UNITED STATES DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
WEATHER BUREAU SOUTHERN REGION
Fort Worth, Texas

TECHNICAL MEMORANDUM NO. 11

SEVERE STORM WARNING SYSTEMS IN THE SOUTHERN REGION

By

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INTRODUCTION

Warning of severe weather is the Weather Bureau's most urgent responsibility. When damaging storms are imminent, the warning function takes priority over all other activity. Since minutes and sometimes seconds are critical, effective planning is essential.

Each service office in the Southern Region has an individual operational environment. Communication facilities, population distribution, social and economic structure, interest in and frequency of severe storms, as well as the size and basic mission of each office--all these factors vary widely over the Region. This has led to a wide variety of storm warning procedures at different stations. In many respects, each station has a unique system.

This regional note is concerned with warnings of tornado and severe thunderstorm situations. During recent years, new systems have been developed and old systems improved. The purpose of this note is to point out some of these new and improved procedures that may be applicable to many stations and to tell of some of the new and improved techniques developed by SELS which are of concern to all stations.

Regardless of the size of the service office and the characteristics of the service area, the issuance of effective storm warnings is the prime responsibility of each office. And the key to fullfilling this responsibility is the development of a workable plan of action.

OBSERVING AND DISTRIBUTING SYSTEMS

A well trained and alert group of storm "spotters" is a desired goal at stations where there is a threat from time to time of severe local storms and/or tornadoes. But local storm warning networks, especially in areas where tornadoes have been infrequent in recent years, often become ineffective because the people become disinterested. This happens quite often even in spite of efforts of station personnel to develop enthusiasm and a sense of personal responsibility of the group of storm observers.

A highly mobile group of "spotters" with rapid communication capability appears most effective. At many Southern Region stations, storm warning networks are composed of law enforcement groups such as the highway patrol, the sheriff's department, or the local police. Personnel in these groups have mobility, effective communication, and probably are more easily trained than other individuals or groups in recognizing and reporting tornadoes, funnel clouds, and other severe local storm conditions.

After a warning network has sighted a tornado or other severe local storm, the speed and accuracy with which it can be disseminated to the public determines the "moment of truth." It is the real measure of effectiveness of the entire storm warning program. Many stations find a public weather circuit a very effective means for disseminating severe weather warnings to the public. Some stations with direct radio capability can, in a matter of a few minutes or less, activate a network of radio stations to disseminate their tornado warnings.

The following are examples of severe storm warning programs in use around the Region which have proved quite effective and which might prove valuable at other locations.

Tulsa and Oklahoma City have very effective local storm warning programs and rightfully so as they are located in the heart of the tornado belt. Dependence for reports of severe local storms (tornadoes, funnel clouds, etc.) is principally by law enforcement agencies, especially the state highway patrol. In addition, Tulsa has forty-seven mobile Civil Defense units in the immediate Tulsa area which can rapidly flash back reports via radio to the Weather Bureau and keep a constant surveillance on the storm. Civil Defense, during a storm emergency, mans a radio in the Weather Bureau office and this direct 2-way communication has been used to track the movement of damaging storms.

The joining together of the Oklahoma City and Tulsa "local loops" into the Oklahoma State Public Weather Circuit last year further strengthened the capability of both offices to disseminate urgent warnings of severe local storms. Since the Department of Public Safety in Oklahoma is tied to this circuit, this Agency can not only send reports of tornadoes from its roving field units rapidly back to the Weather Bureau but it can also keep current with Weather Bureau forecasts and warnings transmitted on this circuit.

WBAS, Lubbock has enlisted the cooperation of a fleet of gasoline trucks in that area as storm observers. The 120 vehicles participating in this program are equipped with 2-way radio. With this instant communication capability and with the mobility they have, gas trucks are providing an effective supplement to the regular storm warning reporting network in the High Plains.

WBAS, Jackson has something similar but a little different. It uses a fleet of farm trucks with citizen band radio that keep an eye out for severe storms in Central Mississippi. Also, a number of county extension agents have citizen band radios in their offices and this has been the tip-off during severe storm development.

