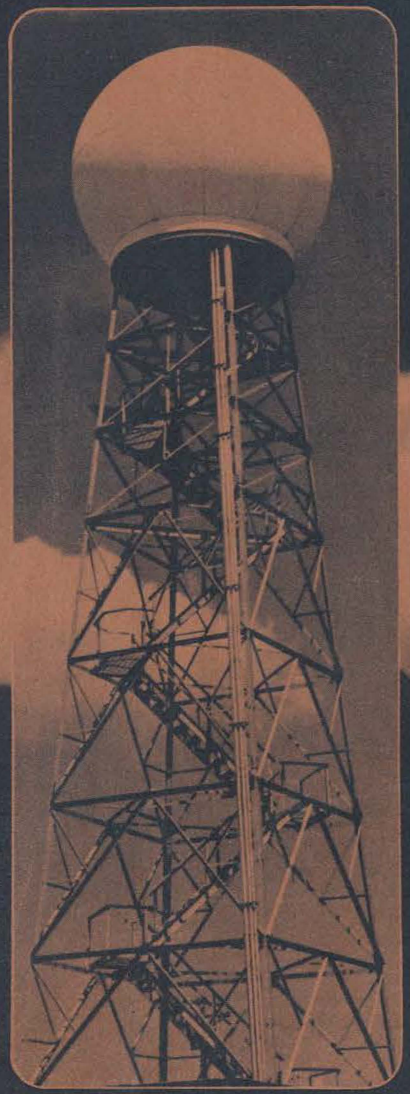
FEDERAL PLAN FOR

WEATHER RADARS & REMOTE DISPLAYS



U.S. DEPARTMENT OF COMMERCE
Environmental Science Services Administration
OFCM–67–3

FEDERAL PLAN FOR WEATHER RADARS AND REMOTE DISPLAYS

FISCAL YEARS 1967-1971

U.S. DEPARTMENT OF COMMERCE
Environmental Science Services Administration
Federal Coordinator for Meteorological
Services and Supporting Research
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FOREWORD

This plan for weather radar was prepared by the Interdepartmental Committee for Meteorological Services of the Office of the Federal Coordinator for Meteorological Services and Supporting Research in response to a Bureau of the Budget request for a study to determine how to use national weather radar resources most effectively and economically. The study was to address itself to both synoptic network and local uses, application of remoting equipment, standardization of operational procedures, and equipment required in various geographic and climatic regions. Federal agencies concerned with weather radar or radar having a weather capability have participated in preparing this plan, specifically the Air Force, Army, Federal Aviation Administration, National Aeronautics and Space Administration, Navy, and ESSA-Weather Bureau.

ROBERT M. WHITE
Federal Coordinator for Meteorological Services and Supporting Research

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INTRODUCTION

This plan is limited to fixed radars and remote displays used for weather surveillance. Obsolete radars and equipment used only for research and development are not included as part of the plan although a brief discussion of them is given for background purposes. Mobile radars used for field support of tactical units of the Army, Navy, and Air Force have not been considered.

The plan:

- Establishes national requirements for weather radar data based on the combined needs of Federal agencies in the 48 conterminous States.
- Develops an operational concept and presents a coordinated plan, consisting of agency programs by fiscal years, which provides the maximum integration of current and future weather radar facilities consistent with effective and efficient mission accomplishment.
- Recommends actions to improve the efficiency and effectiveness of weather radar operations.

Agency programs presented in this plan represent current agency objectives and the agencies are obligated to meet these objectives to the best of their abilities. This is especially critical in any coordinated interagency plan such as this where investment and operating costs are substantially reduced through cooperative efforts. If an agency fails to meet a key objective, requirements of other agencies may not be met and the entire plan and cooperative approach may be jeopardized.

New technology and changing needs for services will change agency requirements and programs in coming years. In addition, funds requested to implement the programs are allocated on an annual basis. Thus, the ability of each agency to implement its part is subject to normal budgetary considerations. These, and other changes in the plan, should be promptly brought to the attention of the Federal Coordinator for Meteorological Services and Supporting Research. The plan will be reviewed annually and updated as required.

I. WEATHER RADAR

Weather radar information represents an important and valuable supplement to the surface and upper-air networks by giving the meteorologist a capability to look electronically far beyond the visual horizon and evaluate what is detected in terms translatable to synoptic and local uses. This information is not available from other data sources even in areas having dense surface and upper-air observation coverage. Weather radar provides:

- A continuous and almost instantaneous means of detecting precipitation within range of the set. This information is a prime input to the weather watch of the "local" area and helps avoid surprise onsets of unexpected weather conditions.
- The best means now available for identifying and tracking squall lines, tornadoes, and other destructive storms. This information is essential to adequate local warnings for protection of life and property. Figure 1 shows a radar presentation of a squall line with hook-shaped echoes often associated with tornadoes.
- A means of locating, tracking, and estimating the intensity of hurricanes as they approach the U.S. coastal areas. This information is vital to issuing warnings to the public, industry, and government. Figure 2 is a radar presentation of a hurricane with a well-defined eye and typical spiral bands of echoes. Figure 3 shows a radar vertical profile through a hurricane.
- Quantitative information upon which estimates of precipitation rates and amounts can be based. This information enhances the ability of hydrological personnel to provide flash flood warnings and gives a valuable input to the management of water resources in river basins.
- A nearly unique source of three dimensional information on the location, intensity, and movement of precipitation areas and attendant hazardous conditions. This information is a significant input to flight planning as well as control and safety of aircraft in flight.

Figure 1.—PPI presentation of a squall line with hook-shaped echoes associated with tornadoes.

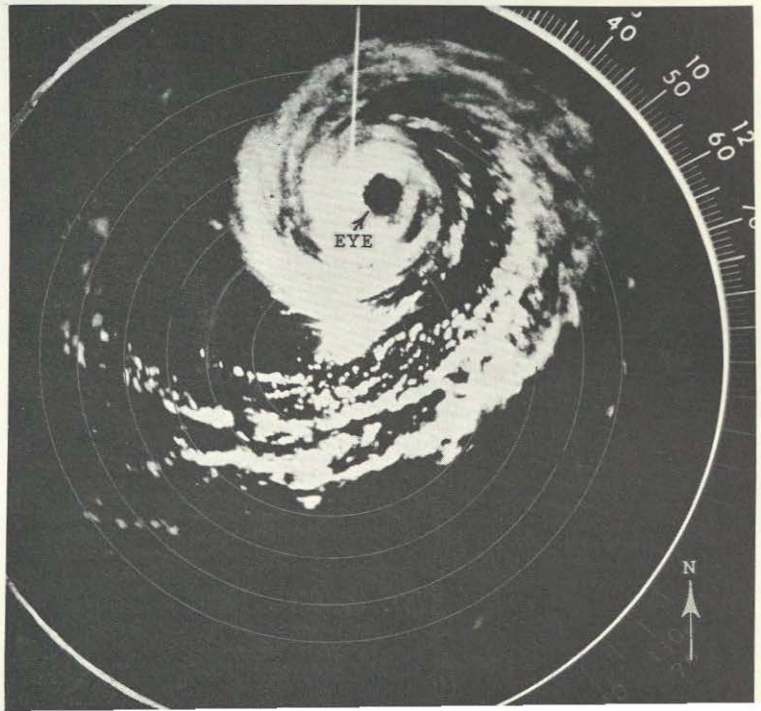


Figure 2.—PPI presentation of a hurricane with a well-defined eye and spiral bands of echoes.

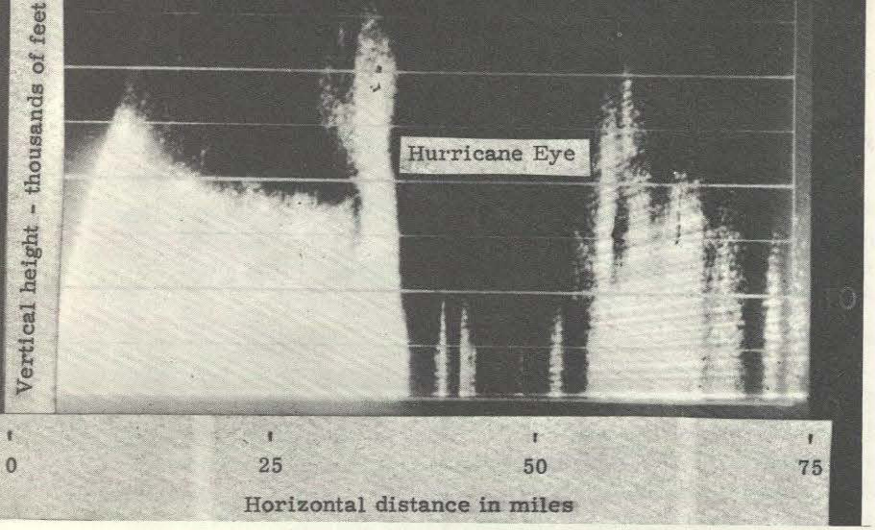


Figure 3.—RHI presentation of a vertical profile through a hurricane.

- A means for indirectly estimating many important meteorological parameters such as turbulence associated with thunderstorms, winds aloft, cloud tops, precipitation types, freezing level, and aircraft icing levels.

The capability of a weather radar to do the varied tasks outlined depends on many factors. Most important of these are:

- Frequency or wavelength
- Pulse length
- Range
- Power transmitted
- Receiver sensitivity
- Beam width
- Accuracy of azimuth, range, and elevation presentations
- Accuracy of echo intensity measurements
- Type of presentations (PPI, RHI, A/R)[1]
- Type of controls (automatic and manual)
- Range normalization
- System calibration

In general, the requirements placed on a weather radar for synoptic network use are more stringent and demanding in all these factors than are requirements for local uses. Network radars must cover substantially greater areas than local use radars without significant degradation of capability. As a result, network weather radars generally operate in the S-band with high transmission power and accurate presentation and measurement capabilities. Newer models of local use weather radars are usually less expensive than network radars since they are lower powered and operate in C-band or X-band where size and cost reductions are possible at the expense of some degradation of performance of functions requiring long-range and minimum precipitation attenuation.

[1] PPI: Plan-Position Indicator
RHI: Range-Height Indicator
A/R: Intensity-Range

WEATHER RADAR EQUIPMENT

There are three major types of weather radars now in use (or soon to come into use) by Federal agencies. The characteristics of each are described in detail in Appendix II. The following are brief descriptions of this equipment:

WSR-57 and AN/FPS-41 Radars

These are S-band radars (10-cm. wavelength) with the power, accuracy, and general sophistication to perform all network and local use functions to at least 100 miles range. Figure 4 shows the operator's console of these radars.

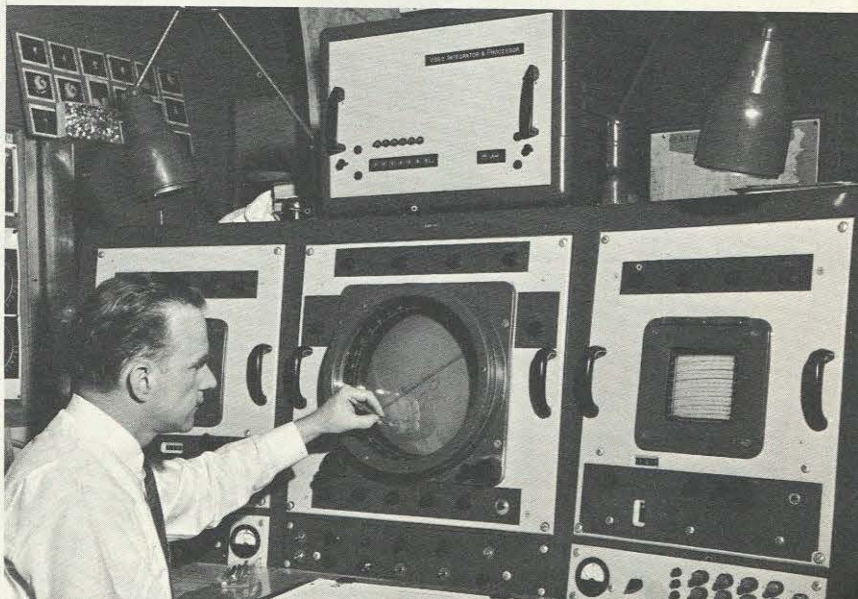


Figure 4.—WSR–57 (AN/FPS–41) operator's console. The 12-inch PPI scope is in the center with the AR scope on the left and the RHI scope on the right.

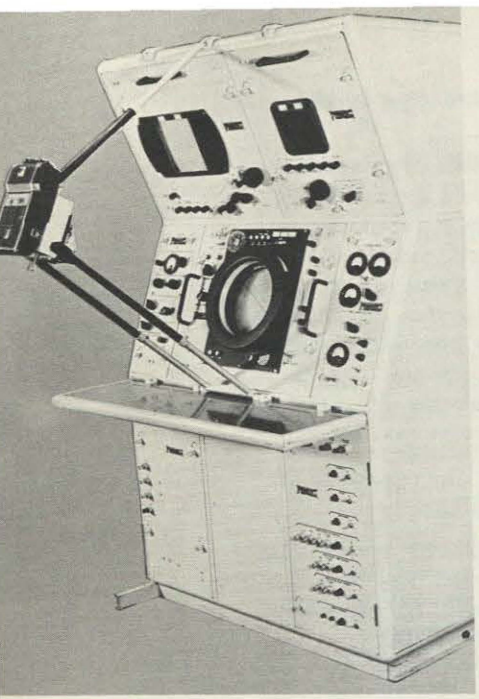


Figure 5.—AN/FPS–77 operator's console with Polaroid camera for PPI scope photography attached.

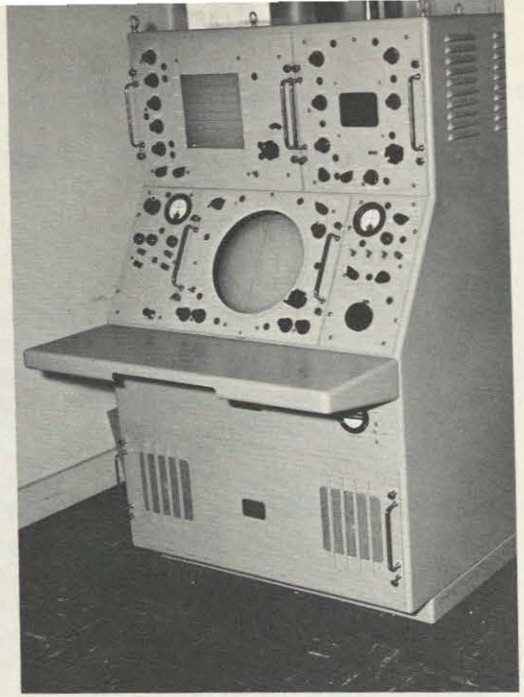


Figure 6.—AN/FPS–81 operator's console.

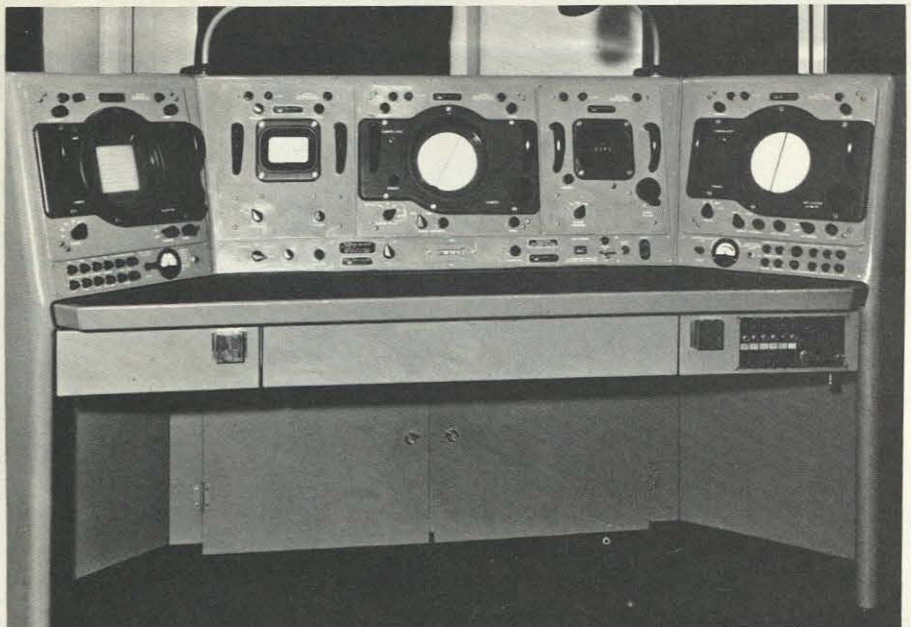


Figure 7.—AN/CPS–9 operator's console.

