3,716 |
| KS,  Topeka | KTWX | Alma, KS | 1,415 |
| KS,  Wichita | KICT | Wichita Mid-Continental Airport | 1,400 |
| KY,  Jackson | KJKL | Jackson, KY | 1,462 |
| KY,  Louisville | KLVX | Fort Knox Military Reservation | 833 |
| KY,  Paducah | KPAH | Barkley Regional Airport | 506 |
| LA,  Lake Charles | KLCH | Lake Charles Regional Airport | 94 |
| LA, Slidell | KLIX | Slidell Airport | 138 |
| LA,  Shreveport | KSHV | Shreveport Regional Airport | 387 |
| MA,  Boston | KBOX | Taunton, MA | 232 |
| ME, Caribou | KCBW | Houlton, ME | 860 |
| ME,  Portland | KGYX | Gray, ME | 474 |
| MI,  Detroit | KDTX | White Lake, MI | 1,186 |

Updates for site information, along with other site data, can be found at: www.roc.noaa.gov/ssb/srchmain.asp
\* - Redundant RDA

# TABLE 3-1
# NETWORK SITES

| Metropolitan Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| MI,  Grand Rapids | KGRR | Kent County Intl. Airport | 875 |
| MI,  Marquette | KMQT | Negaunee, MI | 1,525 |
| MI,  N. Cent. Lower-MI | KAPX | Gaylord, MI | 1,562 |
| MN,  Duluth | KDLH | Duluth, MN | 1,542 |
| MN,  Minneapolis | KMPX | Chanhassen, MN | 1,060 |
| MO, Pleasant Hill | KEAX | Pleasant Hill, MO | 1,093 |
| MO,  Springfield | KSGF | Springfield Regional Airport | 1,375 |
| MO,  St. Louis | KLSX | Weldon Spring, MO | 722 |
| MS,  Jackson | KDGX | Brandon, MS | 609 |
| MT,  Billings | KBLX | Yellowstone County, MT | 3,663 |
| MT,  Glasgow | KGGW | Valley County Intl. Airport | 2,357 |
| MT,  Great Falls | KTFX | Great Falls, MT | 3,779 |
| MT,  Missoula | KMSX* | Point Six Mtn., MT | 7,904 |
| NC,  Morehead City | KMHX | Newport, NC | 145 |
| NC, Raleigh/Durham | KRAX | Clayton, NC | 462 |
| NC,  Wilmington | KLTX | Shallotte, NC | 145 |
| ND,  Bismarck | KBIS | Bismarck Muncpl. Airport | 1,756 |
| ND, Grand Forks/Fargo | KMVX | Mayville, ND | 1,083 |
| NE, Grand Island | KUEX | Blue Hill, NE | 2,057 |
| NE,  North Platte | KLNX | County Airport Thedford, NE | 3,068 |
| NE,  Omaha | KOAX | Valley, NE | 1,262 |
| NM,  Albuquerque | KABX | Albuquerque, NM | 5951 |
| NV,  Elko | KLRX * | Elko, NV | 6,858 |
| NV,  Las Vegas | KESX | Opal Mtn:  Nelson, NV | 4,948 |

Updates for site information, along with other site data, can be found at: www.roc.noaa.gov/ssb/srchmain.asp
* - Redundant RDA

## TABLE 3-1
## NETWORK SITES

| Metropolitan Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| NV, Reno | KRGX* | Nixon, NV | 8,397 |
| NY, Albany | KENX | East Berne, NY | 1,907 |
| NY, Binghamton | KBGM | Binghamton Reg. Airport | 1,704 |
| NY, Buffalo | KBUF | Greater Buffalo Intl. Airport | 790 |
| NY, Brookhaven | KOKX | Upton, NY | 199 |
| OH, Cincinnati | KILN | Wilmington, OH | 1,170 |
| OH, Cleveland | KCLE | Cleveland-Hopkins Airport | 860 |
| OK, Norman | KTLX | Midwest City, OK | 1,278 |
| OK, Tulsa | KINX | Inola, OK | 749 |
| OR, Medford | KMAX* | Mount Ashland, OR | 7,561 |
| OR, Pendleton | KPDT | Eastern Oregon Regional Airport | 1,580 |
| OR, Portland | KRTX | Scappoose, OR | 1,686 |
| PA, State College | KCCX | State College, PA | 2,486 |
| PA, Philadelphia | KDIX | Fort Dix: Manchester, NJ | 230 |
| PA, Pittsburgh | KPBZ | Coraopolis, PA | 1266 |
| SC, Charleston | KCLX | Grays, SC | 211 |
| SC, Columbia | KCAE | Columbia Metropolitan Airport | 345 |
| SC, Greer | KGSP | Greenville-Sprtb Airport: Greer, SC | 1,054 |
| SD, Aberdeen | KABR | Aberdeen Regional Airport | 1,383 |
| SD, Rapid City | KUDX | New Underwood, SD | 3,130 |
| SD, Sioux Falls | KFSD | Sioux Falls, SD | 1,495 |
| TN, Knoxville/TriCities | KMRX | Morristown, TN | 1,435 |
| TN, Memphis | KNQA | Millington Naval Air Station, TN | 379 |
| TN, Nashville | KOHX | Old Hickory, TN | 676 |

Updates for site information, along with other site data, can be found at: www.roc.noaa.gov/ssb/srchmain.asp
* - Redundant RDA

