OPERATIONS REPORT ON A
CLOUD SEEDING PROGRAM
FOR THE
EDWARDS UNDERGROUND WATER DISTRICT

NAWC WM-86-6

NORTH AMERICAN WEATHER CONSULTANTS

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Salt Lake City, Utah 84124

OPERATIONS REPORT ON A CLOUD SEEDING PROGRAM FOR THE EDWARDS UNDERGROUND WATER DISTRICT

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Prepared for

THE EDWARDS UNDERGROUND WATER DISTRICT

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1. INTRODUCTION

North American Weather Consultants (NAWC) was contacted by several entities in Texas during the Summer and Fall of 1984 concerning the possibility of developing summertime cloud seeding programs to enhance naturally occurring rainfall. Parts of Texas had experienced a significant drought during the Spring and Summer of 1984 which depleted existing water supplies. An interest in weather modification (cloud seeding) developed due to these drought conditions. NAWC responded to a request for proposals issued by the Edwards Underground Water District (DISTRICT) in San Antonio for a cloud seeding program over portions of the Edwards Aquifer. NAWC and its subcontractor, Weather Modification Inc., were awarded this contract. The first year of operation was 1985 when operations were conducted between July 8 and September 30, 1985. This is our second year of operation which ran from April 1 to September 30, 1986.

Texas law requires that a firm or individual be licensed to conduct cloud seeding operations within the State as well as obtaining a permit to conduct operations in a specific area. As part of the permit requirement, a Notice of Intent must be published for three consecutive weeks in the local newspapers within the area. A provision of the Texas law stipulates that if 25 residents from the proposed target area sign a petition, then a public hearing is required before the Texas Water Commission can grant the permit. Such a petition

was filed in 1985 on the Edwards program following publication by NAWC of the Notice of Intent. The permit was granted to the Edwards Underground Water District program on June 18, 1985 following a public hearing held in Leakey, Texas on April 9, 1985. No public hearings were required in 1986, since a four year permit was granted in 1985.

Cloud seeding operations were conducted from April 1 to September 30, 1986 for the DISTRICT by NAWC. An earlier climatological investigation indicated that the best months for convective seeding would be April through September. The target area is shown in Figure 1.1 and includes all or portions of the following counties: Uvalde, Medina, Bandera, Kerr, Real, Edwards, Kendall and Kinney.