AN/FPS-68, 77, and 81 Radars

These are C-band radars (5-cm. wavelength) designed for local use. Their use for longer-range network purposes is limited by precipitation attenuation in heavy rainfall. Figure 5 shows an AN/FPS–77 operator's console and Figure 6 illustrates the AN/FPS–81 operator's console.

AN/CPS-9 Radars

These are X-band radars (3-cm. wavelength) and were the first radars specifically designed for weather uses. They suffer from precipitation attenuation in moderate or heavier rainfall and would require considerable modification to permit objective determination of echo information. Further, since these radars are based on designs and engineering of the late 1940's, and have been in use for more than 10 years, maintenance costs are high in comparison with more modern equipment. Figure 7 illustrates the AN/CPS–9 operator's console.

WEATHER RADAR REMOTING EQUIPMENT

There are also three major types of weather radar remoting equipment in use or under development by Federal agencies. The following are brief descriptions of this equipment:

Wide Band Video Remoting Systems

Wide band video remoting systems include repeater scopes (usually PPI) which require either video coaxial cabling or a video microwave link between the radar set and the remote location. These types of remoting systems present the radar information in real time without discernable degradation of details. Coaxial cabling and microwave link video remotes are expensive and have significant disadvantages. For example, the console operator cannot send interpretive data over the video channel, the remote display is not retained when the operator changes from normal PPI scan to another mode of operation, and voice communications between the remote and console operator require a separate telephone channel. Because of the expense and disadvantages, few microwave link video remotes are planned. Coaxial cable video remotes do have some application in those cases in which the disadvantages will not seriously

affect the utility of the display. They are, however, generally limited to about a mile by the cost of the cable and installation.

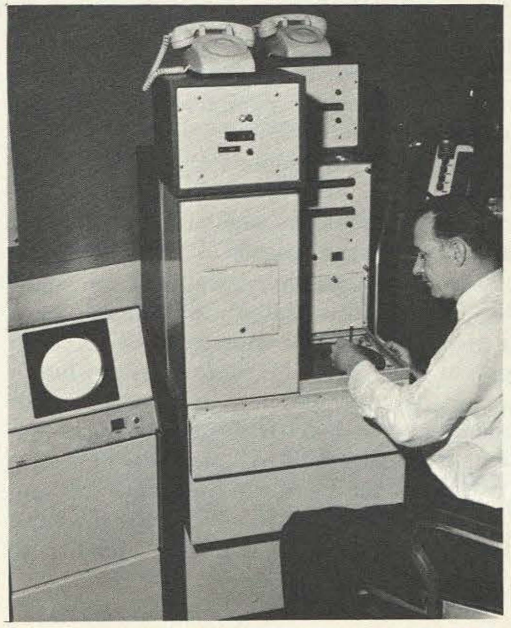
Narrow Band Video Remoting Systems

Narrow band video remoting systems are designed for narrow bandwidth circuits (3kHz) between the radar console and remote receiver locations. There are several systems now in use and more are under procurement, test, or development. All of these are essentially the same in that they use the principle of slow-scan television and differ only in the degree of sophistication and types of presentation. The principal systems considered are:

The Weather Bureau Radar-Telephone Transmission System (WB/RATTS) now under procurement by the Weather Bureau provides for slow-scan remoting of PPI displays updated so that no part of the display is more than two minutes old. It also provides for data insertion by the radar console operator to give interpretive information on echo heights, intensity, movement, etc.; and for data insertion on the receiving end to tailor the display to local needs. Each transmitter unit can support as many as eight receiving units and each receiving unit can handle as many as six displays (TV receivers). An optional receiving unit consisting of a single 7-inch PPI-type presentation is available when the receiving location requires only a single display.[2] The system provides for retaining or storing the remoted displays when it is necessary for the radar operator to go to a mode of operation other than normal PPI scan or when transmissions are interrupted for voice contact between the remote location and the radar console operator. Five gray levels provided by the system give good definition and resolution on standard TV receivers. Figure 8 shows the WB/RATTS remoting equipment.

A weather radar echo contouring device, termed "Video Integrator and Processor" (VIP), has been developed by ESSA-Weather Bureau. The VIP is intended for use with WSR–57 radars and provides for simultaneous display of six contours of echo intensity on the PPI scopes, including remote displays. The

[2] The Weather Bureau has begun a small development effort to modify a weather facsimile recorder to replace the entire slow-scan receiving unit. This modified facsimile recorder would have the advantage of lower initial cost and simpler, less expensive maintenance.



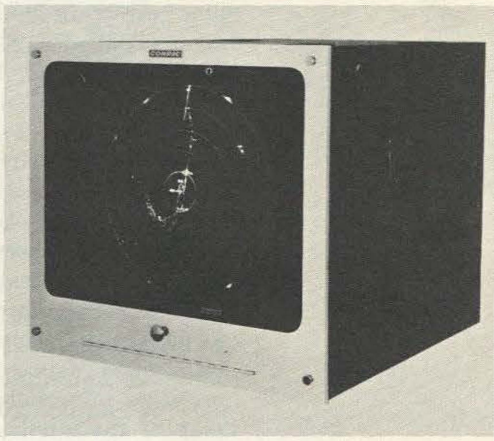


Figure 8. (Top left)—Receiver Unit for CCTV Displays. (Top right)—Direct View Receiver for Single Displays. (Left)—WB/RATTS–65 Slow Scan Transmitter Unit with operator manually inserting data. (Right), 21–inch CCTV Display Unit

Figure 9.—PPI presentation of a squall line with VIP echo intensity contouring.

calibrated contours of echo intensity add an important dimension to remote displays by providing current information on the intensity of all echoes without the need for time-consuming manual data insertion. Echo-intensity contour presentations use only white, one gray shade and black, thereby largely eliminating the dependence on gray scale separation for echo-intensity determinations. Figure 9 illustrates a PPI (or remote) presentation with VIP. Developmental models of the VIP have been in use for the past two years at the National Severe Storms Laboratory, Norman, Oklahoma. A prototype model has been installed on the Washington, D.C., WSR–57 radar for testing until July 1, 1967. If the tests establish that the equipment is suitable, the Weather Bureau plans to begin equipping its WSR–57 radars with VIP in FY 68. Priority will be given to radars supporting remote displays.

The FAA Slow-Scan Television System was intended to make essential weather radar information available to air traffic controllers with a minimum of additional interpretation and interference with controlling duties. It is similar in its basic performance characteristics to the Weather Bureau RATTS. The transmitted data consist of echo-intensity contours, plus interpretative information, and the presentation is a composite display of the weather radar data and air traffic information. An experimental installation from the WSR–57 weather radar at Washington National Airport to the FAA Air Route Traffic Control Center (ARTCC) at Leesburg, Va., was used to test the concept and system in 1965. The system did not prove completely satisfactory in comparison with its rather high costs. No further development is planned for this system.

Digital Remoting Systems

Digital remoting devices using narrow band circuits are in the developmental and evaluation stages at the present time and have no operational applications in this plan. They are discussed briefly, however, for background on potential developments in remoting systems.

The Air Force Storm Radar Data Processor (STRADAP) is an automatic processing system which converts echo location, and height and intensity information into digital format for transmission over narrow bandwidth circuits. It has been tested but is not presently programed for operational use. STRADAP was intended to provide inputs into a synoptic network.

The ESSA National Severe Storms Laboratory has a weather radar digital remoting system under development. It has passed feasibility tests and development is proceeding on automatic equipment to translate the echo information into digital format for long-line transmissions.

The Army has under development a digital presentation system for quantizing precipitation information which may be adaptable to remoting. It is currently undergoing preliminary testing and evaluation.

AIR TRAFFIC CONTROL RADAR EQUIPMENT

There are a number of types of search radars used for air traffic control and air defense. These radars were designed to do a very specialized job—detect aircraft. This specialization restricts or, in some types, completely negates their ability to provide meteorologically significant data. In general, these radars are deliberately designed to remove or subdue weather echoes and emphasize the aircraft targets they wish to detect and track. Some, however, may be operated in modes which allow useful meteorological data to be obtained.

The FAA operates two types of search radar for air traffic control. The ARSR series operating in the L-band (20 cm.) has a range of about 200–250 nautical miles with a fan-shaped beam about 1.3° wide in azimuth and 4–6° wide in elevation.

The ASR series operating in the S-band has a range of about 60 nautical miles with a fan-shaped beam similar to that of the ARSR series. In the normal mode of operation, weather echoes are intentionally subdued through use of circular polarization (CP) and moving target indicator (MTI) circuitry. With the circular polarization and moving target indicator features in operation, the stronger weather echoes appear on the PPI scopes and the weaker echoes are eliminated by the attenuation effects of these features. The circular polarization and moving target indicator features can be turned off and all detectable weather echoes displayed on the PPI scope. A limited, but useful, assessment of weather echo intensity can be made by comparing weather echoes displayed with these features turned on with those displayed when they are turned off. The usefulness of the radar for its primary purpose of tracking aircraft may be seriously degraded when circular polarization and moving target indicator features are not in use and aircraft target data must compete with weather echoes. It is used in this mode when air traffic is at a minimum and the traffic control displays can be degraded for the brief period necessary to make the weather radar observation. Heights of weather echoes cannot be determined by these radars since the elevation angle of the radar beam cannot be varied.

Current FAA thinking envisions use of the normal ARTCC radar presentation as the principal source of data on hazardous weather echoes. The stronger precipitation areas which "punch through" the CP and MTI attenuation will be presented in the ARTCC's to give location and estimates of intensity of the harder cores of storms.

The FAA has developed an arrangement, termed "Weather Channel CP Bypass" for making weather echoes from the ARSR series radars available in the ARTCC's. This system essentially bypasses the weather subduing features of the radar and transmits the resulting video information over a separate weather channel from the radar to the ARTCC. An installation of this type using the ARSR radar at Suitland, Md., transmitting to the Washington ARTCC at Leesburg, Va., has been tested. This system is intended as a follow-on option which can be added to the "punch through" data and thereby provide ARTCC's with a contoured display consisting of the approximate boundaries of precipitation areas and the harder cores within these areas. These techniques, if used, will be employed chiefly within the National Airspace System automatic (digital) systems.

The Air Force operates a number of long-range search radars as a part of the North American Air Defense Command. These radars have characteristics similar to those of the FAA air traffic control system and are capable of providing, under certain modes of operation, useful weather echoes. A joint-use policy which allows Weather Bureau personnel to operate in selected Air Defense Command radar sites to make observations under specified hazardous conditions (principally hurricanes) has been in effect for several years. As control of the Air Force long-range search radars becomes more automatic and frequency diversity comes into wide use, these radars will have decreasing usefulness for meteorological purposes.

The Army has a substantial number of air defense search radars which operate in the S-band or L-band. These radars, like the FAA and Air Force radars, are designed to eliminate as many weather echoes as possible. Most of the Army radars would require substantial modification to provide useful weather echo information; and, in general, these radars are located near large metropolitan areas or major military installations where weather radars already exist.

All of the long-range air traffic control and air defense search radars are limited to a significant degree by the following:

- Beam characteristics generally preclude anything more than a general PPI presentation of weather echoes. RHI and A/R scopes are not usually available.
- There is no manual control of azimuth (automatic rotation is the only mode of operation in most cases) and antennas are not tiltable for height of echo determinations.
- The radars do not have range normalization and other features essential to objective determination of echo characteristics.

In summary, long-range search radars of the FAA and Air Force can, under certain operating conditions, provide information on weather echo locations and useful estimates of echo in-

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tensity. Much of the information desirable for network or local uses cannot be provided due to the design features of the radars. The degree of usefulness of these radars in the western intermountain regions was determined in 1965 by a Weather Bureau/FAA test at Salt Lake City. This test concluded that operationally useful weather radar information could be obtained from PPI displays associated with the Salt Lake City ARTCC from air traffic control radars at seven locations in the States of Wyoming, Montana, Idaho, Nevada, and Utah. The information generated was found to be very useful to FAA controllers as well as providing an interim means of expanding some network-type functions into the intermountain region at minimum costs even though current operating practices preclude unrestricted synoptic use of these radars. Full-time synoptic use could be achieved, however, by use of the Weather Channel CP Bypass. This solution appears feasible in the western intermountain area where the air traffic density is relatively low, population centers are relatively small and dispersed, and the incidence of severe weather is relatively low.

II. REQUIREMENTS FOR WEATHER RADAR DATA

There are two general categories of requirements or uses for weather radar data. The first is "synoptic" and the second is "local." Each category places certain demands on the type of equipment as well as its location and mode of operation. These general categories are discussed in this section.

SYNOPTIC USE REQUIREMENTS

Synoptic use of weather radar data requires systematic observations by a network of radars for input to meteorological charts depicting the state of the atmosphere on the macroscale. The network of radars must provide accurate, quantitative measurement of meteorologically significant echoes in terms of azimuth, range, height, intensity, and positive identification of echoes indicative of severe storms to the maximum range necessary to provide complete area coverage. Studies have shown that operation of a radar for quantitative precipitation purposes is limited to a range of about 100 to 125 nautical miles. Therefore, the stations should be approximately 200 nautical miles apart in a pattern which provides maximum coverage for all areas with a minimum of radars. In regions where high rainfall rates occur, the network radars should operate in the S-band; and in regions where heavy rains rarely occur and precipitation attenuation is not a problem, a radar which operates in the C-band is preferable. Both must have beam width characteristics, sensitivity, power and other capabilities necessary to detect precipitation falling at a rate of 0.01 in./hr. or more to a range of about 100 nautical miles.[3]

Weather radar observations for synoptic use are required hourly on a scheduled basis when precipitation is observed within the assigned area of responsibility. Observations are required more frequently under certain conditions related to severe storms or rapidly changing weather situations. Equipment must be maintained and operated so as to ensure the integrity and compatibility of data. Observations must convey the same values of meteorological parameters regardless of equipment, season, or location.

Synoptic weather radar observations are collected, analyzed, and composited hourly to provide inputs to the preparation of conventional weather maps and forecasts. Composite weather radar charts for those parts of the United States having weather radar coverage are currently prepared on an hourly basis by the Weather Bureau in Kansas City, Mo., and are transmitted on a three-hourly basis by facsimile to Weather Bureau, FAA, Air Force, and Navy local weather offices to support analysis, forecasting, and briefing beyond the range of local radars. Facsimile transmissions of these charts have been requested on an hourly basis by the Air Force, Navy, NASA, and FAA. Availability of transmission time on the National Facsimile Circuit is the principal obstacle to transmitting these charts on an hourly basis. A

[3] See Appendix II for characteristics of current weather radars and desired characteristics of an ideal network radar. Research has just begun on the use of doppler techniques in association with the more conventional surveillance techniques. Results of this research may indicate that S-band radars are necessary to take full advantage of the doppler measurements in identifying the character and intensity of echoes.

survey of National Facsimile Circuit users will be made in 1967 to determine requirements and priorities for products, including weather radar composite charts, on the system.

Synoptic use of weather radar in mountainous areas places unusual requirements on both the weather radar equipment and the installation. Terrain features usually require that radar antennas be installed on mountain peaks in order to give a reasonably unrestricted horizon. These installations are frequently very costly since the radar must be operated by remote control from the operating console and the site may require new roads and power lines. In addition, beam width characteristics of radars used in mountainous areas should be as narrow as feasible to reduce the ground clutter effect of the irregular terrain.

LOCAL USE REQUIREMENTS

Weather radar coverage of the local area is intended to provide information upon which the weather service office, civil or military, can base short-period forecasts and warnings for the immediate areas of responsibility. Local uses also include current information on the location of hazardous flying conditions for use in flight planning, relay to airborne aircraft, and by FAA controllers handling air traffic operations in the terminal area.

In general terms, the agencies have indicated a requirement for weather radar coverage of the local area for most weather service offices. The requirement is not the same at all locations. Therefore, some agencies have established general criteria and priorities for providing local weather radar coverage for specific locations while other agencies consider each requirement individually. Briefly, the agency criteria or policies are:

ESSA—Weather Bureau

There is a requirement for weather radar data at all first-order stations. Highest priority has been assigned to stations meeting the following criteria:

- Metropolitan areas having a population in excess of 250,000.
- The most important metropolitan area in each state subject to severe storms for which weather radar-based warnings would save life and property.
- Airports with instrument landing systems at which instrument operations (arrivals plus departures) exceed 30,000 annually, and thunderstorms are expected on at least 40 days annually.
- Locations or areas susceptible to damage by floods and flash floods.
- Locations or areas having a high incidence of lightning-caused forest fires.