National Warning System (NAWAS) - Another relatively new and effective vehicle for rapid dissemination of severe local storm warnings is the NAWAS "hotline." This special telephone has been provided by the Office of Civil Defense (OCD) to our offices located at state capitols and several others, mainly in larger cities. Most are in operation; a few are still pending. This phone allows our people to transmit and receive storm information directly from law enforcement agencies and Civil Defense personnel.

WBAS, Little Rock has made arrangements to receive reports of local storms and to relay watch and warnings over the NAWAS facility. The effective warning of Conway, Arkansas (a tornado occurred just before the famous Palm Sunday storms further north), was given over the Civil Defense radio installed in the Weather Bureau office. The Civil Defense official in Conway spread the warning locally after he received the radio alert from WBAS, Little Rock. The Civil Defense radio will give backup capability to NAWAS in case of telephone line outage.

WBAS, Memphis - In the summer of 1965, Weather Bureau representatives working with Mr. Henry W. Slavick, Chairman of the Tennessee Association of Broadcasters, put together a rather unique but most effective means of broadcasting emergency information from WBAS, Memphis. The time lag is only sixty seconds. Briefly, the system consists of a direct telephone line from the Weather Bureau to each of the participating stations (paid for by the Broadcasting Association). In the Weather Bureau office a "black box" is installed adjacent to a microphone in the radar room. A similar "black box" is installed at each of the participating stations. Details of operation are something like this: When an emergency condition such as a tornado, flash flood, or other hazardous condition exists, the forecaster in the Weather Bureau can punch one of two buttons on the box in his office. This will transmit an alerting signal which will sound in all of the radio and television stations. This signal will be transmitted for approximately fifty-five seconds. The forecaster will then punch the other button on the box for a period of five seconds. This will transmit a steady 1000 cycle tone. At the end of five seconds, the forecaster will speak into the microphone and his voice will be carried directly on all participating radio and television channels.

The program has grown quickly and now has nine broadcasting stations and eight other outlets in Memphis (police department, fire department, sheriff's office, Civil Defense, etc.). In addition, the EBS stations (five large coverage stations in the area) simultaneously transmit the Emergency Action Notification Signal. This alerts forty-five additional stations in the Mid-South to receive and rebroadcast "off the air" simultaneously the official warning bulletins.

The outlying radio, FM, and television stations utilize simple "air-alert" receivers which are turned to one of the key stations. When an air-alert receiver picks up the EBS signal, penetrating alarm signal warns the station of the forthcoming announcement. The net effect of the operation of the system provides the public with an instantaneous alert and informs the entire city of Memphis and the Mid-South region, via radio or television, within one minute of the seriousness or potential danger of threatening severe weather.

Mr. R. A. Frase, Chief Engineer of the WMC station in Memphis, printed several thousand diagrams and instructions describing a simple type of air-alert device which can be hooked up to any AM or FM radio receiver. (See following page).

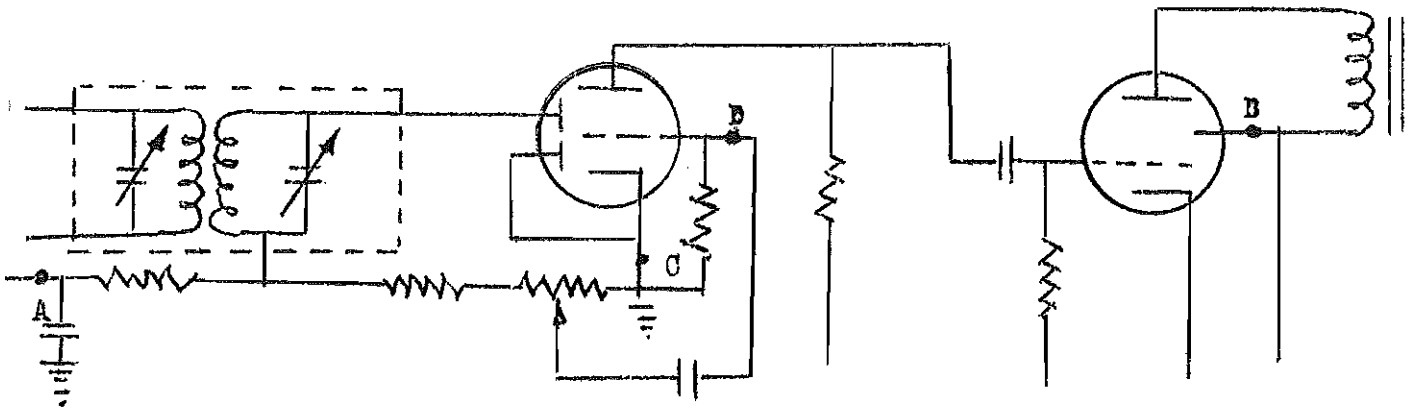
The plan and the diagrams were given wide distribution in the hope that all schools, hospitals, law enforcement agencies, firms, buildings, apartments, and even private homes will install the simple air-alert device.