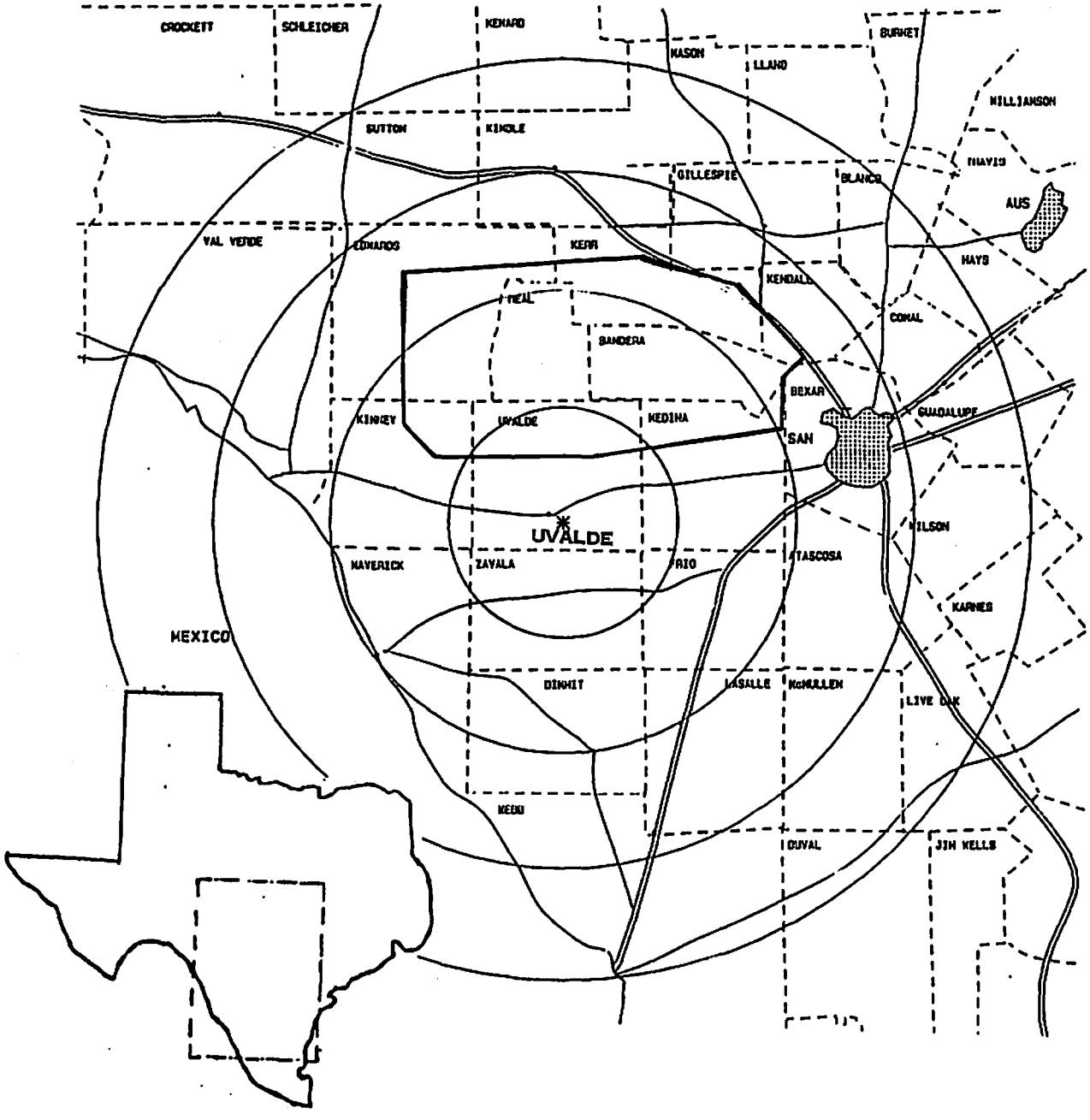


Figure 1.1 Edwards Underground Target Area.

2. TECHNICAL BASIS

Weather modification research and application have been utilized for over thirty years in many areas of the world for several different purposes including, precipitation (rain and/or snow) enhancement, hail reduction, and fog dissipation. Studies by the Southwest Drought Research Program (Eddy and Hurley, 1983) and the Texas Hiplex Report (Riggio, et al., 1983) indicated potential for a summertime rain augmentation program. The technological basis of cloud seeding for precipitation is that a large number of convective clouds are inefficient in the precipitation process. The injection of certain particles into suitable clouds can increase the amount and the rate of formation of precipitation by increasing the efficiency of such clouds. Since precipitation augmentation was the goal of this program, a brief discussion of cloud seeding theory and methods follows.

As moist air is warmed near the ground it becomes warmer than the surrounding environment and begins to rise. As the air rises it expands and cools which raises the relative humidity until it becomes 100%. With further uplifting, the air becomes supersaturated and condensation forms. This condensation level marks the base of the clouds. When clouds reach an altitude in the atmosphere where the temperature is colder than 0C (32F) some of the water drops will freeze. The factor that determines whether a cloud drop will freeze is the purity of the drop. The more pure the drop, the colder it can become before freezing.

In order for precipitation to form, cloud droplets must either collide with other droplets or they must freeze and

grow as large ice crystals, the latter process being quicker and more efficient. Ice crystals are produced by interactions of moisture and microscopic particles called freezing nuclei. It is this process in which cloud seeding is of use. By adding artificial nuclei into the cloud (at the -5C to -15C level), where natural ice nuclei are deficient, the precipitation growth process can be initiated or enhanced.

Past research has determined that silver iodide (AgI) is the best nucleating agent because its crystal structure is similar to that of natural ice crystals. Microscopic AgI particles are injected into suitable clouds by various methods to aid the precipitation process.