Air Force

Weather radar data for local uses are required at all Air Force and most Army airfields. Priorities for meeting these requirements are:

Priority 1: Locations with over 35 days of Radar Detectable Weather (RDW) per year.[4]

Priority 1A:
Locations more than 70 miles from a major weather radar.
Order of Priority by number of RDW days.

Priority 1B:
Locations with 5,000 sorties (individual aircraft flights) or more per month.
Order of Priority by number of RDW days.

Priority 1C:
Base mission priority as established by Headquarters, U. S. Air Force.
Order of Priority by number of RDW days.

Priority 2: Locations with 35 days or less of RDW per year.

Priority 2A:
Locations more than 70 miles from a major weather radar.
Order of Priority by number of RDW days.

Priority 2B:
Locations with 5,000 sorties or more per month.

[4] RDW is number of thunderstorm days per year plus 10% of the number of days with precipitation.

Order of Priority by number of RDW days.

Priority 2C:

Base mission priority.

Order of Priority by number of RDW days.

Navy

The Navy uses weather radar data for local use purposes in support of its aircraft safety programs and requires weather radar data in Navy forecast offices in areas where the frequency of occurrence of radar detectable weather (RDW) is a safety factor. These requirements can be met by local use radars (C-band), remote displays or radar data on teletypewriter and facsimile—depending on mission—distance from a remotable radar, and frequency of RDW.

FAA

The FAA requires weather radar data for the local area for use by Flight Service Station personnel in pilot weather briefings and by controllers assigning altitudes, establishing holding patterns, and exercising separation standards in approach zones around major air terminals. The FAA also requires weather radar data for the airways under control of an ARTCC.

NASA

Weather radar data are required for local uses by NASA in conjunction with its programs. Since some NASA programs are carried on at NASA facilities and others are carried on at facilities operated by other agencies, weather radar data sources are varied. Weather radar data are obtained from other agencies whenever possible, and in some cases search radars or other special-purpose radars are used to provide necessary information. In general, the requirements of the Manned Spaceflight Program are the more demanding of NASA needs and include a small facsimile network to transmit PPI photographs from Tampa and Daytona Beach to Miami and Cape Kennedy, Fla.

Army

The Army has a requirement for local use weather radar data at certain of its research and development facilities. This requirement is usually met by use of R&D models of weather radars or by use of other special-purpose radars at the particular facility. Army requirements for weather radar data at its major airfields are fulfilled in most cases by Air Force programs.

Private Users of Weather Radar Data

Private sectors of the economy have used weather radar data for a number of years. These users include television stations, industrial and research and development corporations, universities, and private meteorologists.

A number of television stations located in the southern and midwestern states have installed small weather radars as a supplement to their "weather" programing. Some stations have obtained remote PPI displays from Weather Bureau radars and many more stations are expected to add these remoted displays as the newer slow-scan equipment comes into greater use.[5]

Corporations engaged in weather-sensitive operations have used weather radar data for some time. There is no specific information readily available on the number of weather radars involved in this area; however, there are sets at several locations along the coasts of the Atlantic Ocean and Gulf of Mexico and in the midwestern states.

Most of the universities with atmospheric sciences programs have weather radars to support their research activities and for use in their student courses. The full extent of this equipping is not precisely known, but at least six modern weather radars are operated by universities alone or in conjunction with other private or governmental programs.

Industrial and private meteorologists are finding weather radar to be a valuable input to their operations. In general, they are unable to afford the initial investment and annual maintenance costs for their own radars. They are, however, showing a growing interest in the new slow-scan remoting systems which will bring these data to them at reasonable costs.

[5] These systems, with their data insertion features, offer a new and quite promising means of quickly and effectively communicating weather warnings and alerts to the public. The Weather Bureau, in its Circular Letter 4–65, has provided for agreements and licensing of radar remotes for nongovernment agencies and offices.

III. OPERATIONAL CONCEPTS

Requirements for weather radar data specified in Section II may be met by use of a weather radar at the location requiring the data. Under certain conditions it is possible to meet local use requirements by use of a remote display from a weather radar some distance away. Determination of the method to be used in meeting any specific requirement necessitates an evaluation of what data must be provided against costs of the various means of providing it.

SYNOPTIC WEATHER RADAR

Synoptic weather radar data are presently obtained by operators working at the radar console with direct access to the radar controls to make the quantitative measurements and detailed echo examinations necessary for synoptic uses. Current state-of-the-art remote displays are not adequate for observing, collecting, processing, or compositing data for synoptic purposes. Development of automated systems to perform these functions is receiving considerable priority. The outlook is bright for radical improvements in this area within the next few years.

The WSR–57, or similar S-band radar, is the primary radar for the synoptic network. Radars of the AN/FPS–68, 77, and 81, or similar types of C-band radars, are preferable substitutes for the S-band radars in the intermountain area west of about 105°W and in the area north of 45°N. The AN/CPS–9 and other similar types of X-band radars are limited to interim use as network radars in all areas because of precipitation attenuation and other shortcomings related to lack of capability for objective determination of echo intensity.

LOCAL USE WEATHER RADAR

Weather radar data for local uses have traditionally been supplied by sets owned by the agency and operated at the location requiring the data. In a very few instances, agencies agreed to use remote displays from another agency's radar. This general absence of remoting was due to the cost of microwave or coaxial cable systems, lack of height and intensity data in the remote display, loss of effective remote display when the radar was not on normal PPI scan, little or no user control over what was displayed, and the unwieldy or unsatisfactory administrative arrangements for managing these joint endeavors. The state-of-the-art of remote weather radar displays has now advanced to a point where it is technically feasible to provide a remote PPI display with analyzed information on intensities, heights, and movements at costs substantially below that of individual weather radars. Problems related to direct access to the radar console to "control" the set at all times have been greatly reduced since the slow-scan systems "freeze" the remote display when the radar is used for sector-scanning, height determinations, and other similar functions necessary for network or local uses. Agencies have agreed that standard procedures for operating radars supporting remotes will be made a part of the interagency manual governing weather radar observations.

Remote displays can meet local use requirements when the following criteria are met:

- The prime weather radar should be an S-band of the type WSR–57. C-band radars of the type AN/FPS–68, 77, and 81 are acceptable substitutes in most cases; X-band radars of the AN/CPS–9 type should be used only on an interim basis until they can be replaced by an acceptable S- or C-band radar.
- Remoting as far as 75–85 miles is feasible from WSR–57 type radars. Remoting as far as 50 miles is feasible from C- and X-band radars. Each remoting case must be considered individually to assure effective weather radar coverage at least 50 miles around the office having the remote display.[6]
- The weather radar must be maintained, calibrated, and operated at a high level of performance in accordance with established interdepartmental instructions. Standby

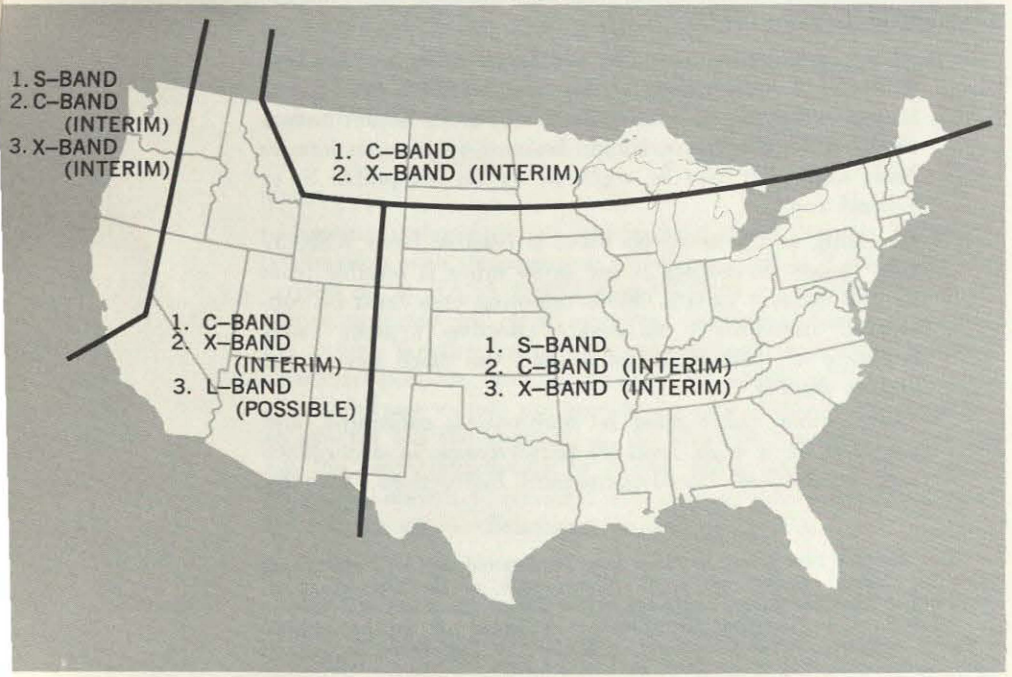
[6] The distance over which a radar may be remoted and still provide an effective display depends on many factors such as the type of radar, intervening terrain features and relative location of the radar, and remotes in relation to predominant direction of movement of weather echoes. Feasible remoting distances should, therefore, be considered as general guidelines.

power for the radar and remote system transmitter should be available.

- An adequate staff must be available at the prime radar to provide for interpretation of weather echoes to include intensity, height, and velocity; preparation of inserted data; and response to special queries and requests for assistance 24 hours per day.
- The mission, functions, and investment in weather-sensitive equipment at the remoted location may be considered in a few unique cases.

Figure 10

ORDER OF SUITABILITY OF RADARS FOR SYNOPTIC NETWORK USES



METHOD OF MEETING REQUIREMENTS

The method of meeting requirements for synoptic and local weather radar data is discussed in the following paragraphs.

Synoptic Use

This plan is based on a network of weather radars to provide general synoptic data and meet as many local use requirements as possible. The network will be installed and operated by the Weather Bureau as an integral part of the U. S. basic meteorological services system when feasible from the standpoint of efficiency and economy in use of resources. Exceptions to this general rule occur in a number of locations where another agency previously installed, or is now installing, a weather radar to meet its own priority local requirements. The Synoptic Weather Radar Network is, therefore, a joint endeavor and the weather radars contained in it will change from year to year as the participating agencies add modern weather radars suitable for network uses and obsolete or unsuitable radars are decommissioned or returned to the purely local uses for which they were designed and installed.

The network can be developed most effectively and efficiently by completing the partial network of S-band radars (WSR–57 or AN/FPS–41) operated by the Weather Bureau and Navy in those areas requiring S-band radars. C-band radars (AN/FPS–68, 77, or 81) should be used where possible to fill gaps in the network, with X-band radars (AN/CPS–9) employed on an interim basis. Figure 10 shows these areas and order of suitability of radars in each. The agencies agree that weather radars in the synoptic network must be maintained, calibrated, and operated in accord with national standards to assure accuracy and integrity of the observations. This requires a sufficient complement of trained personnel for each network radar to assure 24-hour coverage of significant weather events.[7]

[7] Agency standards vary in regard to training and manning. This is due primarily to different concepts. ESSA-Weather Bureau looks to its network radars as a prime observing facility serving many users. Accordingly, it gives its operators extensive training and provides for 24-hour, 7-day per week coverage. The other agencies view their weather radars as data sources for local uses and do not provide the same level of training or manning. Network radars must have an adequate staff with standby power and communications necessary to assure effective operation during severe weather conditions.

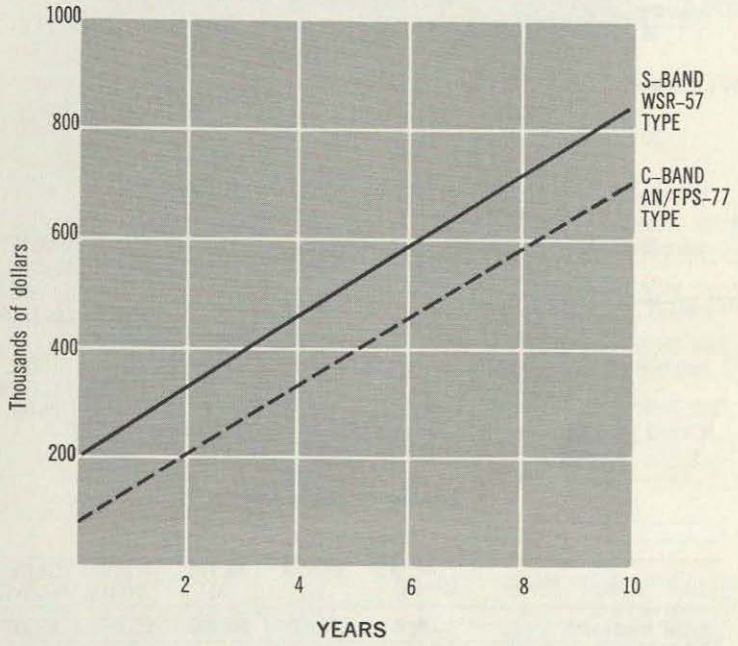
The value of a network of synoptic weather radars from the Rocky Mountain Range westward to the Sierra Nevada-Cascade Mountain Ranges has not been clearly established in relationship to the high costs of developing and operating these radars and the use of substitute sources such as weather satellites and radars of the air traffic control system. The previously referenced test at Salt Lake City, Utah, established the feasibility of using the remoted air traffic control radar displays to obtain some useful synoptic weather radar data. The Weather Bureau initiated a limited synoptic program at the Salt Lake City ARTCC in FY 66 and plans to expand it in FY 68 to a full-period synoptic program. No actions should be taken toward a synoptic weather radar network in the western intermountain area until this program has been fully evaluated and the cost/benefit aspects of a synoptic weather radar network determined in comparison with use of the remoted air traffic control radars.

Appendix III presents a synoptic weather radar network for the 48 conterminous States. The network changes from year to year as modern weather radars are added and obsolete or local use radars are replaced. The network contains a number of Air Force and Navy radars. Some of these military radars are included on a permanent basis and others are only interim until a more suitable and effective Weather Bureau radar can be obtained and placed in operation. In the case of Navy radars at NAS Brunswick, Maine, NAS Quonset Point, R. I., and NAS Memphis, Tenn., the Weather Bureau has accepted the Navy position that these radars constitute a basic service and is taking budgetary actions to relocate, maintain, and operate these sets. In the intervening period, the Navy will be unable to participate in network functions at these locations due to shortages in operator and maintenance personnel.

Figure 11 compares costs of providing synoptic weather radar network coverage by S-band and C-band radars. This chart shows that the principal long-term costs are associated with annual operating and maintenance costs (personnel). In this respect, the 10-year cost differential between the two types of radars is $145,000 or $14,500 per year, mainly attributable to the differences in initial investments. The superior network capabilities of

Figure 11

TYPICAL CUMULATIVE COSTS FOR PROVIDING SYNOPTIC NETWORK WEATHER RADAR DATA



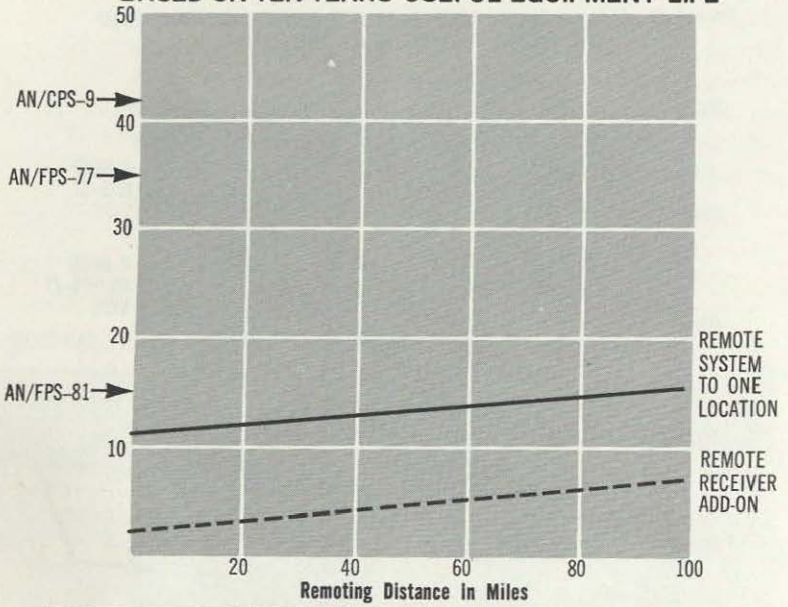
1. Nominal costs computed from:

a. S–BAND WSR–57	Purchase and Install	$200,000
	Annual Operation & Maintenance (O&M)	$ 65,000
b. C–BAND AN/FPS–77	Purchase and Install	$ 75,000
	Annual Operation & Maintenance (O&M)	$ 63,000

2. Annual O&M costs reflect Weather Bureau mode of operation and includes 1 technician and 5 operators for both types of radar, as well as estimated spare parts and related costs.