## TABLE 3-1
## NETWORK SITES

| Metropolitan Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| TX, Amarillo | KAMA | Amarillo International Airport | 3,668 |
| TX, Austin/San Antonio | KEWX | New Braunfels Muncpl. Airport | 730 |
| TX, Brownsville | KBRO | Brwnsvl/S.Padre Is. Intl. Airport | 88 |
| TX, Corpus Christi | KCRP | Corpus Christi Intl. Airport | 142 |
| TX, Dallas/Fort Worth | KFWS | Fort Worth, TX | 764 |
| TX, El Paso | KEPZ | County Airport SantaTeresa, NM | 4,218 |
| TX, Houston/Galvstn | KHGX | Dickinson, TX | 115 |
| TX, Lubbock | KLBB | Lubbock Intl. Airport | 3,340 |
| TX, Midland/Odessa | KMAF | Midland Intl. Airport | 2,933 |
| TX, San Angelo | KSJT | Mathis Field: San Angelo, TX | 2,004 |
| UT, Cedar City | KICX * | Blowhard Mtn: Iron County | 10,714 |
| UT, Salt Lake City | KMTX* | Promontory Pt: Box Elder County | 6,574 |
| VA, Sterling | KLWX | Sterling R&D Center: Sterling, VA | 369 |
| VA, Roanoke | KFCX | Coles Knob Floyd County | 2,966 |
| VA, Norfolk | KAKQ | Wakefield, VA | 209 |
| VT, Burlington | KCXX | Colchester, VT | 431 |
| WA, Seattle/Tacoma | KATX | Everett, WA | 608 |
| WA, Spokane | KOTX | Spokane, WA | 2,449 |
| WI, Green Bay | KGRB | Green Bay, WI | 779 |
| WI, La Crosse | KARX | La Crosse, WI | 1,357 |
| WI, Milwaukee | KMKX | Dousman, WI | 1,023 |
| WV, Charleston | KRLX | Ruthdale, WV | 1,194 |
| WY, Cheyenne | KCYS | Cheyenne, WY | 6,193 |
| WY, Riverton/Lander | KRIW | Riverton Regional Airport | 5,633 |

Updates for site information, along with other site data, can be found at: www.roc.noaa.gov/ssb/srchmain.asp
* - Redundant RDA

# TABLE 3-2
## SUPPLEMENTAL SITES

| Coverage Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| AL, Maxwell AFB | KMXX | Carrville, AL | 514 |
| AL,  Fort Rucker | KEOX | Echo, AL | 499 |
| CA,  Beale AFB | KBBX | Oroville, CA | 221 |
| CA,  Edwards AFB | KEYX | Boron, CA | 2,855 |
| CA,  Vandenberg AFB | KVBX | Orcutt, CA | 1,321 |
| DE,  Dover AFB | KDOX | Ellendale, DE | 164 |
| FL, Eglin AFB | KEVX | Red Bay, FL | 221 |
| GA,  Moody AFB | KVAX | South Stockton, GA | 292 |
| GA,  Robins AFB | KJGX | Jeffersonville, GA | 618 |
| KY,  Fort Campbell | KHPX | Trenton, KY | 624 |
| LA,  Fort Polk | KPOE | Fort Polk, LA | 473 |
| MS,  Columbus AFB | KGWX | Greenwood Springs, MS | 557 |
| ND,  Minot AFB | KMBX | Deering, ND | 1,591 |
| NM,  Cannon AFB | KFDX | Field Village, NM | 4,698 |
| NM,  Holloman AFB | KHDX | Ruidoso, NM | 4,270 |
| NY,  Fort Drum | KTYX | Montague, NY | 1,960 |
| OK,  Altus AFB | KFDR | Frederick, OK | 1,315 |
| OK,  Vance AFB | KVNX | Cherokee, OK | 1,258 |
| TX, Ft. Hood | KGRK | Granger, TX | 603 |
| TX,  Dyess AFB | KDYX | Moran, TX | 1,582 |
| TX,  Laughlin AFB | KDFX | Brackettville, TX | 1,196 |

Updates for site information, along with other site data, can be found at:: www.roc.noaa.gov/ssb/srchmain.asp

## TABLE 3-3
## DOT NON-CONUS SITES

| Metropolitan Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| AK,  Anchorage | PAHG* | Kenai, AK | 356 |
| AK,  Bethel | PABC* | Bethel, AK | 193 |
| AK,  Fairbanks | PAPD* | Pedro Dome, AK | 2,707 |
| AK, Sitka | PACG* | Biorka Island, AK | 272 |
| AK,  King Salmon | PAKC* | King Salmon, AK | 144 |
| AK,  Middleton Island | PAIH* | Middleton Island, AK | 142 |
| AK,  Nome | PAEC* | Beam Road:  Nome, AK | 90 |
| HI,  Kamuela/Kohala | PHKM* | Kamuela, HI | 3,926 |
| HI,  Molokai | PHMO* | Kukui Amikopala: Molokai, HI | 1,444 |
| HI,  South Shore | PHWA* | Maalehu, HI | 1,461 |
| HI,  South Kauai | PHKI* | McBryde Sugar Mill:  Nimila, HI | 293 |
| PR,  San Juan | TJUA* | Vereda Los Baldios: Cayey, PR | 2,908 |

Updates for site information, along with other site data, can be found at: www.roc.noaa.gov/ssb/srchmain.asp
* All sites have a redundant RDA and RPG

## TABLE  3-4
## DOD NON-CONUS SITES

| Metropolitan Area | Radar ICAO | RDA System Location | Antenna Elev. (Ft) |
|---|---|---|---|
| GUAM, Andersen AFB | PGUA | Barrigada Communication Facility | 378 |
| JAPAN, Kadena AB | RODN | Okinawa, Japan:  White Beach | 332 |
| PORTUGAL, Lajes AB | LPLA | Santa Barabara Mtn, Isl.of Terceira | 3,415 |
| SOUTH KOREA, Camp Humphreys | RKSG | Camp Humphreys, ROK | 133 |
| SOUTH KOREA, Kunsan AB | RKJK | Kunsan Air Base: Radio Relay Hill | 192 |

Updates for site information, along with other site data, can be found at: www.roc.noaa.gov/ssb/srchmain.asp

# TABLE 3-5

# CALCULATION OF ANTENNA ELEVATION

**Antenna** ANTENNA ELEVATION (Feet):  The elevation of the center of the WSR-88D
**Elev. (Ft)** antenna is expressed in feet above mean sea level (MSL).  It is the sum of the
antenna's center-point height above ground level (AGL) and the RDA site's
terrain elevation.