The program is called "Emergency Weather Warning System" (EWWS) and operates within the Emergency Broadcast System (EBS).

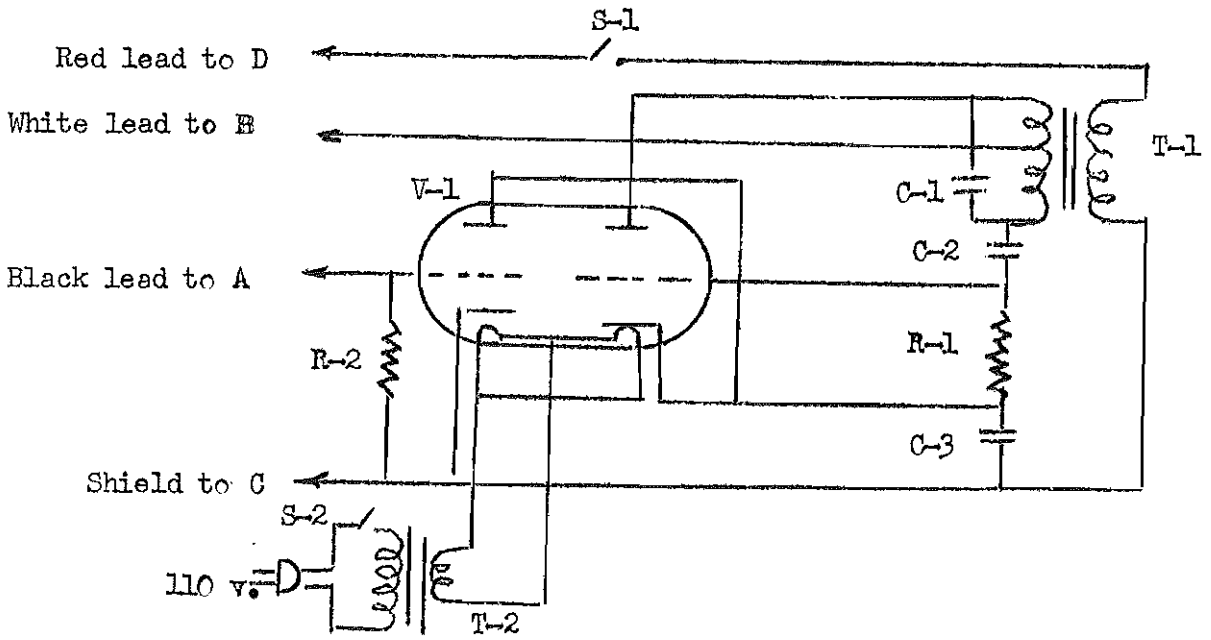
St. Louis school became the first school in Memphis to become a part of the project when its air-alert device was installed in late October.

WBAS, Atlanta works closely with the State Civil Defense in its emergency weather warning program. State Civil Defense headquarters in Atlanta has excellent communications with all law enforcement agencies in the state including State Board of Conservation. Severe weather reports received by State CD headquarters in Atlanta are relayed to WBAS, Atlanta over the local public weather service circuit. Bulletins or statements regarding a tornado "watch" or "warning" are transmitted over the public weather circuit directly to State CD headquarters. Mass media (AP, UPI, etc.) outlets are also on this circuit.

In addition to the rapid communications capability inherent in the public weather circuit, Atlanta can also use the NAWAS telephone. Direct radio broadcasts during storm emergencies can be made over WSB (one of the South's most powerful stations) by first placing a phone call to the station. In a matter of a minute or so, tornado warnings can be going out over WSB from the Weather Bureau.