Figure 12

TYPICAL ANNUAL COSTS FOR PROVIDING LOCAL USE WEATHER RADAR DATA BASED ON TEN YEARS USEFUL EQUIPMENT LIFE



Cost Factors

	AN/CPS 9	AN/FPS 77	AN/FPS 81	REMOTE* SYSTEM	REMOTE** RECEIVER
Initial Investment	N/A	$75,000	$80,000	$27,000	$9,900
Annual Operations & Maintenance	$42,000	$27,000	$ 7,000	$ 8,000	$1,000
Remoting Circuit Costs/Mile	N/A	N/A	N/A	$42	$42

* WB/RATTS-65 System. Annual costs include 0.5 technician and spares.
** WB/RATTS-65 Receiver added to system. Annual costs include only spares.

Annual Costs computed from:

$$\text{Radars} = \frac{\text{Initial Investment}}{10} + \text{Annual Costs}$$

$$\text{Remotes} = \frac{\text{Initial Investment}}{10} + \text{Annual Costs} + \$42.00 \text{ per mile remoted}$$

the S-band radar, in most cases, warrant this increase in initial investment costs and modest increase in annual operational costs.

Local Uses

Requirements for weather radar data for local uses can be met by relatively low-cost radars or by remote displays from C- or S-band radars.[8] Figures 12 and 13 show that it is always less expensive from the aspects of capital investment and annual operating and maintenance costs to meet new local use requirements by means of slow-scan television remote displays to the effective remoting limits. These figures also show that, in some cases, it is more economical to decommission an existing radar and substitute a remote display.

Redundant coverage by a local use weather radar may, in certain locations, be a desirable situation to provide back-up support to the Synoptic Weather Radar Network. In other cases, agencies have indicated that the nature of the local requirement is such that the weather radar set must be located with and completely controlled by the local weather service office; economy of operation becomes secondary in such cases. Remote displays should be used to meet local use requirements in all cases where there is a suitable radar existing or planned within effective remoting distances, and the local requirement does not uniquely demand a separate local use radar.

The question of the most effective and efficient course of action in cases of two or more existing weather radars giving redundant coverage has no easy answer. Economy of operation points toward substitution of remote displays wherever feasible; but, this requires additional agency funds to buy and install the remote displays, and the weather radar then represents a resource for which the agency (or perhaps even the Federal Government) may have no need. The best approach to this problem is to avoid further cases and:

- Substitute remote displays as the radars become obsolete or uneconomical to maintain.

[8] In certain, unique cases, local use requirements can be met by use of weather radar data from teletypewriter and facsimile circuits.

- Substitute remote displays when the radar could be moved to meet a nonremotable Federal requirement at another location in the U.S. or overseas.

Locations requiring weather radar coverage which are considered to be feasible for remoting from a nearby radar are reflected in the Federal Plan presented in Section V. There are a few locations not recommended for remoting even though they meet the general remoting criteria presented earlier. These locations are listed in Appendix I together with the reasons for not recommending remoting.

IV. WEATHER RADAR RESOURCES

Agency requirements for synoptic and local use weather radar data have been stated and general concepts for meeting these requirements have been outlined in previous sections. This section summarizes current national weather radar and remote display resources reflected in this Plan and presents agency programs for adding to these resources to meet stated requirements. The information presented is a summary of the agency programs by fiscal years. Complete agency programs for both radars and remote displays by location and fiscal year are contained in Section V. As of the writing of this Plan, funds have not yet been programed by the Department of Defense for procurement of remote display receivers and transmitters as indicated.

FY 67 RESOURCES

Agencies of the Federal government had the following modern weather radar resources for meteorological services purposes in the 48 conterminous States in FY 67:

ESSA—Weather Bureau

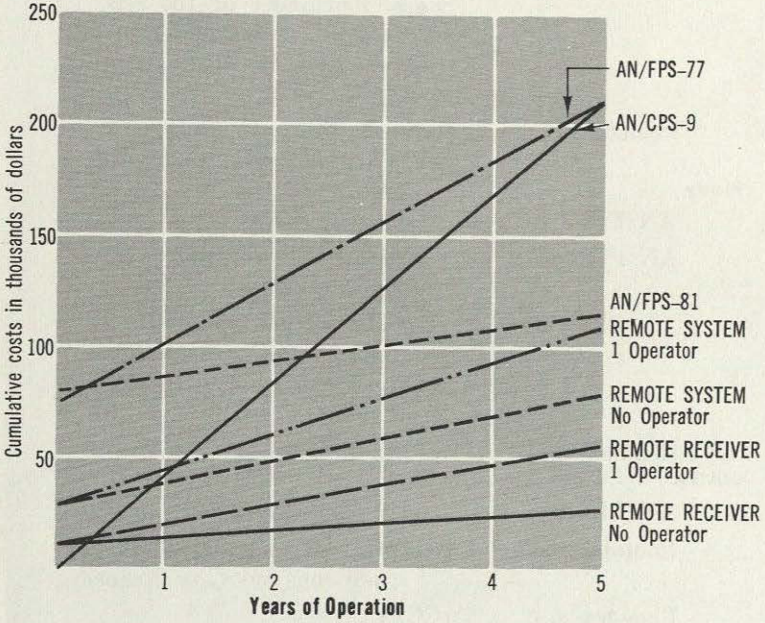
WSR–57	44 (Does not include 1 training)
Remotes	15 Installed (various types); 32 additional RATTS programed

Air Force

AN/CPS–9	32 (2 base closings scheduled in FY 67)

Figure 13

COMPARISON OF COSTS OF PROVIDING LOCAL WEATHER RADAR DATA



Cost Factors

	AN/CPS–9	AN/FPS 77	AN/FPS 81	REMOTE* SYSTEM	REMOTE* RECEIVER
Initial Investment	0	75,000	80,000	27,000	9,900
Annual Maintenance	29,000	20,500	**7,000	8,000	1,000
Annual Operations (2 Operators)	13,000	N/A	N/A	N/A	N/A
Annual Operations (1 Operator)	N/A	6,500	N/A	6,500	6,500
Annual Operations (No Operator)	N/A	N/A	0	0	0
Annual Circuit Lease (50 Mi.)	N/A	N/A	N/A	2,100	2,100
Annual Total (2 Operators)	42,000	N/A	N/A	N/A	N/A
Annual Total (1 Operator)	N/A	27,000	N/A	16,600	9,600
Annual Total (No Operator)	N/A	N/A	7,000	10,100	3,100

* Remoted 50 miles by WB/RATTS–65
** Includes Operations Costs.

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AIR FORCE—continued

AN/FPS–77	73	(Does not include 6 for training and 5 for Maintenance Shops. Remainder of 105 sets procured will be installed overseas or held in contingency stock.)
Remotes	3	Installed (various types); 2 RATTS programed

Navy

AN/FPS–41	6	
AN/FPS–68	4	(Includes 1 programed for relocation overseas)
AN/FPS–81	13	(Includes 3 not installed; 2 programed for relocation overseas and 1 scheduled for procurement)
Remotes	5	RATTS programed

NASA

AN/CPS–9	1	
Photofacsimile	1	Network (Daytona Beach-Tampa-Miami and Cape Kennedy)
Remotes	1	(CCTV)

FAA

Remotes	28	(Various types)

FY 68 CHANGES

ESSA—Weather Bureau

WSR–57M	3	Additional
AN/FPS–41	4	Transferred from Navy
Remotes	8	Additional

Air Force

AN/CPS–9	15	Decommissioned (base closings and AN/FPS–77 replacement)
Remotes	8	Additional

Navy

AN/FPS–41	4	Transferred to Weather Bureau
AN/FPS–81	1	Relocated overseas
Remotes	11	Additional

FY 69 CHANGES

ESSA—Weather Bureau

WSR–57M	2	Additional
Remotes	2	

Air Force

AN/CPS–9	13	Decommissioned (AN/FPS–77 and remote replacement)
Remotes	1	Additional

Navy

AN/FPS–68	1	Decommissioned (replaced by relocated AN/FPS–81)
AN/FPS–81	2	Additional (spares)
Remotes	2	Additional

FAA

Remotes	14	Additional

FY 70 AND 71 CHANGES

ESSA—Weather Bureau

WSR–57M	3	Additional
Remotes	59	Additional

Air Force

AN/CPS–9	2	Decommissioned (base closing and remote replacement)
Remotes	8	Additional

Navy

AN/FPS–68	1	Relocated overseas
Remotes	4	Additional

Army

Remotes 2 Additional

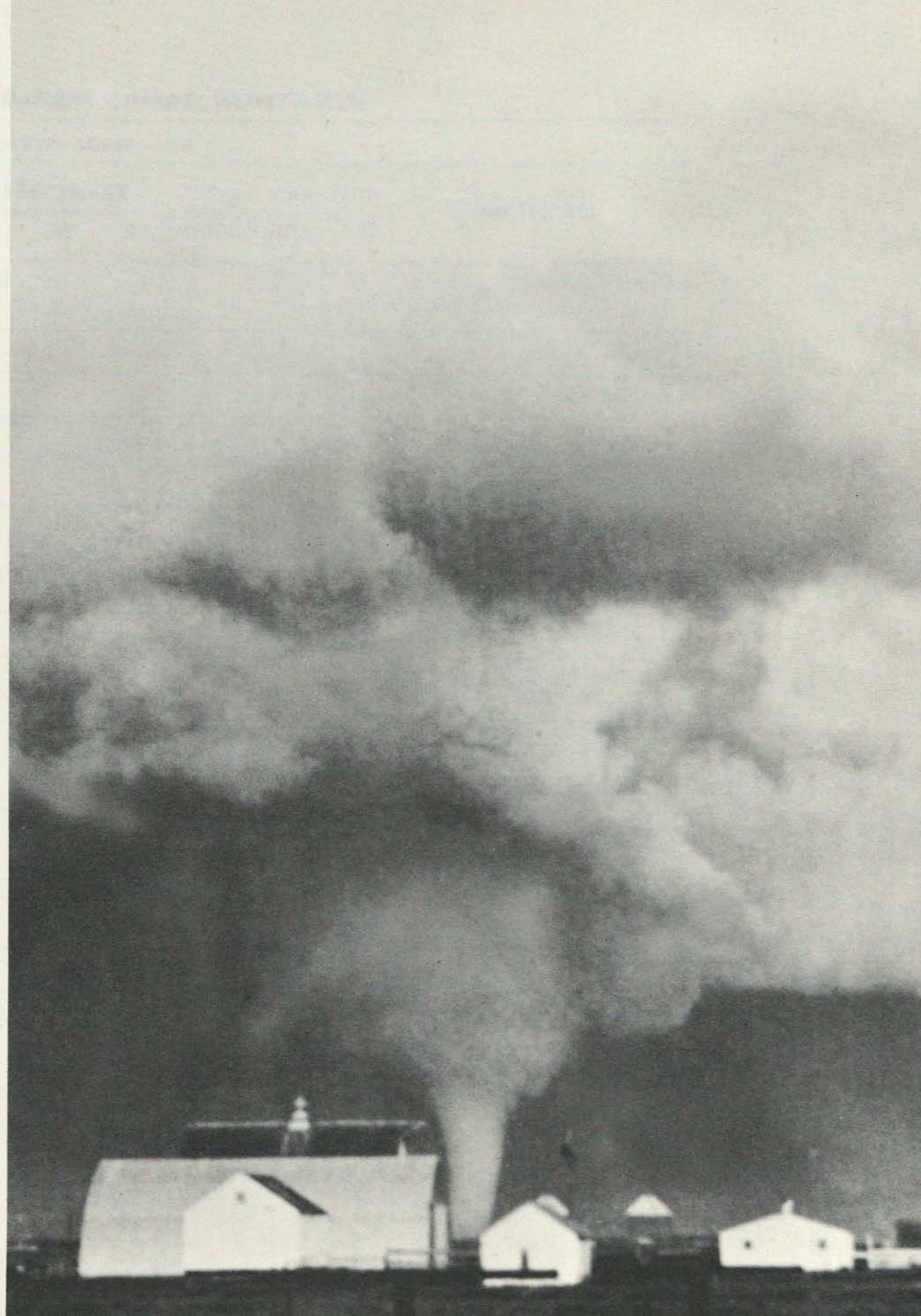
FAA

Remotes 50 Additional

V. FEDERAL PLAN FOR WEATHER RADARS AND REMOTE DISPLAYS THROUGH FY 1971

The following symbols and abbreviations are used throughout this section:

B— Buy
C— Coaxial Cable Remote
F— Facsimile
I— Install
M— Microwave Remote
O— Operational
P— Under Procurement
R— Relocate
S— Slow-Scan Remote
AFB— Air Force Base
NAS— Naval Air Station
NAF— Naval Air Facility
WBO— Weather Bureau Office
CCTV— Closed-Circuit Television
MCAF— Marine Corps Air Facility
MCAS— Marine Corps Air Station
NAAF— Naval Auxiliary Air Facility
NAAS— Naval Auxiliary Air Station
WBAS— Weather Bureau Airport Station
9— AN/CPS–9 Radar
41— AN/FPS–41 Radar
57— WSR–57 Radar
68— AN/FPS–68 Radar
77— AN/FPS–77 Radar
81— AN/FPS–81 Radar



WEATHER RADAR REQUIREMENTS AND PROGRAMS

ESSA—WEATHER BUREAU

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Olympia, Wash.	X	X				B57		IO	WB	S to Seattle, Astoria, and Paine AFB.
Seattle, Wash.		X					BS	IO		S to WBAS from 57 at Olympia.
Astoria, Oreg.		X					BS	IO		S to WBAS from 57 at Olympia.
Corvallis, Oreg.	X	X					B57	IO	WB	S to Salem, Eugene, and Portland.
Eugene, Oreg.		X						BS		S to WBAS from 57 at Corvallis.
Medford, Oreg.	X	X			B57		IO			77 at Kingsley AFB in Network until FY 70.
Portland, Oreg.		X					BS			S to WBAS from 57 at Corvallis.
Salem, Oreg.		X					BS			S to WBAS from 57 at Corvallis.
Catalina Island, Calif.	X	X	57							F to WBAS Los Angeles.
Los Angeles, Calif.		X	F							F to WBAS from 57 at Catalina Island.
Oakland, Calif.		X					BS	IO		S from 57 at Sacramento.
Sacramento, Calif.	X	X	57						WB	S to Oakland and San Francisco. S to Beale, McClellan, Mather, and Travis AFB.
San Francisco, Calif.		X	F				BS	IO		F to WBAS from 57 at Sacramento. S from Sacramento FY 71.
Phoenix, Ariz.	X	X						BS	WB	77 at Luke AFB in Network. S to WBAS.
Tucson, Ariz.	X	X						BS	WB	77 at Davis-Monthan AFB in Network. S to WBAS.
Las Vegas, Nev.	X	X						BS	WB	77 at Nellis AFB in Network.