2.1 Seeding Method

Recent studies have shown that the dynamic seeding method has the best potential for increasing precipitation in summertime cumulus clouds (Woodley et al., 1976). The goal of dynamic seeding is to freeze large amounts of supercooled water droplets resulting in increased buoyancy from the release of latent heat of fusion. Dynamic seeding appears to cause cumulus clouds to grow taller, wider, and last longer than similar non-seeded clouds. This expansion of the cloud system generally results in an increase in precipitation. NAWC had adopted this dynamic seeding method on earlier operational cloud seeding programs in Georgia and Jamaica (Griffith and Brown, 1976; Griffith, 1982).

NAWC utilized the dynamic seeding method during the 1986 Edwards Underground Water District program by dropping burning flares impregnated with AgI from an aircraft into suitable

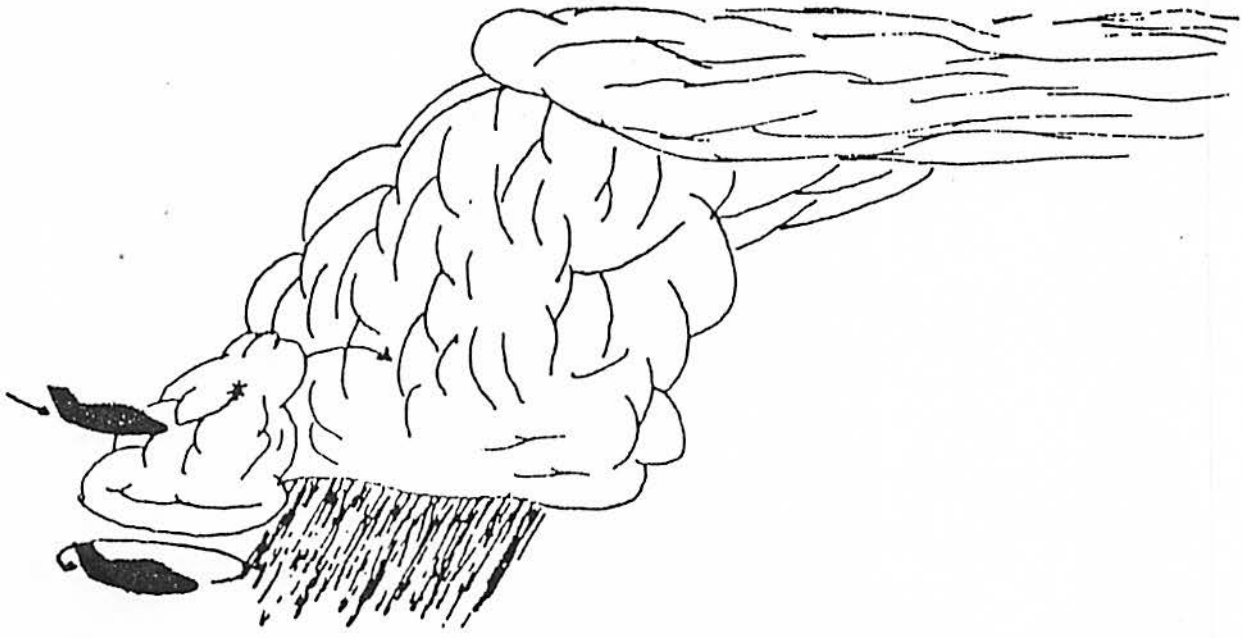
convective clouds. Figure 2.1 illustrates the seeding method used for single and multiple convective cells. The aircraft used to perform the cloud seeding (a Cessna 340 and a Beechcraft Duke) were pressurized, twin turbocharged, radar equipped, and capable of dropping 102, 10 20, or 30, gram flares over a three hour period. There may be certain circumstances where cloud top penetrations are not feasible (safety and logistics) for cloud seeding. Therefore, wing-tip mounted, AgI-acetone, nuclei generators were installed on the aircraft to enable the aircraft to continue seeding activities below cloud base when less than favorable conditions occurred. Once a candidate cloud was identified, either by radar or by visual means, the cloud was treated by penetrating the updraft area with the aircraft at the -10 to -15C level (typically 18,000 - 23,000 ft). A number of AgI flares were ejected into the cloud depending on specific conditions present (amount of liquid water present, updraft velocity, and radar intensity). Other clouds, with acceptable characteristics within the target area, were treated in a similar manner and observed for treatment response.