TYPICAL RECEIVER DIAGRAM



EMERGENCY WEATHER WARNING AIR ALERT DEVICE

USE

This modification can be made on any radio receiver equipped with AVC (automatic volume control). By so doing, schools, hospitals, homes, etc. could be automatically alerted to severe weather (tornado warnings) direct from the Weather Bureau by tuning to a participating station.

THEORY

Basically, the alarm consists of a keyer and audio oscillator which is triggered by the absence of the receiver AVC voltage. As soon as the broadcast station cuts its carrier, (five seconds or so) the oscillator in the monitor becomes active and its signal is fed back into the receiver.

INSTALLATION

1. The black lead goes to the receiver AVC bus. (A on the diagram)
2. The white lead goes to the receiver B+. (B on the diagram)

3. The red lead goes to the grid of the first audio tube. (D on the diagram).
4. The shield is connected to B- of the receiver. (C on the diagram).

Note: Switch S-1 allows the receiver to be in "play" or "muted" position.

PARTS

R-1	100K Resistor 1/2 watt
R-2	5.6 Meg. Resistor 1/2 watt
C-1, 2	.005 mfd Capacitor Disc 600 v
C-3	.1 mfd Capacitor 600 v
T-1	Audio Output Transformer (Stancor A-3823)
T-2	Filament Transformer 6.3 v (Stancor P-6134)
S-1, 2	SPST Toggle Switch
V-1	12AX7
	9-pin Tube Socket
	Line Cord with Plug
	5 x 3 x 2 Minibox (Bud CU-3006A0)

WRITTEN AGREEMENTS WITH SAFETY AGENCIES

Formal contracts with state governments for the purpose of handling severe weather warnings have proved effective in a number of areas. These contracts assign specific tasks to the respective parties and thus minimize the chance of misunderstanding. Agencies cooperating with the Weather Bureau often feel a keener sense of personal responsibility for the success of the warning effort when a formal contract is in effect. Following is a copy of the agreement between WBAS, Albuquerque and the New Mexico Office of Civil Defense.

SEVERE WEATHER WARNING

Agreement Between U. S. Weather Bureau, Albuquerque
and New Mexico Office of Civil Defense

I. SITUATION

A. General:

1. The occurrence of unusual and severe weather phenomena can adversely affect the safety of life and property and/or result in unnecessary suffering. When the probability of such conditions are known in advance, precautions can be taken and preparation can be made to substantially reduce the impact and aid in recovery efforts when the hazard has passed.

2. The U. S. Weather Bureau has the professional competence to forecast the occurrence of severe weather situations and to predict their approximate intensities and duration.

II. MISSION

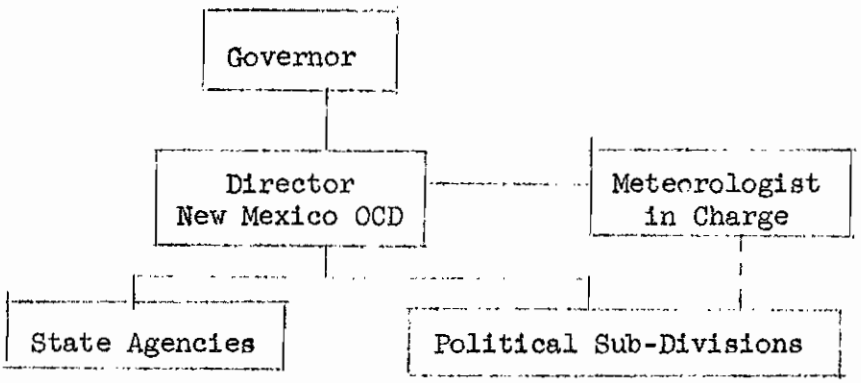
A. To provide the appropriate New Mexico State agencies and city and county governments within the State with the advance warning and other pertinent information when unusually hazardous weather conditions are forecast or are occurring.

B. To provide the warning to the general public when conditions warrant such action.

III. ORGANIZATION

A. The Civil Defense Organization structure of New Mexico will apply. Albuquerque Weather Bureau Forecast Center will provide consultant and technical advisor services in the execution of this plan.