WEATHER RADAR REQUIREMENTS AND PROGRAMS—continued

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Salt Lake City, Utah	X	X								77 at Hill AFB in Network. ARTCC Radar Remotes used for limited network data.
Great Falls, Mont.	X	X	M							9 (77) at Malmstrom AFB in Network. M to WBAS.
Helena, Mont.		X						BS		S to WBAS from 57 at Missoula.
Missoula, Mont.	X	X	57						WB	C to Forest Service; S to Helena.
Cheyenne, Wyo.	X	X						BS	WB	77 at F. E. Warren AFB in Network. S to WBAS.
Colorado Springs, Colo.	X	X						BS	WB	S to WBAS from 77 at Peterson Field; Network requirement by 77 until FY 70.
Denver, Colo.	X	X		BS	B57		IO IO		WB	S to WBAS Denver and Buckley AFB.
Albuquerque, N. Mex.	X	X	S		IO				WB	77 at Kirtland AFB in Network; S to WBAS. Equipment on hand, not installed.
Amarillo, Tex.	X	X	57							C to AF at Amarillo AFB.
Austin, Tex.		X		BS		IO				S to WBAS from 57 at San Antonio.
Brownsville, Tex.	X	X	57							
Corpus Christi, Tex.		X		BS		IO			WB	S to WBAS from 81 at Corpus Christi NAS.
Dallas, Tex.		X	M				BS			S to WBAS from 57 at Fort Worth replaces M.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES. EQUIP.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.		67	68	69	70	71		
Del Rio, Tex.	X	X						BS	WB	77 at Laughlin AFB in Network. S to WBAS.
Fort Worth, Tex.	X	X	57						WB	M to WBAS Dallas replaced by S to Dallas and Waco. S to NAS Dallas and Carswell AFB.
Galveston, Tex.	X	X	57						WB	S to Port Arthur, Houston, and Ellington AFB.
Houston, Tex.		X	S							S to WBAS from 57 at Galveston.
Laredo, Tex.		X						BS	WB	S to WBAS from 77 at Laredo AFB.
Midland, Tex.	X	X		B57 BS			IO IO		WB	77 at Webb AFB in Network until FY 70. S to WBAS from radar site east of Midland. S to WBAS San Angelo.
Port Arthur, Tex.		X	S	IO						S to WBAS from 57 at Galveston.
San Antonio, Tex.	X	X		B57 BS		IO IO			WB	9 at Kelly AFB in Network until FY 69. S to WBAS San Antonio, Austin, and Kelly AFB.
San Angelo, Tex.		X		BS			IO			S to WBAS from 57 near Midland.
Waco, Tex.		X						BS		S to WBAS from 57 at Fort Worth.
Oklahoma City, Okla.	X	X	57						AF	S to Tinker AFB.
Dodge City, Kans.		X		BS			IO			S to WBAS from 57 at Garden City.
Garden City, Kans.	X	X		B57			IO		WB	S to Dodge City.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Topeka, Kans.		X		BS		IO				S to WBAS from 57 at Kansas City.
Wichita, Kans.	X	X	57							
Grand Island, Nebr.	X	X		B57		IO				9 (77) at Offutt AFB in Network until FY 69.
Scottsbluff, Nebr.		X						BS	WB	S to WBAS from 77 at F. E. Warren AFB.
Aberdeen, S. Dak.		X				BS	IO			S to WBAS from 57 at Huron.
Huron, S. Dak.	X	X				B57	IO		WB	S to Sioux Falls and Aberdeen.
Rapid City, S. Dak.	X	X	S		IO				WB	9 (77) at Ellsworth AFB in Network; S to WBAS.
Sioux Falls, S. Dak.		X				BS	IO			S to WBAS from 57 at Huron.
Grand Forks, N. Dak.	X				BS	IO			WB	77 at Grand Forks AFB in Network. S to WBAS Fargo.
Fargo, N. Dak.		X			BS	IO			WB	S to WBAS from 77 at Grand Forks AFB.
Minot, N. Dak.	X	X						BS	WB	9 (77) at Minot AFB in Network. S to WBAS.
Boothville, La.	X	X		R57					WB	S to WBO and WBAS New Orleans.
Lake Charles, La.	X	X	57							
New Orleans, La.		X	57	R57 BS		IO				R 57 to Boothville, La., FY 67. S to WBO and WBAS from 57 at Boothville.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Little Rock, Ark.		X	57					R57 BSIO		Relocate to Prescott for satisfactory site. S to WBAS Little Rock and Texarkana.
Prescott, Ark.	X	X						R57	WB	S to Little Rock and Texarkana. 9 (77) at Barksdale AFB in Network until FY 71.
Texarkana, Ark.		X						BS		S to WBAS from 57 at Prescott.
Kansas City, Mo.	X	X	57						WB	S to Topeka, NAS Olathe, and Whiteman AFB.
St. Louis, Mo.	X	X	57						WB	S to Springfield, Ill.
Springfield, Mo.	X	X		B57			IO			
Des Moines, Iowa	X	X	57						WB	S to Waterloo.
Waterloo, Iowa		X						BS		S to WBAS from 57 at Des Moines.
Duluth, Minn.	X	X						BS	WB	77 at Duluth AFB in Network. S to WBAS.
Minneapolis, Minn.	X	X	57						WB	S to St. Cloud, Rochester, and NAS Twin Cities.
Rochester, Minn.		X						BS		S to WBAS from 57 at Minneapolis.
St. Cloud, Minn.		X						BS		S to WBAS from 57 at Minneapolis.
Jackson, Miss.	X	X	57		IO57				WB	S to Vicksburg and Meridian.
Meridian, Miss.		X		BS		IO				S to WBAS from 57 at Jackson.
Vicksburg, Miss.		X						BS		S to WBAS from 57 at Jackson.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES. EQUIP.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.		67	68	69	70	71		
Birmingham, Ala. (Tuscaloosa)	X	X		B57 BS		IO57 IO			WB	9 at Maxwell in Network until FY 69. S to WBAS Birmingham, Montgomery, and Maxwell AFB from radar site near Tuscaloosa.
Huntsville, Ala.		X						BS		S to WBAS from 57 at Nashville.
Mobile, Ala.		X		BS		IO			USN	S to WBAS from 41 at Pensacola NAS.
Montgomery, Ala.		X		BS		IO				S to WBAS from 57 at Birmingham.
Bristol, Tenn.	X	X		B57			IO		WB	S to Knoxville and Asheville.
Knoxville, Tenn.		X			BS	IO				S to WBAS from 57 at Nashville.
Knoxville, Tenn.		X					BS	IO		S to WBAS from 57 at Bristol.
Memphis, Tenn.	X	X		BS	041 IO	R41			USN	41 transfers to WB FY 68 and relocates. S to WBAS, NAS Memphis and Blytheville AFB.
Nashville, Tenn.	X	X		B57 BS		IO IO			WB	S to WBAS Nashville, Knoxville, and Huntsville. 9 at Sewart AFB in Network until FY 69.
Chicago, Ill.	X	X	57	BS		IO	R57		WB	S to WBO and WBAS Chicago, Peoria, Rockford, and NAS Glenview. Relocate 57 to site southwest of Chicago in FY 70.
Peoria, Ill.		X		BS		IO				S to WBAS from 57 at Chicago.
Springfield, Ill.		X					BS	IO		S to WBAS from 57 at St. Louis.
Rockford, Ill.		X		BS		IO				S to WBAS from 57 at Chicago.

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ESSA —WEATHER BUREAU—continued

LOCATION	Requirement		PRES. EQUIP.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.		67	68	69	70	71		
Louisville, Ky.		X					BS	IO		S to WBAS from 57 at Evansville.
Lexington, Ky.		X		BS		IO				S to WBAS from 57 at Cincinnati.
Evansville, Ind.	X	X	57						WB	S to Louisville.
Indianapolis, Ind.		X						BS		S to WBAS from 57 at Cincinnati.
Canton-Akron, Ohio		X						BS		S to WBAS from 57 at Pittsburgh.
Cincinnati, Ohio	X	X	57 M	BS					WB	M to WBO replaced by S; S to Dayton, Indianapolis, Columbus, Lexington, and Wright-Patterson AFB.
Cleveland, Ohio		X					BS	IO		S to WBAS from 57 at Detroit.
Columbus, Ohio		X						BS		S to WBAS from 57 at Cincinnati.
Dayton, Ohio		X		BS		IO				S to WBAS from 57 at Cincinnati.
Toledo, Ohio		X	S							S to WBAS from 57 at Detroit.
Youngstown, Ohio		X						BS		S to WBAS from 57 at Pittsburgh.
Green Bay, Wis.	X	X		BS	B57		IO IO		WB	S to WBAS Green Bay, Milwaukee, and Madison from radar site south of Green Bay.
Milwaukee, Wis.		X		BS			IO			S to WBAS from 57 at Green Bay.
Madison, Wis.		X		BS			IO			S to WBAS from 57 at Green Bay.
Detroit, Mich.	X	X	57 S						WB	S to Lansing, Flint, Cleveland, Toledo, NAS Grosse Ille (when moved to Selfridge AFB), and Selfridge AFB.
Flint, Mich.		X		BS		IO				S to WBAS from 57 at Detroit.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Houghton Lake, Mich.	X	X						BS	WB	77 at Wurtsmith AFB in Network. S to WBAS.
Lansing, Mich.		X		BS		IO				S to WBAS from 57 at Detroit.
Marquette, Mich.	X	X						BS	WB	77 at K. I. Sawyer AFB in Network. S to WBAS.
Apalachicola, Fla.	X	X	57						WB	S to Tallahassee.
Daytona Beach, Fla.	X	X	57						WB	S to Orlando.
Jacksonville, Fla.		X		BS		IO				S to WBAS from 57 at Waycross.
Key West, Fla.	X	X	57						USN	S to NAS Key West.
Miami, Fla.	X	X	57						WB	S to West Palm Beach.
Orlando, Fla.		X						BS		S to WBAS from 57 at Daytona Beach.
Pensacola, Fla.	X	X		BS		IO			USN	41 at Pensacola NAS in Network. S to WBAS.
Tallahassee, Fla.		X					BS	IO		S to WBAS from 57 at Apalachicola.
Tampa, Fla.	X	X	57						AF	S to McDill AFB.
West Palm Beach, Fla.		X						BS		S to WBAS from 57 at Miami.
Waycross, Ga.	X	X	57	BS	IO57 IO				WB	S to WBAS Jacksonville.
Athens, Ga.	X	X	57						WB	S to Atlanta, Macon, Augusta, Greenville, and NAS Atlanta.
Atlanta, Ga.		X		BS		IO				S to WBAS from 57 at Athens.
Augusta, Ga.		X						BS		S to WBAS from 57 at Athens.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Macon, Ga.		X		BS		IO				S to WBAS from 57 at Athens.
Savannah, Ga.		X					BS			S to WBAS from 57 at Charleston.
Charleston, S.C.	X	X	57				BS	IO	WB	M to Charleston AFB; S to Savannah and Columbia.
Columbia, S.C.		X					BS	IO		S to WBAS from 57 at Charleston.
Greenville, S.C.		X						BS		S to WBAS from 57 at Athens.
Asheville, N.C.		X						BS		S to WBAS from 57 at Bristol.
Greensboro, N.C.		X						BS		S to WBAS from 57 at South Boston.
Hatteras, N.C.	X	X	57							
Wilmington, N.C.	X	X	57							
Norfolk, Va.		X	M	BS		IO			USN	S to WBAS from 81 at Norfolk NAS, replaces M.
Roanoke, Va.		X						BS		S to WBAS from 57 at South Boston.
Richmond, Va.		X		BS		IO				S to WBAS from 57 at Washington.
South Boston, Va.	X	X						B57	WB	S to Raleigh, Greensboro, and Roanoke. 9 at Pope AFB in Network replaced by Seymour-Johnson 77 until FY 72.
Washington, D.C.*	X	X	57S						WB	S to NMC Suitland, WB Silver Spring, Baltimore, Richmond, NAF Andrews, and Patuxent River NAS from relocated Washington 57 radar site.

* Washington, D. C. and NAS Patuxent River, Md. radars are redundant. Navy has stated that Patuxent River 41 can be replaced by remote and radar made available to WB. Washington, D. C., 57 requires relocation. The excess radar will be used to meet network deficiency and reduce WB buy program in FY 68 or FY 69.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Baltimore, Md.		X			BS	IO				S to WBAS from 57 at Washington.
Wilmington, Del.		X					BS	IO		S to WBAS from 57 at Atlantic City.
Atlantic City, N.J.	X	X	57						WB	S to Wilmington and Philadelphia.
Newark, N.J.		X	M							M to WBAS from 57 at New York.
Erie, Pa.		X						BS		S to WBAS from 57 at Buffalo.
Philadelphia, Pa.		X					BS	IO		S to WBAS from 57 at Atlantic City.
Pittsburgh, Pa.	X	X	57S						WB	S to WBAS and WBO from radar site. S to Youngstown and Canton-Akron.
Wilkes-Barre, Pa.		X						BS		S to WBAS from 57 at Binghampton.
Williamsport, Pa.		X						BS		S to WBAS from 57 at Binghampton.
Binghampton, N.Y.	X	X					B57		WB	S to Syracuse, Williamsport, and Wilkes-Barre. 77 at Griffiss AFB in Network until FY 72.
Buffalo, N.Y.	X	X	57						WB	S to Rochester and Erie.
New York, N.Y.	X	X	57M						WB	M to WBAS La Guardia, Kennedy, and Newark; S to Bridgeport and NAS New York.
Rochester, N.Y.		X					BS	IO		S to WBAS from 57 at Buffalo.
Syracuse, N.Y.		X						BS		S to WBAS from 57 at Binghampton.

ESSA—WEATHER BUREAU—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Bridgeport, Conn.		X						BS		S to WBAS from 57 at New York.
Hartford, Conn.		X			BS	IO				S to WBAS from 41 at Providence.
Providence, R.I.	X	X			O41 BS	R41 IO			WB	41 at Quonset Point NAS transfers to WB FY 68 and relocates to vicinity Providence. S to WBAS Hartford, Worcester, Boston, NAS Quonset Point, Otis AFB, and NAS South Weymouth.
Boston, Mass.		X			BS	IO				S to WBAS from 41 at Providence.
Worcester, Mass.		X			BS	IO				S to WBAS from 41 at Providence.
Concord, N.H.		X						BS		S to WBAS from 41 at Portland.
Burlington, Vt.	X	X						BS	WB	77 at Plattsburg AFB. S to WBAS.
Caribou, Maine	X	X						BS	WB	9 (77) in Network (Loring AFB). S to WBAS.
Portland, Maine	X	X			O41 BS	R41 IO			WB	41 at Brunswick NAS transfers to WB FY 68 and relocates. S to WBAS Concord and NAS Brunswick.

AIR FORCE

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Altus AFB, Okla.		X	9 P77			IO77			AF	S to Fort Sill.
Amarillo AFB, Tex.		X	C							C to AF from 57 at Amarillo.
Andrews AFB, Md.		X	9 P77		IO77.					

AIR FORCE—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Barksdale AFB, La.		X	9 P77		IO77					Network functions until FY 71. 57 relocated to Prescott.
Beale AFB, Calif.		X						BS	WB	S from 57 at Sacramento.
Bergstrom AFB, Tex.		X	P77		IO77				AF	Network functions until FY 69. S to Fort Hood.
Blytheville AFB, Ark.		X		BS	IO				USN	S from 41 at Memphis.
Buckley AFB, Colo.		X						BS	WB	S from 57 at Denver.
Bunker Hill AFB, Ind.		X	9 P77		IO77					
Cannon AFB, N. Mex.		X	P77		IO77					Network functions.
Carswell AFB, Tex.		X	9		BS	IO			WB	Replace 9 with S from 57 at Fort Worth.
Chanute AFB, Ill.		X	9 P77		IO77					Operator Training plus Local Use (1 - 9; 6 - 77's).
Charleston AFB, S.C.		X	M							M to AF from 57 at Charleston.
Columbus AFB, Miss.		X	P77	IO						
Craig AFB, Ala.		X	P77	IO						
Davis-Monthan AFB, Ariz.		X	P77	IO					WB	S to WBAS Tucson. Network functions. S to Fort Huachuca.
Dobbins AFB, Ga.		X	P77		IO				USN	S to NAS Atlanta (Dobbins AFB).
Dover AFB, Del.		X	P77		IO					
Duluth AFB, Minn.		X	P77		IO				WB	S to WBAS Duluth. Network functions.
Dyess AFB, Tex.		X	9 P77			IO77				Network functions until FY 69.

AIR FORCE—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Eglin AFB, Fla.		X	9 P77		IO77				AF	Test Range Support. S to Hurlburt AFB.
Ellsworth AFB, S. Dak.		X	9 P77		IO77				WB	S to WBAS Rapid City. Network functions.
England AFB, La.		X	P77	IO						
F. E. Warren AFB, Wyo.		X	P77		IO				WB	S to WBAS Cheyenne and Scottsbluff. Network functions.
Fairchild AFB, Wash.		X	P77		IO					Network functions.
Forbes AFB, Kans.		X	P77		IO					
Fort Benning, Ga.		X	P77		IO					
Fort Campbell, Ky.		X	P77	IO						
Fort Hood, Tex.		X						BS		S from 77 at Bergstrom AFB.
Fort Riley, Kans.		X	P77		IO					
Fort Rucker, Ala.		X	P77	IO						
Fort Sill, Okla.		X						BS	AF	S from 9 (77) at Altus AFB.
Fort Wolters, Tex.		X	P77		IO					
Grand Forks AFB, N. Dak.		X	P77		IO				WB	Network functions. S to WBAS Grand Forks and Fargo.
Griffiss AFB, N.Y.		X	P77	IO						Network functions until FY 70.
Hill AFB, Utah		X	P77		IO					Network functions.
Holloman AFB, N. Mex.		X	P77		IO				Army	Network functions. S to White Sands.
Homestead AFB, Fla.		X	P77		IO					
Hunter AFB, Ga.		X	9							Base closes FY 67.
Hurlburt AFB, Fla.		X						BS	AF	S from 9 (77) at Eglin AFB.