For example, the WSR-88D antenna elevation for San Diego (KNKX) is;

    a.  Antenna height (AGL)    =    RDA Tower  +  Antenna Pedestal Height.

    b.  Antenna height (AGL)    =    25.0 m  +  4.7 m  =  29.7 m.

    c.  Antenna height (AGL)    =    ( 29.7 m )  x   3.28 ft / m   =   97.4 ft  [Round  to 97].

    d.  Antenna Elevation (MSL)    =    Antenna height  +  RDA elevation.

    e.  Antenna Elevation (MSL)    =    97 ft  +  955 ft  =  1,052 ft  MSL.

Values for the RDA site elevation and RDA tower height come from the National Implementation Staff (NIS)
Site Reference Book.  The value for antenna pedestal height was provided by the ROC.

# CHAPTER 4


# OPERATIONAL MODES, VOLUME COVERAGE PATTERNS, AND PRODUCTS


**4.1  Introduction.**  This chapter outlines the WSR-88D operational modes [1], volume coverage patterns [2], and the full suite of WSR-88D products that may be generated.


**4.2  Operational Modes.** Two operational modes have been implemented: Clear Air and Precipitation. Each mode has one product mix and one or more volume coverage patterns. Selection of the operational mode is closely related to the detected coverage of precipitation. The Precipitation Detection Function (PDF) is designed to automatically determine if precipitation is occurring within 124 nm of the radar. The PDF examines reflectivity returns from the four lowest elevation angles, and compares them to the Precipitation Rate Threshold and an Area Threshold (the sum of the Precipitation Area Threshold and the Nominal Clutter Area Threshold). One of the following three Precipitation Categories is assigned each volume scan depending on which combination of thresholds are met or exceeded:

    Category 0 - No precipitation detected within the past hour.
    Category 1 - Significant precipitation detected.
    Category 2 - No significant precipitation has been detected in the past hour and light precipitation is detected.

The Nominal Clutter Area (NCA) threshold is the only adaptable parameter of the Precipitation Detection Function that may be changed under authority of the Unit Radar Committee (URC). The routine practice of adjusting the nominal clutter area should be based on policies set forth by your local URC.

When significant precipitation is detected and exceeds the threshold values, Precipitation Category 1 is assigned.  When Precipitation Category 1 has not been detected within the past hour and light precipitation exceeds the threshold values, Precipitation Category 2 is assigned. When no precipitation is detected for one hour, the Precipitation Category is 0. [3]

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[1]  Operational Mode  --  A combination of one or more volume coverage patterns and product lists designed to better observe one or more features in a given meteorological environment.

[2]  Volume Coverage Pattern --   An automated method that repetitively scans the atmosphere through the same set sequence of predefined elevation angles, antenna rotation rates, and pulse characteristics. This given sequence, called a volume scan, is completed in 4.1, 5, 6, or 10 minutes (subject to change in future software builds), and then repeated.

[3]   As of RPG Build 5, the Precipitation Processing System (PPS) algorithms will no longer key off the PDF in determining the rainfall status. Instead, a somewhat analogous function, internal to the PPS, that assesses rainfall areas on the assembled Hybrid Scan will be used to determine start/stop times of distinct precipitation events.

**4.2.1 Mode A -- Precipitation Mode.**  This mode should be used when significant weather echoes are present or severe weather is occurring or is anticipated.  Usually, this mode will have been selected automatically due to the detection of Precipitation Category 1.  At times, however, such as the early, mid-level formation of convective echoes, the RPG Human-Computer Interface (HCI) operator may choose to enter the Precipitation Mode manually.

**4.2.2 Mode B -- Clear-Air Mode.**  This mode may be used when there is no detectable precipitation (Precipitation Category 0) or when precipitation intensity and areal extent are small (Precipitation Category 2).  The RPG software will not allow a change to Clear-Air Mode until Precipitation Category 1 has not been detected for at least one hour.  Since there is not an automatic switch to a Mode B VCP, the operator must use the RPG HCI to effect a change to the Clear-Air Mode from Precipitation Mode.

**4.3**  **Volume Coverage Patterns.**  During operations, the antenna is controlled by automatic scanning programs.  Volume coverage patterns (VCPs) are matched to an operational mode to optimize product generation for given meteorological situations; the various VCPs are defined in Part C of this handbook.  In each operational mode, scanning is continuous.  Principal users are informed of the radar operational mode and the VCP in use through the system status messages.

**4.3.1 Volume Coverage Patterns 31 and 32.**  Both of these VCPs are used in the Clear-Air Mode to optimize the sensitivity of the WSR-88D.  The VCP 31 (long pulse) provides a better signal-to-noise ratio permitting lower reflectivity returns to be detected, while VCP 32 (short pulse) provides a higher unambiguous velocity.

**4.3.2 Volume Coverage Patterns 11 and 21.**  These VCPs are used in the Precipitation Mode to better sample the vertical structure of convective weather echoes and to provide better temporal resolution.  VCP 11 provides better vertical sampling of weather echoes near the antenna than VCP 21 and is usually preferred in situations where convective precipitation is within 60 nmi of the antenna.

**4.3.3 Volume Coverage Pattern 12.**  This VCP, added in 2004 with Build 5, has the same number of elevation angles as VCP 11.  However, denser vertical sampling at lower elevation angles will provide better vertical definition of storms, improve detection capability of radars impacted by terrain blockage for better rainfall and snowfall estimates, result in more storms being identified, and provide quicker updates.