B. Organization Chart: (Abbreviated)



IV. CONCEPT

A. When, in his judgement, the duty forecaster, Albuquerque Weather Bureau Facility, considers a weather situation, or other natural phenomenon which will cause unusual hazard or serious problem to the continuation of normal day by day activities is developing, he will so advise the Office of Civil Defense. He will brief the Civil Defense representative on the nature of the situation, expected intensity and duration, and any other applicable information. The Director of Civil Defense, or his representative, will assume the responsibility to further transmit the warning to the affected state agencies and/or localities as prudence dictates. Of primary concern, not necessarily all inclusive, are: heavy rains causing or contributing to flooding; winter storms of blizzard proportion; tornadoes.

V. TASKS

A. The duty forecaster, Albuquerque Weather Bureau Facility will:

1. Automatically alert the State Civil Defense Office when any of the above conditions, or any other which he considers potentially dangerous, exist, or are forecast within the State.

2. When such conditions are, or are expected to be localized to a geographical area serviced by a National Warning System (NAWAS) terminal, he will also advise the NAWAS operator on duty. (See paragraph VI, B.)

3. Provide, on request of the State Civil Defense Office or State Police, such other routine weather information as may be needed from time to time.

4. Continue to comply with all agency directives, policies and/or established practices regarding public warning or warning to other governmental agencies.

B. The New Mexico OCD will:

1. Evaluate any severe weather warning received as to its application to a Civil Defense responsibility and initiate any action required.

2. Relay the information to any affected local governments for their determination of action to be taken.

3. Maintain liaison with the Meteorologist in Charge to assure that this plan is current at all times and/or updated as required.

C. The New Mexico State Police will:

1. Maintain a continuous listening watch at the Santa Fe Office NAWAS Net Control Point, and will notify a representative of the State Civil Defense Office of any weather warnings received during nights and week ends when the Civil Defense Office is closed. The standard "emergency call roster" will be used for this purpose.

2. Request any weather information reasonably required in the furtherance of the effective accomplishment of their mission.

3. Assure that officers in the field are alert to recognize hazardous weather conditions in remote and unpopulated areas where weather observation facilities do not exist, and that they report such conditions for prompt relay to the Weather Bureau Duty Forecaster.

D. All State Warning Point Operators will:

1. Record all severe weather warnings directed to their area, and immediately advise the local Civil Defense Directors and/or heads of government. Take any other action required by local procedure. Warnings will be copied and repeated verbatim. No attempts at evaluation or interpretation will be made by the operator and the message will be identified as a Weather Bureau forecast.

VI. COMMUNICATIONS

A. The New Mexico segment of the Civil Defense National Warning System (NAWAS) with its ten warning points will be the primary communications system for execution of this plan. The State CENTREX/WATS System will be used to relay to points not served by NAWAS. The Civil Defense Emergency Radio System will be used as back-up as necessary.

B. NAWAS Terminals are located at:

1. Santa Fe
   State Police Hq. (call sign "Santa Fe")
   Civil Defense Hq. (call sign "New Mexico, Two")
   AEC, Sandia Base
   AEC, Los Alamos
   AEC, Fort Wingate
   Albuquerque Weather Bureau
   Albuquerque (State Police Division Hq.)
   Mesilla Park (State Police Division Hq.)
   Roswell (City Police Dept.)
   Clovis (City Police Dept.)
   Hobbs (City Police Dept.)
   Gallup (City Police Dept.)
   Deming (Luna County Sheriff's Office)

Except as noted, call signs are identical to stated locations.

C. System operation and message procedure will be generally consistent with DOD OCD Publication FG-E-1.2, "National Warning System (NAWAS) Operation Manual," January 1964. This is not meant to exclude common conversational phraseology in the interest of communicating messages from point to point. Voice "call-up" will be the normal means of establishing initial contact.

1. Message example:

Weather Bureau: New Mexico Two, this is Albuquerque Weather---------.

N. Mex. C. D. : Albuquerque Weather, this is New Mexico Two. Go ahead.

Weather Bureau: New Mexico Two, severe weather warning follows. (weather info) Did you copy?

N. Mex. C. D. : Roger your message, Albuquerque Weather.

Weather Bureau: Albuquerque Weather out, 1045 Mountain Standard Time, four July.