AIR FORCE—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Keesler AFB, Miss.		X	9 P77		IO77					
Kelly AFB, Tex.		X	9		BS	IO			WB	Replace 9 with S from 57 at San Antonio. Network functions until FY 69.
Kingsley AFB, Oreg.		X	P77	IO						Network functions until FY 70.
Kirtland AFB, N. Mex.		X	P77	IO					WB	S to WBAS Albuquerque. Network functions.
K. I. Sawyer AFB, Mich.		X	P77			IO			WB	S to WBAS Marquette. Network functions.
L. G. Hanscom AFB, Mass.		X	77							R&D plus local use.
Langley AFB, Va.		X	P77		IO					
Laredo AFB, Tex.		X	P77		IO				WB	S to WBAS Laredo.
Laughlin AFB, Tex.		X	P77			IO			WB	S to WBAS Del Rio. Network functions.
Little Rock AFB, Ark.		X	9 P77		IO77					
Lockbourne AFB, Ohio		X	P77		IO					
Loring AFB, Maine		X	9 P77		IO77					Network functions.
Luke AFB, Ariz.		X	P77		IO				WB	Network functions. S to WBAS Phoenix. S to Williams AFB.
McDill AFB, Fla.		X	9		BS	IO			AF	Replace 9 with S from 57 at Tampa.
Malmstrom AFB, Mont.		X	9M P77			IO77				M to WBAS Great Falls. Network functions.
Mather AFB, Calif.		X						BS	WB	S from 57 at Sacramento.

AIR FORCE—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Maxwell AFB, Ala.		X	9		BS	IO			WB	Replace 9 with S from 57 in Tuscaloosa area. Network functions until FY 69.
McClellan AFB, Calif.		X						BS	WB	S from 57 at Sacramento.
McChord AFB, Wash.		X	P77		IO					Network functions until FY 71.
McConnell AFB, Kans.		X	P77		IO					
McCoy AFB, Fla.		X	P77		IO					
McGuire AFB, N.J.		X	9 P77		IO77					
Minot AFB, N. Dak.		X	9 P77			IO77				Network functions.
Moody AFB, Ga.		X	P77		IO					
Mountain Home AFB, Idaho		X	P77		IO					
Myrtle Beach AFB, S.C.		X	P77	IO						
Nellis AFB, Nev.		X	P77		IO					Network functions.
Offutt AFB, Nebr.		X	9 P77		IO77					Network functions until FY 69.
Otis AFB, Mass.		X		BS	IO				WB	S from 41 at Providence.
Paine AFB, Wash.		X						BS	WB	S from 57 at Olympia.
Patrick AFB, Fla.		X	9 P77 CCTV		IO77				AF	ETR support. CCTV Remote to NASA Kennedy Spaceflight Center.
Pease AFB, N.H.		X	P77		IO					
Perrin AFB, Tex.		X	P77	IO						
Peterson Field, Colo.		X	P77	IO					WB	S to WBAS Colorado Springs. Network functions until FY 69.

AIR FORCE—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Plattsburgh AFB, N.Y.		X	P77		IO				WB	S to WBAS Burlington. Network functions.
Pope AFB, N.C.		X	9			BS	IO		AF	Replace 9 with S from 77 at Seymour-Johnson AFB. Network functions until FY 70.
Randolph AFB, Tex.		X	P77		IO					
Reese AFB, Tex.		X	9 P77			IO77				
Richards-Gebaur AFB, Mo.		X	P77		IO					
Robbins AFB, Ga.		X	9 P77		IO77					
Scott AFB, Ill.		X	9 P77		IO77					
Selfridge AFB, Mich.		X	9		BS	IO			WB	Replace 9 with S from 57 at Detroit.
Sewart AFB, Tenn.		X	9							Network functions until FY 69. Base closes FY 70.
Seymour-Johnson AFB, N.C.		X	P77		IO				AF	S to Pope AFB.
Shaw AFB, S.C.		X	P77	IO						
Sheppard AFB, Tex.		X	P77			IO			WB	S to WBAS Wichita Falls. Network functions.
Suffolk Co. AFB, N.Y.		X	P77		IO					
Tinker AFB, Okla.		X	9		BS	IO			AF	Replace 9 with S from 57 at Oklahoma City.
Travis AFB, Calif.		X						BS	WB	S from 57 at Sacramento.
Turner AFB, Ga.		X								Base transfers to USN FY 68.

AIR FORCE—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Tyndall AFB, Fla.		X	P77		IO					
Vance AFB, Okla.		X	P77		IO					
Vandenberg AFB, Calif.		X	P77	IO						
Walker AFB, N. Mex.		X	9							Base closes FY 67. Network functions until closed.
Webb AFB, Tex.		X	P77		IO					Network functions until FY 69.
Westover AFB, Mass.		X	9 P77		IO77					
Whiteman AFB, Mo.		X	9		BS	IO			WB	Replace 9 with S from 57 at Kansas City.
Williams AFB, Ariz.		X						BS	WB	S from Luke AFB.
Wright-Patterson AFB, Ohio		X	9		BS	IO			WB	Replace 9 with S from 57 at Cincinnati.
Wurtsmith AFB, Mich.		X	P77		IO				WB	S to WBAS Houghton Lake. Network functions.

NAVY

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Andrews NAF, Md.		X			BSIO				WB	S from 57 in Washington, D.C., area.
Atlanta NAS, Ga.		X		BSIO					WB (Athens) USN (Dobbins)	S from 57 at Athens until 77 is installed at Dobbins AFB in FY 69; then S from Dobbins.

WEATHER RADAR REQUIREMENTS AND PROGRAMS—continued

NAVY—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Beaufort MCAS, S.C.		X	41							
Brunswick NAS, Maine		X	41		BSIO				WB	41 capability exceeds needs. 41 transfers to WB FY 68. S from 41 at Portland.
Cecil Field NAS, Fla.		X		BSIO						S from NAS Jacksonville.
Chase Field NAAS, Tex.		X	81							
Cherry Point MCAS, N.C.		X	81						USN	S to MCAF New River.
Corpus Christi NAS, Tex.		X	81						WB	S to NAAS Kingsville and WBAS Corpus Christi.
Dallas NAS, Tex.		X			BSIO				WB	S from 57 at Fort Worth.
Ellyson Field NAAF, Fla.		X			BSIO					S from NAS Pensacola.
Glenview NAS, Ill.		X	81			BSIO R81			WB	S from 57 at Chicago in FY 69. 81 relocated to replace undesignated 68.
Glynco NAS, Ga.		X	81							
Grosse Ille NAS, Mich.		X			BSIO				WB	S from 57 at Detroit when NAS relocates to Selfridge AFB.
Jacksonville NAS, Fla.		X	68						USN	S to NAS Cecil Field.
Johnsville NAS, Pa.		X					BSIO			S from NAS Lakehurst.
Key West NAS, Fla.		X	81	BSIO R81					USN	S from 57 at Key West. 81 on hand, but not installed, relocates to overseas.
Kingsville NAAS, Tex.		X	81	BSIO R81						S from 81 at NAS Corpus Christi. 81 on hand, but not installed, relocates to overseas.

NAVY—continued

LOCATION	Requirement		PRES. EQUIP.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.		67	68	69	70	71		
Lakehurst NAS, N.J.		X	81						USN	Radar also used with USN training programs. S to NADC Johnsville and NAS Willow Grove.
Memphis NAS, Tenn.		X	41		BSIO				USN	41 capability exceeds needs. 41 transfers to WB FY 68. S from 41 at Memphis.
New Orleans NAS, La.		X	81							
New River MCAF, N.C.		X	81		BSIO R81					S from 81 at MCAS Cherry Point. 81 relocates to overseas.
New York NAS, N.Y.		X						BS	WB	S from 57 New York.
Norfolk NAS, Va.		X	81						USN	S to NAS Oceana and WBAS Norfolk.
Oceana NAS, Va.		X		BSIO						S from 81 at NAS Norfolk.
Olathe NAS, Kans.		X				BSIO			WB	S from 57 at Kansas City.
Patuxent River NAS, Md.		X	41		BSIO				WB	41 capability exceeds needs. 41 transfers to WB FY 68. S from 57 in Washington, D.C., area.
Pensacola NAS, Fla.		X	41						USN	S to WBAS Pensacola, WBAS Mobile, NAAS Saufley, Ellyson Field NAAF, and Whiting Field NAAF. Network functions.
Point Mugu NAS, Calif.		X	68	R68						Relocates to Barking Sands, Hawaii. Support to test range operations.
Quantico MCAS, Va.		X								Requirement will be met by use of data from teletypewriter and facsimile.

NAVY—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Quonset Point NAS, R.I.		X	41		BSIO				WB	41 capability exceeds needs. 41 transfers to WB FY 68. S from 41 at Providence.
Sanford NAS, Fla.		X	68		R68					Base closing. 68 relocated to Turner AFB, Ga.
Saufley NAAS, Fla.		X			BSIO					S from NAS Pensacola.
South Weymouth NAS, Mass.		X			BSIO				WB	S from 41 at Providence.
Turner AFB, Ga.		X			IO68					68 relocated from Sanford NAS, Fla.
Twin Cities NAS, Minn.		X					BS	IO	WB	S from 57 at Minneapolis.
Whiting Field NAAF, Fla.		X	68				BSIO R68		USN	S from NAS Pensacola. 68 phased out; no disposition decision.
Willow Grove NAS, Pa.		X					BSIO		USN	S from NAS Lakehurst.
Spare			81							To overseas location.
Spare				B81						Contingency use.
Spare						B81				Replace overage equipment.
Spare						B81				Replace overage equipment.

ARMY—NASA

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
ARMY										
White Sands, N. Mex.		X						BS	Army	S from 77 at Holloman AFB.

WEATHER RADAR REQUIREMENTS AND PROGRAMS—continued

ARMY—NASA—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Fort Huachuca, Ariz.		X						BS	Army	S from 77 at Davis-Monthan AFB.
NASA Mississippi Test Operation		X	9							Support to test operations.
Space Flight Meteorological Group Weather Radar Photofacsimile Network	X	X	F							Weather radar PPI-scope pictures from 57's at Tampa and Daytona Beach sent to Spaceflight Meteorological Group Center in Miami for compositing with pictures from 57 at Miami.
Kennedy Spaceflight Center, Cape Kennedy, Fla.		X	CCTV						AF	CCTV from 9 at Patrick AFB replaced by CCTV from 77 at Cape Kennedy.

FEDERAL AVIATION ADMINISTRATION FLIGHT SERVICE STATIONS

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter Provided By	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71		
Abilene, Tex.		X	C							
Albany, N.Y.		X	C							
Amarillo, Tex.		X	C							From 57.
Austin, Tex.		X	C							
Birmingham, Ala.		X	C							
Boston, Mass.		X	C							
Buffalo, N.Y.		X	C							From 57.
Charleston, S.C.		X	C							From 57.

FEDERAL AVIATION ADMINISTRATION FLIGHT SERVICE STATIONS—continued

LOCATION	Requirement		PRES.	FISCAL YEAR PROGRAMS					Remote Transmitter	REMARKS
	NET.	LOC.	EQUIP.	67	68	69	70	71	Provided By	
Cleveland, Ohio		X	C							
Columbus, Ohio		X	C							
Des Moines, Iowa		X	C							From 57.
Houston, Tex.		X	C							
Houston, Tex.		X	S							S from 57 Galveston.
Jackson, Miss.		X	C							
Joliet, Ill.		X	C							
Leesburg, Va. (ARTCC)		X	M							CP ByPass from ARSR( ) Suitland.
Memphis, Tenn.		X	C							
Miami, Fla.		X	C							From 57.
Minneapolis, Minn.		X	C							From 57.
Mobile, Ala.		X	C							
Nashville, Tenn.		X	C							
Raleigh, N.C.		X	C							
St. Louis, Mo.		X	C							From 57.
Tulsa, Okla.		X	C							
Washington, D.C.		X	C							From 57.
Wichita, Kans.		X	C							From 57.
Wichita Falls, Tex.		X	C							
Windsor Locks, Conn.		X	C							
Additional Remotes at Unspecified FSS's		X				14	25	25		Remotes will be C or S depending upon the most economical means of meeting the requirement.

VI. PROCUREMENT, INSTALLATION, AND OPERATION OF WEATHER RADARS

The Federal Plan for locating and installing weather radars and remote displays and the evolution of a synoptic weather radar network was presented in Section V. This section covers equipment procurement, installation schedules, and operating procedures.

EQUIPMENT PROCUREMENT

Weather radars are currently under procurement by the Air Force, Navy, and Weather Bureau. The Government agencies are programing or considering procurement of additional weather radars in Fiscal Years 68–71. The Weather Bureau plans call for procuring only the WSR–57 network radar through FY 71 and a limited number of local use radars in subsequent years.[9] Tentative plans of other agencies also call for procurement of local use radars principally as replacements for existing sets which are obsolescent or are projected to be beyond economical repair. Accordingly, a common type of weather radar should be jointly procured to meet these and future local use needs in order to realize savings which accrue from reduced R&D costs and volume production of a common radar. Further, common equipment will simplify operating instructions and offer the opportunity for additional savings in operator and maintenance technician training.

A similar situation exists in the case of procurement of remote displays. A large number of slow-scan remoting systems and components are programed for procurement in the next three to four years. It is imperative that these systems be completely compatible so that one agency can remote from another agency's radar or remote transmitter, and that maintenance of the equipment can be done effectively and economically. In this respect agencies have agreed that cross-service maintenance of remote display equipment installed by one agency at another agency's radar site is feasible and desirable; and that such arrangements will be made in cases where the distance between locations exceeds about 10 miles. Further, agencies have agreed that the Department of Commerce should assume responsibility for all maintenance training for slow-scan radar remoting systems. Accordingly, a single type of remoting system should be jointly procured.

Agency responsibility for procurement of slow-scan remote transmitters generally rests with the agency requiring the remote service. In a number of cases involving multiagency remoting from a prime radar, agencies having a priority requirement or funds available have agreed to provide the transmitters.

INSTALLATION SCHEDULES

The installation schedules given in Section V represent the best agency programs available at this time. Slippages due to funding problems, production and installation delays, and changes in priority can be expected; however, those agencies programing a weather radar or a remote display transmitter which will serve remote displays of other agencies should take every possible action to assure that the programs are carried out as scheduled. In the event that circumstances beyond the control of an agency prevent it from carrying out an action affecting other agencies, it should immediately advise the Interdepartmental Committee for Meteorological Services (ICMS) of the Office of the Federal Coordinator for Meteorological Services and Supporting Research of the situation so that alternative arrangements can be made.

INSTALLATION OF REMOTE DISPLAYS

The agency installing a remote display system from another agency's weather radar or remote display transmitter is responsible for making all arrangements for installation, including necessary communications circuits and maintenance of equipment located in that agency's facility.

OPERATING PROCEDURES

Actions are being taken in the ICMS Subcommittee on Basic

[9] Modern local use radars will be located where it is not technically feasible to remote from an existing radar or a small, critical gap in network coverage must be filled. Specific locations have not been determined.

Meteorological Services to standardize weather radar observations. The Weather Bureau's Weather Surveillance Radar Manual has been adopted by the Air Force and Navy as an interim standard for making weather radar observations. This first step provides for common observation techniques and a single reporting code. Further, actions are underway to prepare an Interagency Manual on Weather Radar Observations which will provide standard instructions for:

- Observation schedules for network use
- Observation instructions for network and local use
- Scope photography for network and local use
- Transmission of reports on teletypewriter circuits
- Quality control procedures for network observations
- Staffing standards for prime radars supporting remote displays
- Procedures for operation of prime radars supporting remote displays

These actions should be completed as quickly as possible.

REVIEWING PROCEDURES & PLANS

The ICMS or its Subcommittee on Basic Meteorological Services should arrange for systematic review and updating of the operational concepts and procedures for the Synoptic Weather Radar Network and local use support by remote displays. This work should be pointed toward assuring that concepts and procedures are consistent with current technology and user requirements for weather radar data. The ICMS should also periodically review the entire Plan and make recommendations for revisions to the Federal Coordinator for Meteorological Services and Supporting Research.