**4.3.4.  Volume Coverage Pattern 121.**  This VCP, added in 2004 with Build 5, has the same elevation angles as VCP 21, but more scans.  This VCP implements the multi-pulse repetition frequence detection algorithm (MPDA) which will help mitigate range/velocity aliasing (the Doppler Dilemma).

**TABLE 4-1**
**VOLUME COVERAGE PATTERN DESCRIPTION**

| Volume Coverage Pattern Number | Number Of Azimuthal Scans | Number Of Different Elevation Angles | Time To Complete (Minutes) |
|---|---|---|---|
| 11 | 16 | 14 | 5 |
| 12 | 17 | 14 | 4.1 |
| 21 | 11 | 9 | 6 |
| 31 | 7 | 5 | 10 |
| 32 | 7 | 5 | 10 |
| 121 | 20 | 9 | 5 |

**4.4 WSR-88D Product Suite.**  Table 4-2 provides brief descriptions of every WSR-88D product. Products are initiated for generation through one of several means: through the RPG Product Generation Table, Routine Product Set (RPS) lists, alert-product pairing, and through one-time requests from associated users.  The specific products that constitute the baseline Product Suite for each weather mode are defined in the WSR-88D Operator Handbook, Guidance on Adaptable Parameters - RPG.  Additions to supplement the Product Suite are permissible as long as the integrity of the baseline is maintained.  The products listed in Table 4-2 are current as of RPG software Build 5 (March 2004 release).

## TABLE 4-2
## PRODUCT DESCRIPTION

| PROD ID | PROD NUM | DATA LEVELS | COVERAGE (nmi) | RESOLUTION (nmi or see key) | PRODUCT NAME AND DESCRIPTION |
|---|---|---|---|---|---|
| R | 16 | 8 | 0 - 124 | .54 x 1E | Reflectivity. |
| R | 17 | 8 | 0 - 248 | 1.1 x 1E | Reflectivity. |
| R | 18 | 8 | 0 - 248 | 2.2 x 1E | Reflectivity. |
| R | 19 | 16 | 0 - 124 | .54 x 1E | Reflectivity. |
| R | 20 | 16 | 0 - 248 | 1.1 x 1E | Reflectivity. |
| R | 21 | 16 | 0 - 248 | 2.2 x 1E | Reflectivity. |
| V | 22 | 8 | 0 - 32 | .13 x 1E | Mean Radial Velocity. |
| V | 23 | 8 | 0 - 62 | .27 x 1E | Mean Radial Velocity. |
| V | 24 | 8 | 0 - 124 | .54 x 1E | Mean Radial Velocity. |
| V | 25 | 16 | 0 - 32 | .13 x 1E | Mean Radial Velocity. |
| V | 26 | 16 | 0 - 62 | .27 x 1E | Mean Radial Velocity. |
| V | 27 | 16 | 0 - 124 | .54 x 1E | Mean Radial Velocity. |
| SW | 28 | 8 | 0 - 32 | .13 x 1E | Spectrum Width. |
| SW | 29 | 8 | 0 - 62 | .27 x 1E | Spectrum Width. |
| SW | 30 | 8 | 0 - 124 | .54 x 1E | Spectrum Width. |
| USP | 31 | 16 | 0 - 124 | 1.1 x 1 E | User Selectable Precipitation. Can be adapted for the period of accumulation. |
| DHR | 32 | 256 | 0 - 124 | .54 x 1 E | Digital Hybrid Reflectivity. Not available for PUPs or for RPCCDS. |
| HSR | 33 | 16 | 0 - 124 | .54 x 1 E | Hybrid Scan Reflectivity. |
| CFC | 34 | 8 | 0 - 124 | .54 x 1.4 E | Clutter Filter Control. Generated when clutter suppression definition changes. |
| CR | 35 | 8 | 0 - 124 | .54 x .54 | Composite Reflectivity. |

## TABLE 4-2
## PRODUCT DESCRIPTION

| PROD ID | PROD NUM | DATA LEVELS | COVERAGE (nmi) | RESOLUTION (nmi or see key) | PRODUCT NAME AND DESCRIPTION |
|---------|----------|-------------|----------------|-----------------------------|------------------------------|
| CR | 36 | 8 | 0 - 248 | 2.2 x 2.2 | Composite Reflectivity. |
| CR | 37 | 16 | 0 - 124 | .54 x .54 | Composite Reflectivity. |
| CR | 38 | 16 | 0 - 248 | 2.2 x 2.2 | Composite Reflectivity. |
| ET | 41 | 16 | 0 - 124 | 2.2 x 2.2 | Echo Tops. Min=5,000 ft, Max=70,000 ft MSL. |
| SWR | 43 | 16 | 0 - 124 | .54 x 1E | Severe Weather Analysis -- Reflectivity. Presentation area is 27 nmi x 27 nmi and is centered on: (a) alerting phenomenon or, (b) user selected coordinates. |
| SWV | 44 | 16 | 0 - 124 | .13 x 1E | Severe Weather Analysis -- Velocity. See SWR (ID #43) description. |
| SWW | 45 | 16 | 0 - 124 | .13 x 1E | Severe Weather Analysis -- Spectrum Width. See SWR (ID# 43) description. |
| SWS | 46 | 16 | 0 - 124 | .27 x 1E | Severe Weather Analysis -- Radial Shear. See SWR (ID#43) description, above. |
| SWP | 47 | 4 | 0 - 124 | n-a | Severe Weather Probability. Default presentation 'box' is 15.1 nmi x 15.1 nmi. |
| VWP | 48 | 30 | 16 (default value) | 1,000 ft (z) | VAD Wind Profile. Barbs show speeds to nearest 5 kt. Height (every 1000 ft) is plotted on z-axis and time (up to 11 volume scans) is plotted on x-axis. |
| RCS | 50 | 16 | 0 - 124 | .54 x .27(z) | Cross Section -- Reflectivity. Min=0 ft, Max=70,000 ft MSL . |
| VCS | 51 | 16 | 0 - 124 | .54 x .27(z) | Cross Section -- Velocity. Min=0 ft, Max=70,000 ft MSL. |