2.2 Suspension Criteria

Due to the large number of atmospheric variables that may contribute to the weather at any one time, suspension criteria were developed to avoid contributing to, or appearing to contribute to a hazardous condition. The following are the criteria used for suspending operations during the 1986 Edwards season:

1. Tornadoes, and funnel bearing clouds were not intentionally seeded.

Single Cell Seeding at Cloud Top for Dynamic or Microphysical Effects and at Cloud Base for Microphysical Effects.



Dynamic Seeding at Cloud Top of Clustered Cells and at Cloud Base for Microphysical Effects.

Figure 2.1

2. Based upon radar reflectivity measurements, cloud systems that had the potential for producing excessive rainfall in a short period of time as well as all clouds within a 23-mile radius of these systems were not seeded. A determination of the potential for excessive rainfall was based upon the following criteria:

   a. Cloud systems consisting only of stratiform clouds will not be seeded;
   b. Stationary storms will not be seeded;
   c. moving convective cells or other moving cloud systems will not be seeded and seeding activities will be suspended if, based upon radar reflectivity, the system will produce or begins to produce greater than one inch per hour of rainfall at a fixed point on the ground as determined from the graph shown in Appendix A.

3. Storm complexes were not seeded that were expected to produce hail reaching the ground. The criteria that was used is the observation of a 45 dBz level on the 5 cm radar at or above 1.5 km above the freezing level (Foote and Knight, 1979; Mather, et al., 1976; and Waldvogal et al., 1979). These criteria were developed to discriminate between clouds that produced hail reaching the ground and those that did not.

4. Seeding was not conducted within the project area whenever a National Weather Service Severe Weather Warning was issued that affected any part of the target area.

5. Excessive soil moisture - This condition was determined by the DISTRICT officials, and, if requested, seeding was not conducted on any storms in the designated area.

6. Hurricanes - No seeding was conducted within the target area when hurricane warnings (not watches) were in effect for any part of the target area.

7. Operations were suspended, when, in the project meteorologists opinion, a hazardous condition existed.

8. Suitable clouds that were expected to exit the target area boundary within 60 minutes were not seeded. The 700 mb wind was used to predict cell movement along with weather radar observations.

3. PROCEDURES

The success of any program depends on the dedication of the selected field personnel. Since weather occurs on a 24 hour basis, the personnel must be ready to conduct operations on short notice. Therefore, field personnel were essentially on a 24 hour, 7 days a week notice. There were days when no suitable weather was forecast (i.e., clouds reaching the -10C level) and under those conditions, a standby was initiated which allowed more freedom for project personnel. However, a visual surveillance was encouraged for any unexpected weather activity.

The daily routine and decisions were based on a number of variables associated with the current weather conditions. NAWC processed and evaluated the 00Z and 12Z rawinsonde (weather balloon data) from Del Rio, Midland, or Victoria. Stability indices were calculated (i.e., SWEAT, K, Lifted) when needed to determine the strength and depth of convection. A graphic illustration of the decision flowchart is shown in Figure 3.1. The seeding decisions were based on a number of atmospheric conditions. The decision process for cloud seeding is graphically illustrated in Figure 3.2. The goal of the seeding was to achieve a concentration of 10 - 100 AgI particles per liter at the -5C to -15C level in the cloud. A summary of the major criteria are as follows:

a. The cloud top temperature of the newly forming convective cells should be between -5C and -25C. This applies to both new cells and cells adjacent to larger convective complexes.