VII. AUTHENICATION

A. The signatories hereto mutually agree to the stated concept and general procedures contained in this plan.

S/H. L. Jacobson
H. L. JACOBSON
Meteorologist in Charge
Albuquerque District
U. S. Weather Bureau

S/H. C. Naugle
H. C. NAUGLE
Director
New Mexico Office of Civil Defense

SELS COMPUTER PROGRAMS

SELS has a continuing technical improvement program and one of the fairly recent innovations is the operational use of an electronic computer. An IBM 1620 computer was used in 1965 but in 1966 a bigger and faster CDC 3100 will perform the computations.

The large volume of data processed by SELS is now done faster by way of computer techniques and the probability of some types of computational error has been reduced. But the actual time of issuance of the basic severe weather forecast remains a function of the availability of data and the actual state of the atmosphere during the sampling periods.

Analyses of portions of the 0600 CST upper air data become available by 0730 CST; detailed vertical profile analyses are available by 1000 CST. Since daytime heating influences most cases of local storm development, surface temperature reports beginning at 1000 CST assume increasing importance. Computer analysis of these data makes 1100 CST a rather critical cutoff period. Frequently SELS can make definite decisions at this time while, previous to this cutoff period, decisions must be more provisional.

SELS personnel welcome the chance of explaining their decisions and coordinating their advices but the analysis of the mass of data described in this paper shows why this desired discussion becomes impossible during some critical periods. Information discussed in this paper has been provided by Messrs. A. D. Pearson, J. G. Galway, D. S. Foster, and W. A. Schroeter of the Kansas City Forecast Center and L. A. Hughes and R. C. Baskin of Central Region Headquarters. Details on forecast models and techniques employed by SELS are outlined in "Forecasting Guide No. 1" and subsequent technical reports.

Since the majority of severe local storms occur in the afternoon, the first computer operation may be considered to be the morning run of UXUS data. Height, temperature, dewpoint, and the 12-hour change of these elements as well as wind direction and speed are plotted for the constant pressure surfaces of 850, 700, and 500 mb. These are printed out on maps by 0730 CST and the charts are then analyzed by hand.

The 850 - 500 mb thickness chart along with the 12-hour change is also plotted from the UXUS data. The 850 - 500 mb shear wind, which is the Vector difference of observed wind, is entered on the map. Three stability measurements are also plotted: Showalter's stability index and 12-hour change, the temperature difference between 850 and 500 mb and the difference between the 850 mb dewpoint and 500 mb temperature.

RAOB analysis by the computer prints out a number of parameters on a map and these are available by 0930 to 1000 CST:

1. An objective maximum surface temperature.
2. Average mixing ratio of the lowest 100 mbs.
3. Lifted index - Difference between 500 mb temperatures and temperature of a lifted parcel with a mean mixing ratio and potential temperature of the lowest 100 mbs (evening RAOB) or the objective maximum temperature (morning RAOB).

4. Level of free convection.
5. Lift required to overcome the negative area when a parcel is raised from the warmest point on an inversion.
6. Computed hail size.

Meso scale maps of the lifted index are printed out each two hours. This lifted index is based on hourly surface temperature and dewpoint observations and an emperically corrected 500 mb temperature. Hourly surface wind reports are used to advect the lifted-parcel temperature which is emperically corrected for diurnal change by a diabatic heating function. This advection of the lifted-parcel temperature yields a tendency of the lifted index. All of this is done by the computer and it plots out a map 720 nautical miles on the side with a 15 x 15 grid and 48 nautical miles between the points. The first of these 2-hourly lifted index and tendency maps is available at 1100 CST and the last about 1900 CST.

Hourly sea level pressure reports and surface wind observations are programmed into the computer and produce the local second time derivative of the surface relative vorticity. Mr. Donald Foster presented a report on this procedure, which has been found useful in forecasting tornadoes, in the July 1964 "Monthly Weather Review." The print-out map and the production time interval are the same as with the lifted index and tendency map.

Several other variables are computed on an optional basis including surface vorticity and divergence and the instantaneous tendencies of these quantities Parcel trajectories for six and twelve hours are made from the second standard reporting level at some upper wind reporting stations. Low level convergence can be inferred from the computed trajectories. Temperature advection is determined at the 850, 700, and 500 mb levels from the winds and from the shear through a 4000-foot layer centered on the particular level.