## TABLE 4-2
## PRODUCT DESCRIPTION

| PROD ID | PROD NUM | DATA LEVELS | COVERAGE (nmi) | RESOLUTION (nmi or see key) | PRODUCT NAME AND DESCRIPTION |
|---------|----------|-------------|----------------|------------------------------|------------------------------|
| SRR | 55 | 16 | 0 - 124 | .27 x 1E | Storm Relative Mean Radial Velocity--Region. See notes for SRM (#56), below. The presentation area is 27 nmi x 27 nmi centered on operator defined location. |
| SRM | 56 | 16 | 0 - 124 | .54 x 1E | Storm Relative Mean Radial Velocity--Map. Derived from vector average of all identified storms or vector input by operator. Presentation area is 0 to 124 nmi. |
| VIL | 57 | 16 | 0 - 124 | 2.2 x 2.2 | Vertically Integrated Liquid Water. |
| STI | 58 | 6 | 0 - 186 | n-a | Storm Tracking Information. Graphic product with 15 minute position intervals. |
| HI | 59 | 5 | 0 - 124 | n-a | Hail Index. Includes overlay to show probability and max hail size per storm. |
| M | 60 | 3 | 0 - 124 | n-a | Mesocyclone. Includes overlay for identified storms' data. |
| TVS | 61 | n-a | 0 - 124 | n-a | Tornadic Vortex Signature. Includes overlay for identified storms' data. |
| SS | 62 | n-a | 0 - 248 | n-a | Storm Structure. Table generated each VCP. |
| LRA | 63 | 8 | 248 x 248 | 2.2 x 2.2 | Layer Composite Reflectivity – Average. Low Layer. |
| LRA | 64 | 8 | 248 x 248 | 2.2 x 2.2 | Layer Composite Reflectivity-- Average. Mid Layer. |
| LRM | 65 | 8 | 248 x 248 | 2.2 x 2.2 | Layer Composite Reflectivity-- Maximum. Low Layer. |
| LRM | 66 | 8 | 248 x 248 | 2.2 x 2.2 | Layer Composite Reflectivity-- Maximum. Mid Layer. |

## TABLE 4-2
## PRODUCT DESCRIPTION

| PROD ID | PROD NUM | DATA LEVELS | COVERAGE (nmi) | RESOLUTION (nmi or see key) | PRODUCT NAME AND DESCRIPTION |
|---------|----------|-------------|----------------|------------------------------|-------------------------------|
| APR | 67 | 8 | 248 x 248 | 2.2 x 2.2 | Layer Composite Reflectivity–AP Removed. Low Layer. |
| UAM | 73 | n-a | n-a | n-a | User Alert Message. Generated upon alert activation. |
| RCM | 74 | 9 | 0 - 248 | 1/16 x 1/16 L | Radar Coded Message. Generated near HH:20 & HH:50 UTC. Derived from the IRM product . See the IRM (ID #83) description, below. |
| FTM | 75 | n-a | n-a | n-a | Free Text Message. Messages can be generated at MSCF and RPG. |
| OHP | 78 | 16 | 0 - 124 | 1.1 x 1E | One-Hour Precipitation. |
| THP | 79 | 16 | 0 - 124 | 1.1 x 1E | Three-Hour Precipitation. |
| STP | 80 | 16 | 0 - 124 | 1.1 x 1E | Storm-Total Precipitation. |
| DPA | 81 | 256 | 0 - 124 | 1/40 x 1/40 L | Digital Precipitation Array. A one-hour accumulation product made with OHP. |
| SPD | 82 | 8 | 0 - 124 | 1/4 x 1/4 L | Supplemental Precipitation Data. Alphanumeric with rain gage values and times. |
| VAD | 84 | 8 | 16 (default value) | n-a | Velocity Azimuth Display. Product is available for altitudes specified by VWP product (#48). |
| RCS | 85 | 8 | 0 - 124 | .54 x .27(z) | Cross Section -- Reflectivity. |
| VCS | 86 | 8 | 0 - 124 | .54 x .27(z) | Cross Section -- Velocity. |
| CS | 87 | 16 | 124 x 124 | 'adaptable' | Combined Shear. |
| LRA | 89 | 8 | 248 x 248 | 2.2 x 2.2 | Layer Composite Reflectivity-- Average. High Layer. |

## TABLE 4-2
## PRODUCT DESCRIPTION

| PROD ID | PROD NUM | DATA LEVELS | COVERAGE (nmi) | RESOLUTION (nmi or see key) | PRODUCT NAME AND DESCRIPTION |
|---|---|---|---|---|---|
| **LRM** | 90 | 8 | 248 x 248 | 2.2 x 2.2 | Layer Composite Reflectivity--Maximum. High Layer. |
| **DBV** | 93 | 256 | lesser of 62 nmi or18K ft AGL | .54 x 1E | ITWS Digital Base Velocity |
| **DR** | 94 | 256 | 0 - 248 | .54 x 1E | Base Reflectivity Data Array |
| **CRE** | 95 | 8 | 0 - 124 | .54 x 1E | Composite Reflectivity Edited for AP |
| **CRE** | 96 | 8 | 0 - 248 | 2.2 x 2.2 | Composite Reflectivity Edited for AP |
| **CRE** | 97 | 16 | 0 - 124 | .54 x .54 | Composite Reflectivity Edited for AP |
| **CRE** | 98 | 16 | 0 -248 | 2.2 x 2.2 | Composite Reflectivity Edited for AP |
| **DV** | 99 | 256 | 0 - 124 | .13 x 1E | Base Velocity Data Array |
| **CLR** | 132 | 11 | 0 - 124 | .54 x 1E | Clutter Likelihood Reflectivity |
| **CLD** | 133 | 12 | 0 - 124 | .54 x 1E | Clutter Likelihood Doppler |
| **DVL** | 134 | 256 | 0 - 248 | .54 x 1E | High Resolution Digital Vertically Integrated Liquid Water |
| **EET** | 135 | 71 | 0-124 | 0.54 | Enhanced Echo Top |
| **SO** | 136 | n-a | n-a | n-a | Superob: NCEP Winds Model Initialization |
| **ULR** | 137 | 16 | 0 - 124 | .54 x 1E | User Selectable Layer Composite Reflecticity |
| **DSP** | 138 | 256 | 0 - 124 | 1.1 x 1E | Storm Total Rainfall Accumulation (Digital Storm Product) |