VII. DEFICIENCIES AND SUPPORTING RESEARCH

The Federal Plan presented in Section V meets stated requirements for a synoptic weather radar network and specific local use locations except as follows:

DEFICIENCIES

Synoptic Weather Radar Network Coverage Deficiencies:

Suitable weather radars should be installed to replace the obsolete and interim radars in the network. Identification of specific deficiencies in the network in the western intermountain area are largely dependent upon the results of the Weather Bureau program for obtaining limited weather radar data from the air traffic control radars in that area. Until this program has been thoroughly examined and the value of a network of weather radars in the area established in comparison with costs, no further network radars should be installed in that area. Further, the results of previously noted research on use of doppler radar will also have a bearing on meeting the synoptic network deficiencies in the intermountain area. There are also some gaps in the synoptic network in other areas which need to be studied in detail to determine how to best fill them. The Weather Bureau is conducting a thorough study of the data acquisition subsystem which will include these problems. A completion date of mid-1967 has been established for the study.

Local Use Deficiencies:

In general, local use deficiencies are a matter of priority for the service and the related allocation of funds to buy, install, and operate local use radars or remote displays. Supporting research is not a factor in this respect. The previously noted Weather Bureau study will also consider the problem of weather radar data for local uses. It is most likely that the study will indicate a need for additional remoting systems to meet requirements at locations where remoting is feasible, in addition to indicating a need for a modern local use radar to meet requirements which cannot be filled by remote displays. Pending completion of this study, it is not possible to give specifics on the deficiencies and requirements. Local use deficiencies exist in most other agencies as well.

SUPPORTING RESEARCH REQUIREMENTS

The present generations of network and local use weather radars, while not meeting all desired standards of performance,

are generally adequate for the jobs to be done. Supporting research is required, however, in the following areas:

- Existing methods of making synoptic weather radar observations and then collecting and compositing them for facsimile transmission involve serious time delays and require a substantial manpower and communications input. Supporting research is needed to make this process faster and less expensive. In this respect, the system developed for automated collection and processing of synoptic weather radar data and the evolving automated FAA air traffic control system should allow for mutual exchange of weather radar data between the systems.
- Development and installation of weather echo-intensity contouring circuitry for prime radars should be accelerated to enhance the utility of remote displays and reduce the amount of information which must be manually inserted at the transmitting location.
- Existing methods for inserting weather radar data into the Air Traffic Control System are inadequate. Supporting research is needed to make both local- and wide-area weather radar data readily available to decision-making personnel in the system.
- Existing techniques for estimating rainfall rates are inadequate to meet the requirements for flood warnings and water management in river basins. Continued supporting research is required to improve the determination of rainfall rates and accumulations by weather radar observations.
- Existing techniques for identifying severe local storms by weather radar for public, industrial, and military warnings vary from fair to very good. Continued supporting research in this area, to include doppler techniques, is urgently required.
- Existing techniques for interpretation of data in terms of hazards to aircraft in flight are crude. Continued supporting research, including doppler techniques, is urgently required.

APPENDIX I. LOCATIONS MEETING MINIMUM REMOTING CRITERIA AND NOT RECOMMENDED FOR REMOTING

SUMMARY OF EXISTING AND PLANNED RADARS WITHIN REMOTING DISTANCE OF ANOTHER EXISTING OR PLANNED RADAR AND NOT RECOMMENDED FOR REMOTING

LOCATION, TYPE, AND STATUS	REMOTING POSSIBLE FROM	REMOTE DISTANCE	REMARKS
Andrews AFB, Md. 9 Operational 77 Planned	Washington, D.C. 57 Operational	10	Support to VIP traffic overriding consideration.
Beaufort MCAS, S.C. 41 Operational	Charleston, S.C.	40	Provides backup for synoptic network in critical hurricane area.
Bergstrom AFB, Tex. 77 Planned	San Antonio, Tex. 57 Planned FY 69	80	Borderline for maximum, effective remoting.
Dover AFB, Del. 77 Planned	Atlantic City, N.J. 57 Operational	55	Unusually large number of weather-sensitive aircraft.

APPENDIX I. LOCATIONS MEETING MINIMUM REMOTING CRITERIA AND NOT RECOMMENDED FOR REMOTING—continued

SUMMARY OF EXISTING AND PLANNED RADARS WITHIN REMOTING DISTANCE OF ANOTHER EXISTING OR PLANNED RADAR AND NOT RECOMMENDED FOR REMOTING

LOCATION, TYPE, AND STATUS	REMOTING POSSIBLE FROM	REMOTE DISTANCE	REMARKS
Eglin AFB, Fla. 9 Operational 77 Planned	Pensacola NAS, Fla. 41 Operational	50	Requirement for radar to support test operations is overriding consideration.
Forbes AFB, Kans. 77 Planned	Kansas City, Mo. 57 Operational	65	Unusually large number of weather-sensitive aircraft.
Fort Campbell, Ky. 77 Planned	Nashville, Tenn. 57 Planned FY 69	65	Requirement cannot wait 2–3 years.
Fort Wolters, Tex. 77 Planned	Fort Worth, Tex. 57 Operational	65	Extensive pilot training in helicopters at many dispersed sites and high incidence of RDW. Borderline for maximum, effective remoting.
Homestead AFB, Fla. 77 Planned	Miami, Fla. 57 Operational	20	Provides backup for synoptic network in critical hurricane area.
Lakehurst NAS, N.J. 81 Operational	Atlantic City, N.J. 57 Operational	40	Radar used for operator training and local uses. Remote planned FY 70 to NADC Johnsville and Willow Grove NAS from Lakehurst 81.
Langley AFB, Va. 77 Planned	Norfolk NAS, Va. 81 Operational	15	Large number of weather-sensitive aircraft and support to major air command headquarters.
Little Rock AFB, Ark. 9 Operational 77 Planned	Little Rock, Ark. 57 Operational	15	57 planned relocation to Prescott, Ark., FY 71. Prescott beyond effective remoting distance.
McChord AFB, Wash. 77 Planned	Olympia, Wash. 57 Planned FY 71	45	57 planned near Olympia—operational FY 71. Requirement cannot wait 3 years.
McConnell AFB, Kans. 77 Planned	Wichita, Kans. 57 Operational	5	Large number of weather-sensitive aircraft, extensive aircrew training, and support to TITAN II missiles.
McCoy AFB, Fla. 77 Planned	Daytona Beach, Fla. 57 Operational	50	Large number of weather-sensitive aircraft, very high incidence of RDW, and critical hurricane area.
McGuire AFB, N.J. 9 Operational 77 Planned	Atlantic City, N.J. 57 Operational	40	Large number of weather-sensitive aircraft.

APPENDIX I. LOCATIONS MEETING MINIMUM REMOTING CRITERIA AND NOT RECOMMENDED FOR REMOTING—continued

SUMMARY OF EXISTING AND PLANNED RADARS WITHIN REMOTING DISTANCE OF ANOTHER EXISTING OR PLANNED RADAR AND NOT RECOMMENDED FOR REMOTING

LOCATION, TYPE, AND STATUS	REMOTING POSSIBLE FROM	REMOTE DISTANCE	REMARKS
Moody AFB, Ga. 77 Planned	Waycross, Ga. 57 Planned	50	57 planned—operational FY 68. AF requirement cannot wait required 2–3 years.
Myrtle Beach AFB, S.C. 77 Planned	Wilmington, N.C. 57 Operational	75	Borderline for maximum, effective remoting.
New Orleans NAS, La. 81 Operational	Boothville, La. 57 Planned Relocation	55	Backup to network radar in critical hurricane area. New Orleans 57 relocates to Boothville FY 67.
Patrick AFB, Fla. 9 Operational 77 Planned	Daytona Beach, Fla. 57 Operational	65	Requirement for radar to support Eastern Test Range is overriding consideration.
Richards-Gebaur AFB, Mo. 77 Planned	Kansas City, Mo. 57 Operational	10	Large number of weather-sensitive aircraft.
Randolph AFB, Tex. 77 Planned	San Antonio, Tex. 57 Planned FY 69	20	Extensive pilot training and high incidence of RDW.
Sanford NAS, Fla. 68 Operational	Daytona Beach, Fla. 57 Operational	30	Base closes; 68 relocates to Turner AFB, Ga.
Scott AFB, Ill. 9 Operational 77 Planned	St. Louis, Mo. 57 Operational	25	Large number of weather-sensitive aircraft; extensive transient and medical air evacuation operations.
Sewart AFB, Tenn. 9 Operational	Nashville, Tenn. 57 Planned FY 69	10	Base closes FY 70.
Shaw AFB, S.C. 77 Planned	Charleston, S.C. 57 Operational	75	Borderline for maximum, effective remoting.
Suffolk Co. AFB, N.Y. 77 Planned	New York, N.Y. 57 Operational	70	Borderline for maximum, effective remoting.
Tyndall AFB, Fla. 77 Planned	Apalachicola, Fla. 57 Operational	40	Extensive pilot training, high incidence of RDW, and critical hurricane area.

APPENDIX I. LOCATIONS MEETING MINIMUM REMOTING CRITERIA AND NOT RECOMMENDED FOR REMOTING—continued

SUMMARY OF EXISTING AND PLANNED RADARS WITHIN REMOTING DISTANCE OF ANOTHER EXISTING OR PLANNED RADAR AND NOT RECOMMENDED FOR REMOTING

LOCATION, TYPE, AND STATUS	REMOTING POSSIBLE FROM	REMOTE DISTANCE	REMARKS
Vance AFB, Okla. 77 Planned	Oklahoma City, Okla. 57 Operational	75	Borderline for maximum, effective remoting.
Webb AFB, Tex. 77 Planned	Midland, Tex. 57 Planned FY 69	45	57 planned near Midland—operational FY 69. Requirement cannot wait 1–2 years.

APPENDIX II. CHARACTERISTICS OF RADARS*

CHARACTERISTICS OF IDEAL NETWORK RADAR

In regions where high rainfall rates occur, the radar should operate in the 2700–2900 mc ("S") band. In regions where heavy rains rarely occur and precipitation attenuation is not a problem, a radar operating in the 5600–5650 mc ("C") band is satisfactory provided it has the beam characteristics, sensitivity, power, and other capabilities, as listed below, necessary to detect precipitation falling at a rate of 0.01 in./hr. or more to a range of 100 nautical miles. The radar shall be tuneable within the operating band to minimize interference problems. Ability to detect the 0.01 in./hr. precipitation rate at a range of 100 miles can be satisfied by an S-band radar having the following capabilities:

Peak transmitted power: 500 Kilowatts.

Receiver sensitivity: —108 decibels below 1 milliwatt.

Pulse length: 4 microseconds plus an optional 0.5 microsecond pulse length for the high resolution necessary to detect critical storm features such as tornado "hooks."

Beam width, both horizontal and vertical: 1 degree.

Radome, so as to permit operation in high winds.

Range normalization $\frac{1}{Range^2}$ to 125 nautical miles.

Capability to measure back-scatter signal strength.

Calibration and measurement of back-scatter signal strength such that accuracy of measured rainfall rate is within a factor of two.

Antenna elevation angle positioning accuracy ± 0.33 degree.

Antenna azimuth angle positioning accuracy ± 0.33 degree.

Range accuracy ± 1% of range.

PPI display ranges 50, 125, 250 nautical miles.

RHI display ranges of 50, 125 nautical miles; height scale to 70,000 feet.

A-scope display ranges of 50, 125, 250 nautical miles.

R-scope gate width variable between 5 and 25 nautical miles.

Antenna azimuth rotation rate 3 to 5 RPM (both automically and manually controllable in azimuth).

Antenna elevation scan rate 6 cycles per minute (both automatically and manually controllable in elevation) sector variable 0–90 degrees.

*See table 1, pages 46 to 49.

Table 1.—CHARACTERISTICS OF VARIOUS RADAR

Type	Primary User	Wave Length	Pulse Length and PRF	Peak Power Output	Type of Antenna	Beam Width	Type of Sweep
WSR–57 FPS–41	WB Navy	10.3 cm.	0.5 μsec—658 pps. 4 μsec—164 pps.	500 kw.	12′ parabola	2°	Automatic and manual in horizontal and vertical, either direction.
CPS–9	AF	3.2 cm.	0.5 μsec—931 pps. 5 μsec—186 pps.	225 kw.	8′ parabola	1°	Manual and automatic in horizontal and vertical, either direction. Sector scan in both planes.
FPS–68 FPS–81 FPS–77V	Navy Navy AF	5.3 cm.	2 μsec—324 pps.	300 kw.	8′ parabola	1.6°	Automatic and manual in azimuth and elevation 5 rpm.
WSR–1	WB	10 cm.	1 μsec—650 pps. 2 μsec—325 pps.	60 kw.	6′ parabola	4°	Automatic, 12 rpm. manual control of antenna tilt.
WSR–3 WSR–4	WB	10 cm.	1 μsec—650 pps. 2 μsec—325 pps.	60 kw.	6′ parabola	4°	Automatic, variable speed to 12 rpm. reversible, automatic and manual control of antenna tilt.
SP (Modified)	WB	10 cm.	1 μsec—600 pps. 5 μsec—120 pps.	700 kw.	12′ parabola	2°	Manual and automatic horizontal, manual in vertical.
Decca–41		3.2 cm.	0.2 μsec—250 pps. 2 μsec—250 pps.	30 kw.	2.6′ high 14′ wide	2.8° vert. 0.6° horiz.	Automatic, 5 rpm. manual elevation.
APQ–13	AF	3 cm.	0.5 μsec—1350 pps. 0.75 μsec—675 pps. 2 μsec—270 pps.	40 kw.	30″ parabola	3°	Automatic, 12 rpm. manual control of antenna tilt.
FPS–20 FPS–67	AF	23 cm.	6 μsec—360 pps.	5000 kw.	40′ wide 16′ high	1.3° azi. 22° vert.	Auto in azimuth.

Presentation	Maximum PPI Range	Ranging Accuracy	Major Deficiencies as a Network Radar
PPI, off-center, PPI, RHI, R, A	250 n. mi.	± 0.5%	Beam width too great.
PPI, off-center, PPI, RHI, R, A	400 s. mi.	± 0.1 mile	Precipitation attenuation, due to operating wave length. No quantitative echo-intensity measurement capability.
PPI, A, R, RHI	200 n. mi.	±0.5% at maximum range	Beam width too great. Precipitation attenuation, due to operating wave length (not as severe as with CPS–9).
PPI, A	180 n. mi.	± 1 mile	No RHI, no quantitative echo-intensity measurement capability, beam width too great, not able to detect 0.01″/hr. rainfall rate at 100 miles, no manual antenna control, insufficient antenna positioning accuracy, no R-scope, no range normalization.
PPI, A, RHI	180 n. mi.	± 1 mile	
PPI, A, R	300 n. mi.	± 0.1 mile	Beam width too great, no quantitative echo-intensity measurement capability, no RHI, no range normalization.
PPI	250 n. mi.	± 1%	Precipitation attenuation, no echo-intensity measurement capability, no RHI, no A/R scope, vertical beam width too wide, no range normalization.
PPI, A	75 s. mi.	± 1 mile	Precipitation attenuation, no echo-intensity measurement capability, no RHI, no R-scope, not able to detect 0.01″/hr. rainfall rate at 100 miles, no manual antenna control, no range normalization.
PPI	250 n. mi.	± 1 mile	No quantitative echo-intensity measurement capability, no RHI, no manual antenna control, beam width too great, no range normalization, no A/R scope.

Table 1.—**CHARACTERISTICS OF VARIOUS RADAR**—continued

Type	Primary User	Wave Length	Pulse Length and PRF	Peak Power Output	Type of Antenna	Beam Width	Type of Sweep
FPS–6 MPS–14		10 cm.	2 μsec—360 pps. (nominal)	5000 kw.	30′ high 8′ wide	3.2° azi. 0.85° elev.	Auto and manual rotation in azimuth and elevation.
CPS–6B FPS–10		10 cm.	1 μsec—600 pps. 2 μsec—300 pps.	900 kw.	25′ wide 15′ high	1° azi. 24° vert.	Auto rotation in azimuth.
MPS–4		4.6 cm.	0.3 μsec—656 pps. 1.37 μsec—656 pps.	140 kw.	15′ high 3′ wide	0.75° vert. 3.75° horiz.	Automatic in azimuth and elevation.
M–33 (Acquisition Radar)		9.1 cm.	1.3 μsec—1000 pps.	1000 kw.	parabola 16′ x 5′	1.4° horiz. variable vertical from narrow to fan-shaped.	Automatic operation in azimuth; 10, 20, 30 rpm; elevation 0 to 45°.
M–33 (Tracking Radar)		3.3 cm.	0.25 μsec—1000 pps.	250 kw.	Waveguide lens, 6′9″ diameter	1.1° horiz. and vert.	Automatic operation in azimuth and elevation.
ARSR–1E	FAA	23 cm.	2 μsec—360 pps.	5000 kw.	40′ wide 11′ high	1.35° horiz. 6.2° $\csc^2$ vert.	Auto PPI.
ARSR–2	FAA	23 cm.	2 μsec—360 pps.	5000 kw.	47′ wide 23′ high	1.2° horiz. 3.75° vert.	Auto PPI.
ASR–4	FAA	10.3 cm.	0.833 μsec— 1040 pps. 1170 pps. 1200 pps.	425 kw.	9′ wide 17′ high	1.5° horiz. 5° $\csc^2$ to 30°	Auto PPI.