## TABLE 4-2
## PRODUCT DESCRIPTION

| PROD ID | PROD NUM | DATA LEVELS | COVERAGE (nmi) | RESOLUTION (nmi or see key) | PRODUCT NAME AND DESCRIPTION |
|---|---|---|---|---|---|
| **MRU** | 139 | 3 | 0 - 124 | n-a | Mesocyclone Rapid Update |
| **MD** | 141 | 3 | 0 - 124 | n-a | Mesocyclone Detection |
| **TRU** | 143 | n-a | 0 - 124 | n-a | Tornadic Vortex Signature Rapid Update |

n-a = not applicable.
z = vertical
The products listed in this table are current as of RPG software Build 5 (March 2004 release).

# KEY FOR TABLE 4-2

**PROD ID**            PRODUCT IDENTIFIER: The official one, two, or three letter abbreviations used by the WSR-88D system and displayed on WSR-88D products.

**PROD NUM**        PRODUCT NUMBER: The official identification number assigned to WSR-88D products. Product numbers are recognized by the system software.

**DATA LEVLS**      DATA LEVELS: The number of gradations that display the magnitude of data in a color indexed graphical format. Some alphanumeric products have multiple categories of information (e.g., severe weather probability). The number of categories is expressed as the number of data levels.

**COVERAGE**        RANGE OF COVERAGE: The geographical scope of coverage for a given product. There are three types of product formats; polar, cartesian, and grid-based. The areal extent for polar and grid-based products is indicated with a polar range limit (e.g., 248 nmi). Cartesian products' areal extent is described by x-axis and y-axis lengths (e.g., 124 nmi x 124 nmi).

**RESOLUTION**      DATA RESOLUTION: Standard units of measure describe the size of the products' discrete data elements. The type of units used (e.g., nmi, arcdegree, grid fraction) is a function of a product's format. Product formats are: polar, cartesian, and grid-based. The limited-area fine mesh (LFM) grid is a standard reference for the radar coded message products.

        **1/40 L:** Approximately 2.2 nmi x 2.2 nmi. The 2.2 nmi length is 1/40 of the LFM grid-point separation.

        **1/16 L:** Approximately 5.4 nmi x 5.4 nmi. The 5.4 nmi length is 1/16 of the LFM grid-point separation.

        **1/4 L:** Approximately 22 nmi x 22 nmi. The 22 nmi length is 1/4 of the LFM grid-point separation.

**PRODUCT NAME AND DESCRIPTION**      The full name of product followed by pertinent information.

# CHAPTER 5


# ARCHIVING


**5.1  Introduction.**  The WSR-88D system has the capability to provide for the archiving of data and products at four functional locations.  The locations are identified as Archive Levels I, II, III, and IV, respectively. The following sections, exclusive of the final section, provide a brief description of each level and potential utilization of data archived at each level.  The final section provides information pertaining to product retention at the National Climatic Data Center (NCDC).

**5.2  Archive Level I.**  The Archive Level I interface is located at the RDA.  Data available are the analog, time-domain output of the receiver.  Information regarding synchronization, calibration, date, time, antenna position, and status is also available at this level.  However, Archive Level I is not used operationally.  Archive Level I data is used for RDA system diagnostics and input for signal processor optimization studies.

**5.3  Archive Level II.**  Archive Level II data are the digital base data output from the signal processor.  The output also includes status information required to properly interpret the data (e.g., information on synchronization, calibration, date, time, antenna position, clutter and notchwidth maps, operational mode).  Archive Level II data are used for many purposes including: support of operational, maintenance and developmental activities at the ROC; activities directed toward algorithm and product enhancement; and research by universities.  The only Level II data archived are those sent to the NCDC by the NWS WSR-88D Level II Central Collection and Distribution Network, reference section 2.4.2.

**5.4  Archive Level III**.  Archive Level III data are the output of the RPG.  Archive Level III data are continuously transmitted from DOC WSR-88D systems to the NCDC via the Advanced Weather Interactive Processing System (AWIPS).

The *WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG,* defines the products and the frequency at which these products are generated for transmission to the NCDC. The handbook can be obtained at the following URL: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.

**5.5  Archive Level IV.**  Archive Level IV data are the output data of the RPG.  The Archive Level IV interface is located at the PUP.  All DOD sites with a PUP will perform Archive Level IV archiving for local training, studies, accident investigation, and other purposes as required. DoD sites with an OPUP have an Archive Level IV-like capability.  At NWS sites, the AWIPS has an Archive Level IV-like capability.

**5.6  Retention by National Climatic Data Center.**  The *WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG* lists the products that shall be archived for Mode A (Precipitation) and Mode B (Clear-air) respectively, at the RPG (Archive Level III) by all Network Sites at the frequency shown.   The handbook can be obtained at the following URL: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.

As an extension of sites sending the narrowband data, beyond Level III, to the RPCCDS, the NCDC receives, archives, and makes these products and data available upon request.  The list of these products in the NCDC archives is available at the following URL: http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?WWDI~RadarList~N.  The data are collected for all WSR-88D sites except for the 4 remote DOD sites (Lajes AB, Kadena AB, Camp Humphreys, and Kunsan AB).

Archive Level II and Archive Level III data are sent to the NCDC for permanent retention. WSR-88D archive data information can be obtained from the NCDC home page (http://www.ncdc.noaa.gov) and clicking on 'Radar.'

# CHAPTER 6


## ADAPTABLE PARAMETER CHANGE AUTHORITY


**6.1  Introduction.**  The WSR-88D's design includes thousands of parameters that permit each WSR-88D system to be adapted to certain geographical and meteorological conditions to support operational requirements.  Since the WSR-88D is operated to satisfy the integrated needs of the principal users and to support the national radar network, centralized control of many of the system and meteorological parameters is required to ensure a baseline operational standard.  However, a subset of these parameters was designed specifically to address the local operational needs.  For this reason the principal user agencies agreed to categorize a number of  WSR-88D adaptable parameters into three levels of change authority (LOCA) as defined in section 6.2.  This was done, primarily, to ensure the proper LOCA use of these adaptable parameters.  As defined, each of these three LOCA categories permits the modification of WSR-88D hardware and software through a controlled process.

Official guidance on WSR-88D adaptable parameters is documented by the *WSR-88D Operator Handbook, Guidance on Adaptable Parameters, Volumes II-IV*.  RPG parameters, are comprehensively categorized by their LOCA in Volume IV, PUP parameters are comprehensively enumerated in Volume II, and RDA system parameters are covered in Volume III and RPG parameters are covered in Volume IV.  Volumes II and IV discuss the default and alternate settings that optimize the control of algorithms and the quality of WSR-88D products and communications.

**6.2  Levels of Change Authority.**  The adaptable parameters have been grouped according to the level of approval that is necessary before the parameter's value can be changed.  These groupings are intended to give maximum flexibility in operational use of the WSR-88D while ensuring that agency operations are not jeopardized and the system remains stable.

> **6.2.1 Radar Operations Center.**  Through the Adaptable Parameter Working Group (APWG) the ROC shall determine the general validity and range of adaptable parameter values for changes that affect the technical and scientific characteristics of WSR-88D data acquisition and algorithmic processing.  In addition, the ROC shall be authorized to determine, specifically, the values for the aforementioned default adaptable parameter values for WSR-88D equipment owned by the DOD, DOT, and the DOC.  Since the APWG shall remain subordinate to the NEXRAD Program Management Committee (NPMC), the ROC level of change authority shall reflect the NPMC's position on triagency policy in WSR-88D operations.

**6.2.2 Unit Radar Committee.** Each Unit Radar Committee (URC) shall be authorized to change their WSR-88D system's adaptable parameter values and establish adaptation parameter policy for the principal users within the URC. Types of changes that a single URC is authorized to implement shall include the "fine-tuning" needed to meet local operational requirements, seasonal changes, and local climatological characteristics.

**6.2.3 Agency.** The agency is the principal user agency (DOC, DOD, or DOT) that controls the involved hardware and software. Each agency is authorized to change the range of adaptable parameter values, change default values, and establish WSR-88D adaptable parameter policy in order to meet agency-specific mission requirements and criteria. Changes that a single agency are authorized to implement may involve user passwords, meteorological algorithm parameters, and certain telecommunications settings.

# APPENDIX A

## ACRONYMS AND ABBREVIATIONS

AB              -   Air Base
AFB             -   Air Force Base
AGL             -   Above Ground Level
APWG            -   Adaptable Parameter Working Group
ATCSCC          -   Air Traffic Control Systems Command Center
AWC             -   Aviation Weather Center
AWIPS           -   Advanced Weather Interactive Processing System

CFC             -   Clutter Filter Control
CONUS           -   Conterminous United States
CR              -   Composite Reflectivity
CRC             -   Composite Reflectivity Contour
CS              -   Combined Shear

DHR             -   Digital Hybrid Reflectivity
DOC             -   Department of Commerce
DOD             -   Department of Defense
DOT             -   Department of Transportation
DPA             -   Digital Precipitation Array
DSP             -   Digital Storm Product

Elev            -   Elevation
ET              -   Echo Tops

FAA             -   Federal Aviation Administration
FMH             -   Federal Meteorological Handbook
Ft              -   Foot
FTM             -   Free Text Message
FTP             -   File Transfer Protocol

HCI             -   Human Computer Interface
HI              -   Hail Index
HPC             -   Hydrometeorological Prediction Center

| | | |
|---|---|---|
| ICAO | - | International Civil Aviation Organization |
| ICMSSR | - | Interdepartmental Committee for Meteorological Services and Supporting Research |
| ID | - | Identifier |
| ITWS | - | Integrated Terminal Weather System |
| | | |
| LFM | - | Limited Area Fine Mesh |
| LOCA | - | Level of Change Authority |
| LRA | - | Layer Composite Reflectivity - Average |
| LRM | - | Layer Composite Reflectivity - Maximum |
| | | |
| m | - | Meter |
| M | - | Mesocyclone |
| MPC | - | Marine Prediction Center |
| MPDA | - | Multi-Pulse Repetition Frequency Detection Algorithm |
| MSCF | - | Master System Control Function |
| MSL | - | Mean Sea Level |
| | | |
| NA | - | Non-Associated; Not Applicable |
| NCDC | - | National Climatic Data Center |
| NCEP | - | National Centers for Environmental Prediction |
| NEXRAD | - | Next Generation Weather Radar |
| nmi | - | Nautical Mile |
| NPC | - | NEXRAD Program Council |
| NWS | - | National Weather Service |
| | | |
| OFCM | - | Office of the Federal Coordinator for Meteorological Services and Supporting Research |
| OHP | - | One-Hour Precipitation Accumulation |
| OWS | - | Operational Weather Squadron |
| | | |
| PDF | - | Precipitation Detection Function |
| PMC | - | Program Management Committee |
| PUES | - | Principal User External System |
| PUP | - | Principal User Processor |
| | | |
| R | - | Reflectivity |
| RCM | - | Radar Coded Message |
| RCS | - | Cross Section - Reflectivity |
| RDA | - | Radar Data Acquisition (System) |