Presentation	Maximum PPI Range	Ranging Accuracy	Major Deficiencies as a Network Radar
RHI	225 n. mi.		No PPI, azimuth beam width too great, no quantitative echo-intensity measurement capability, no range normalization, no A/R scope.
PPI	133 n. mi. 266 n. mi.		No RHI, vertical beam width too great, no manual antenna control, no quantitative echo-intensity measurement capability, no range normalization.
PPI, RHI	120 n. mi.	± 1%	Not able to detect 0.01″/hr. rainfall rate at 100 n. mi., no quantitative echo-intensity measurement capability, horizontal beam width too great, does not operate in an authorized frequency band.
PPI 3-type Precision Indicator	68 s. mi.		Insufficient range, no RHI, vertical beam width too great, no manual antenna control, no quantitative echo-intensity measurement capability on acquisition radar, no range normalization.
A-scan indicators for azimuth, range, and elevation	57 s. mi.		
PPI	250 n. mi.	± 1%	No quantitative echo-intensity measurement capability, optional circular polarization, beam width too great, no manual antenna control, no RHI, no A/R scope.
PPI	250 n. mi.	± 1%	
PPI	60 n. mi.	± 1%	No quantitative echo-intensity measurement capability, optional circular polarization, beam width too great, no manual antenna control, no RHI, no A/R scope, not able to detect 0.01″/hr. rainfall rate at 100 n. mi.

APPENDIX III. SYNOPTIC WEATHER RADAR NETWORK

The Synoptic Weather Radar Network is composed of Department of Commerce WSR–57 radars supplemented by modern Navy and Air Force weather radars. Selection of radars for the network has been made on the basis of attaining required data at a minimum cost. S-band weather radars are used as the primary radar and C-band local use weather radars presently installed or planned are used wherever feasible to avoid further redundant coverage. Pending completion of the installation programs for modern weather radars, a number of obsolete or obsolescent radars are used on an interim basis. In the western intermountain region, air traffic control radars remoted into an ARTCC are used as substitutes for weather radars.

Since the Synoptic Weather Radar Network is composed of radars (or ARTCC remotes) operated by Commerce, Navy, and Air Force, their observations are collected on different teletypewriter systems. In general, Commerce locations transmit on the RAREP and Warning Coordination (RAWARC) systems and the military locations transmit on the COMET II system.

Network observation procedures and schedules as well as instruction for photography, repositing data and quality control, will be specified in the Interagency Manual for Weather Radar Observations.

The following locations are designated as the Synoptic Weather Radar Network with emergency alternate locations as indicated:

ESSA—WEATHER BUREAU

WSR–57 Radars

Primary	*Alternate*
Sacramento, Calif.	None
Catalina Island, Calif.	None
Corvallis, Oreg. (Planned operational FY 71)	None
Medford, Oreg. (Planned operational FY 70)	None
Olympia, Wash. (Planned operational FY 71)	McChord AFB
Missoula, Mont.	None
Denver, Colo. (Planned operational FY 70)	Peterson Field, Colo.
Amarillo, Tex.	Cannon AFB
Fort Worth, Tex.	Carswell AFB*
San Antonio, Tex. (Planned operational FY 69)	Randolph AFB
Midland, Tex. (Planned operational FY 70)	Webb AFB
Galveston, Tex.	None
Brownsville, Tex.	None
Lake Charles, La.	None
New Orleans, La. (Relocates to Boothville, La., FY 67)	New Orleans NAS
Little Rock, Ark. (Relocates to Prescott, Ark., FY 71)	Little Rock AFB*
Oklahoma City, Okla.	Tinker AFB*
Garden City, Kans. (Planned operational FY 70)	None
Wichita, Kans.	McConnell AFB
Kansas City, Mo.	Richards-Gebaur AFB
Springfield, Mo. (Planned operational FY 70)	None
St. Louis, Mo.	Scott AFB*
Grand Island, Nebr. (Planned operational FY 69)	Offutt AFB*

* Obsolete or obsolescent radar; serves as emergency alternate radar until decommissioned. If replaced by modern radar, it continues to serve as alternate.

ESSA WEATHER BUREAU—continued

WSR–57 Radars—continued

Primary	*Alternate*
Huron, S. Dak.	
(Planned operational FY 70)	None
Jackson, Miss.	
(Planned operational FY 68)	Meridian NAAS
Tuscaloosa, Ala.	
(Planned operational FY 69)	Columbus AFB
Nashville, Tenn.	
(Planned operational FY 69)	None
Bristol, Tenn.	
(Planned operational FY 70)	None
Evansville, Ind.	None
Cincinnati, Ohio	Wright-Patterson AFB*
Chicago, Ill.	None
Des Moines, Iowa	None
Minneapolis, Minn.	None
Green Bay, Wisc.	
(Planned operational FY 70)	None
Detroit, Mich.	Selfridge AFB*
Apalachicola, Fla.	Tyndall AFB
Miami, Fla.	Homestead AFB
Key West, Fla.	None
Daytona Beach, Fla.	None
Tampa, Fla.	McDill AFB*
Waycross, Ga.	
(Planned operational FY 68)	None
Athens, Ga.	Dobbins AFB
Charleston, S.C.	Beaufort MCAS
Hatteras, N.C.	Cherry Point MCAS
Wilmington, N.C.	Seymour-Johnson AFB
South Boston, Va.	
(Planned operational FY 72)	None
Washington, D.C.	Andrews AFB*
Atlantic City, N.J.	McGuire AFB*
New York, N.Y.	Suffolk County AFB
Pittsburgh, Pa.	None
Buffalo, N.Y.	None
Binghampton, N.Y.	
(Planned operational FY 72)	Griffiss AFB
Memphis, Tenn.	
(Transfers from Navy in FY 68)	None
†Providence, R.I.	
(Transfers from Navy in FY 68)	None
Portland, Maine	
(Transfers from Navy in FY 68)	None

Obsolete Radars

Wichita Falls, Tex.	
(Replaced by Sheppard AFB 77 in FY 69)	None
Scottsbluff, Nebr.	
(Replaced by F. E. Warren AFB 77 in FY 68)	None
Fort Smith, Ark.	
(Replaced by Springfield, Mo., 57 in FY 70)	None
Springfield, Mo.	
(Replaced by WSR–57 in FY 70)	None
Concordia, Kans.	
(Replaced by Grand Island 57 in FY 69)	None
North Platte, Nebr.	
(Replaced by Grand Island 57 in FY 69)	None
Goodland, Kans.	
(Replaced by Garden City 57 in FY 70)	None
Pueblo, Colo.	
(Replaced by Peterson Field 77 in FY 67)	None

* Obsolete or obsolescent radar; serves as emergency alternate radar until decommissioned. If replaced by modern radar, it continues to serve as alternate.

† Exact location not firm.

ESSA WEATHER BUREAU—continued

Obsolete Radars—continued

Primary	*Alternate*
Sioux Falls, S. Dak. (Replaced by Huron 57 in FY 70)	None
Madison, Wisc. (Replaced by Green Bay 57 in FY 70)	None
Muskegon, Mich. (Replaced by Green Bay 57 in FY 70)	None
Binghampton, N.Y. (Replaced by Griffiss AFB 77 in FY 67)	None
Richmond, Va. (Until decommissioned and replaced by remote in FY 69)	None
Jackson, Miss. (Replaced by WSR–57 in FY 68)	Meridian NAAS
Memphis, Tenn. (Replaced by WSR–57 in FY 68)	None
Nantucket, Mass. (Replaced by Providence WSR–57 in FY 68)	None

NAVY

AN/FPS–41 Radars

Pensacola, Fla.	None

AIR FORCE

AN/CPS–9 Radars

Malmstrom AFB, Mont. (Replaced by 77 in FY 69)	None
Ellsworth AFB, S. Dak. (Replaced by 77 in FY 68)	None
Minot AFB, N. Dak. (Replaced by 77 in FY 69)	None
Offutt AFB, Nebr. (Replaced by 77 in FY 68 and by Grand Island 57 in FY 69)	WBAS Omaha*
Walker AFB, N. Mex. (Closes in FY 67. Replaced by Holloman 77 in FY 68 and Midland 57 in FY 70)	None
Kelly AFB, Tex. (Replaced by Randolph 77 in FY 68)	WBAS San Antonio*
Dyess AFB, Tex. (Replaced by Webb 77 in FY 68)	WBAS Abilene*
Barksdale AFB, La. (Replaced by 77 in FY 68 and by Prescott 57 in FY 71)	WBAS Shreveport*
Sewart AFB, Tenn. (Replaced by Nashville 57 in FY 69. Base closes FY 70)	WBAS Nashville*
Maxwell AFB, Ala. (Replaced by Tuscaloosa 57 in FY 69)	Craig AFB (04–18 LST)
Pope AFB, N.C. (Until decommissioned)	Seymour-Johnson AFB
Loring AFB, Maine (Replaced by 77 in FY 68)	None

AN/FPS–77 Radars

McChord AFB, Wash. (Replaced by Olympia 57 in FY 71)	None

* Obsolete or obsolescent radar; serves as emergency alternate radar until decommissioned. If replaced by modern radar, it continues to serve as alternate.

AIR FORCE—continued

AN/FPS–77 Radars—continued

Primary	Alternate
Fairchild AFB, Wash.	None
Kingsley AFB, Oreg. (Replaced by Medford 57 in FY 70)	None
Hill AFB, Utah	None
Nellis AFB, Nev.	None
F. E. Warren AFB, Wyo.	None
Grand Forks AFB, N. Dak.	None
Duluth AFB, Minn.	None
Luke AFB, Ariz.	None
Davis-Monthan AFB, Ariz.	None
Kirtland AFB, N. Mex.	None
Cannon AFB, N. Mex.	Reese AFB*
Holloman AFB, N. Mex.	None
Peterson Field, Colo. (Replaced by Denver 57 in FY 70)	WBAS Pueblo*
Laughlin AFB, Tex.	None
Webb AFB, Tex. (Replaces Dyess 9, replaced by Midland 57 in FY 70)	WBAS Midland*
Randolph AFB, Tex. (Replaces Kelly 9, replaced by San Antonio 57 in FY 69)	WBAS San Antonio*
Bergstrom AFB, Tex. (Replaced by San Antonio 57 in FY 69)	None
Sheppard AFB, Tex.	Altus AFB*
K. I. Sawyer AFB, Mich.	None
Wurtsmith AFB, Mich.	None
Griffiss AFB, N.Y. (Replaced by Binghampton 57 in FY 72)	WBAS Binghampton*
Plattsburg AFB, N.Y.	None
Malmstrom AFB, Mont. (Replaces 9 in FY 69)	None
Minot AFB, N. Dak. (Replaces 9 in FY 69)	None
Ellsworth AFB, S. Dak. (Replaces 9 in FY 68)	None
Loring AFB, Maine (Replaces 9 in FY 68)	None
Offutt AFB, Nebr. (Replaces 9 in FY 68 and replaced by Grand Island 57 in FY 69)	None
Barksdale AFB, La. (Replaces 9 in FY 68 and replaced by Prescott 57 in FY 71)	None

* Obsolete or obsolescent radar; serves as emergency alternate radar until decommissioned. If replaced by modern radar, it continues to serve as alternate.

FEDERAL AVIATION ADMINISTRATION

ARSR–( ) Radars remoted to Salt Lake City with ESSA—Weather Bureau personnel performing limited synoptic network operations from the remoted displays in the Salt Lake City ARTCC.

Ashton, Idaho	Salt Lake City, Utah
Boise, Idaho	Lovell, Wyo.
Battle Mountain, Nev.	Rock Springs, Wyo.
Cedar City, Utah	

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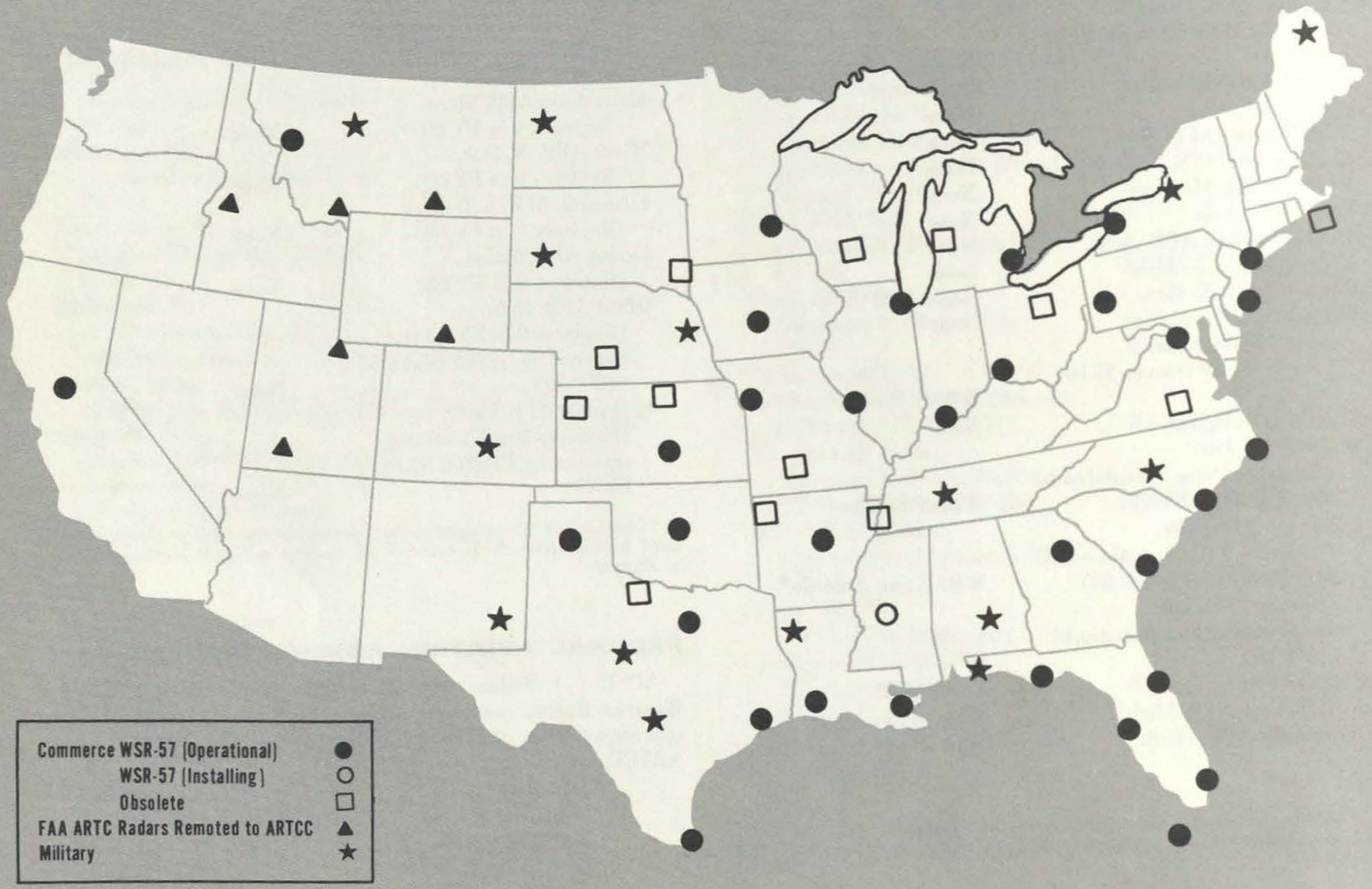
SYNOPTIC WEATHER RADAR NETWORK FY 67



SYNOPTIC WEATHER RADAR NETWORK FY 71