| | | |
|---|---|---|
| RFC | - | River Forecast Center |
| ROC | - | Radar Operations Center |
| RPCCDS | - | Radar Product Central Collection Dissemination Service |
| RPG | - | Radar Product Generator |
| RPS | - | Routine Product Set |
| | | |
| SCIT | - | Storm Cell Identification and Tracking |
| SPC | - | Storm Prediction Center |
| SPD | - | Supplemental Precipitation Data |
| SRM | - | Storm-Relative Mean Radial Velocity, Map |
| SRR | - | Storm-Relative Mean Radial Velocity, Region |
| SS | - | Storm Structure |
| STI | - | Storm Tracking Information |
| STP | - | Storm-Total Precipitation Accumulation |
| SW | - | Spectrum Width |
| SWP | - | Severe Weather Probability |
| SWR | - | Severe Weather Analysis - Reflectivity |
| SWS | - | Severe Weather Analysis - Shear |
| SWV | - | Severe Weather Analysis - Velocity |
| SWW | - | Severe Weather Analysis - Spectrum Width |
| | | |
| THP | - | Three-Hour Precipitation Accumulation |
| TPC | - | Tropical Prediction Center |
| TVS | - | Tornadic Vortex Signature |
| | | |
| UAM | - | User Alert Message |
| ULR | - | User Selectable Layer Composite Reflectivity |
| URC | - | Unit Radar Committee |
| URL | - | Uniform Resource Locator |
| USP | - | User Selectable Precipitation |
| | | |
| V | - | Velocity |
| VAD | - | Velocity Azimuth Display |
| VCP | - | Volume Coverage Pattern |
| VCS | - | Cross Section - Velocity |
| VIL | - | Vertically Integrated Liquid |
| VWP | - | Velocity Azimuth Display Wind Profile |
| | | |
| WG/DRMO | - | Working Group for Doppler Radar Meteorological Observations |
| WSR-88D | - | Weather Surveillance Radar - 1988, Doppler |

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# APPENDIX B

# GLOSSARY

**Adaptable Parameter:**  Generally, data related to a specific WSR-88D system.  These data may consist of meteorological or hydrological parameters or of geographic boundaries, political boundaries, system configuration, telephone numbers, or other like data. Such data may be generated at either a centralized location or locally.

**Associated Principal User:**  A principal user linked to a WSR-88D system with a dedicated telecommunication line.

**Base Data:**  Those digital fields of reflectivity, mean radial velocity, and spectrum width data in spherical coordinates provided at the finest resolution available from the radar.

**Conterminous United States:**  Those states of the United States enclosed within one common boundary.  The conterminous 48 states of the United States is abbreviated 'CONUS'.

**Data Resolution:**  The resolution of the base data as produced by the  signal processor, nominally 0.54 nautical mile (1 kilometer) x 1 degree in azimuth x 1 degree in elevation for reflectivity values and 0.13 nautical mile (0.25 kilometer) x 1 degree x 1 degree for velocity values.

**Default Value:**  A setting or value that will be used in a given software program unless changed.

**Echoes**: Areas of radar reflectivity that are visible in the WSR-88D products that may represent meteorological or non-meteorological phenomena.

**Elevation Angle:**  The angle the WSR-88D antenna subtends to the horizontal plane.  This value can vary from 0E to + 60E.

**External User:**  Anyone other than a Principal User who has access to WSR-88D products, e.g., information service companies, broadcast meteorologists, aviation interests, industrial meteorologists, other government agencies, and universities.

**Mesocyclone:**  A 3-dimensional region in a storm that rotates (usually cyclonically) and is closely correlated with severe weather.

**National Weather Radar Network:**  Consists of WSR-88D sites dispersed throughout the CONUS.

**Network Site:**  A DOC WSR-88D site in the CONUS that continuously collects, collates, and makes available radar data and products in support of the national weather radar network.

**NEXRAD Program Council:**  Composed of a representative from each of the DOC, DOD, and DOT, and the Federal Coordinator for Meteorological Services and Supporting Research.

**Non-Associated Principal User:**  A principal user with access to a WSR-88D system through means of dial telecommunication.

**Non-Network Site:**  A non-CONUS DOD site or a non-CONUS DOT site.

**Operational Mode:**  A combination of one or more volume coverage patterns and product lists designed to better represent one or more features in a given meteorological environment.

**Principal User:**  Principal users are the NWS, the Air Force, the Naval Meteorology and Oceanography Command, the Marine Corps Weather Service Units, and the FAA.

**NEXRAD Program Management Committee:**  A NEXRAD Program triagency organization comprised of representatives of DOC (NWS), DOD (Air Force Weather Agency), and DOT (FAA).  Its responsibilities encompass all WSR-88D operational aspects (e.g., WSR-88D operations, maintenance, logistics, documentation, and training) to ensure that the common and unique agency concerns are addressed.

**Radial Velocity:**  The component of motion of the target toward or away from the radar.

**Reflectivity:**  The measure of the efficiency of a target in intercepting and returning radio energy.  With hydrometeors it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect.

**Spectrum Width:**  A measure of dispersion of velocities within the radar sample volume.

**Supplemental Site:**  A DOD WSR-88D site in the CONUS.  It continuously collects, collates, and makes available radar data and products in support of the DOD.

**Tornadic Vortex Signature:**  The radar signature of a vortex that is indicative of a tornado or tornadic circulation.

**Unit Radar Committee:**  A coordinating committee, established by the MOA for Interagency Operation of the WSR-88D, composed of representatives of each principal user agency associated with a particular WSR-88D system.

WSR-88D