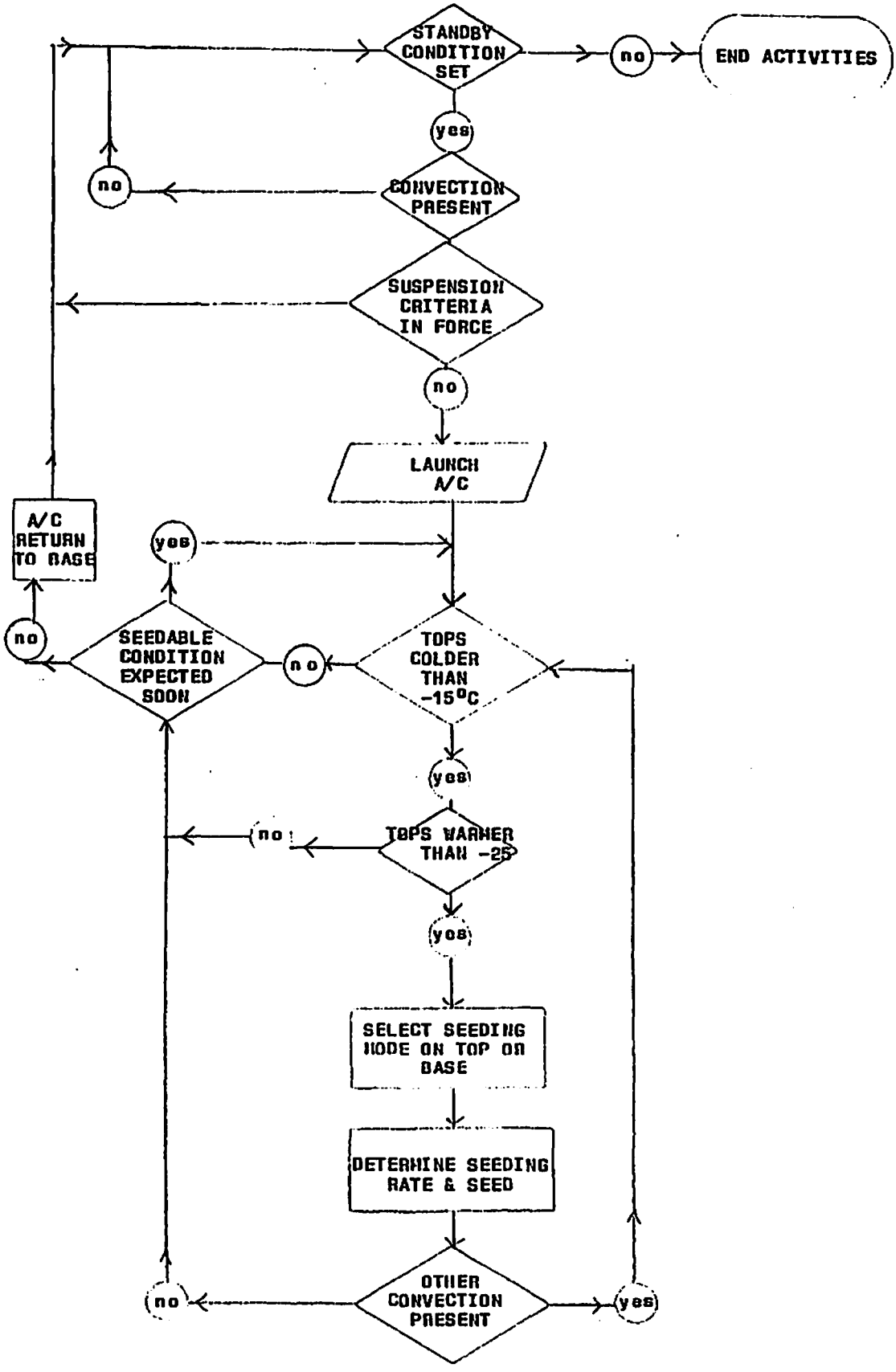


Figure 3.1 Seeding Decision

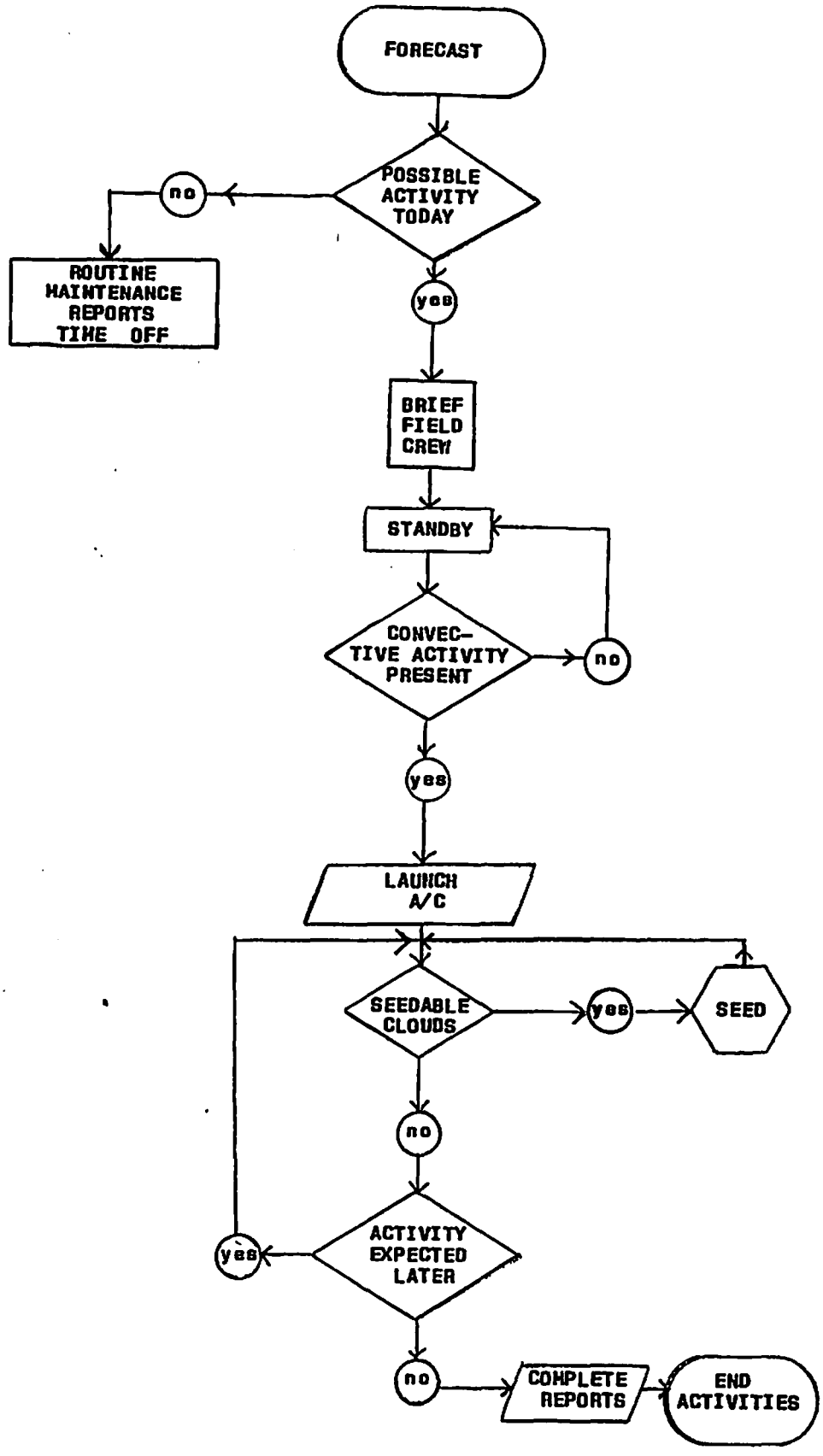


Figure 3.2 Daily Routine

b. The updraft velocity within the cloud must be greater than 400 feet/minute before flares are fired.

c. Other considerations were: cloud liquid water content, strength of convection, and upper atmosphere conditions.

4. PROJECT ORGANIZATION

4.1 Personnel

NAWC provided qualified meteorologists and pilot for the Edwards Underground Water District program. A list of the project personnel involved in the 1986 program is given below:

Table 4-1

Project Personnel

NAME	TITLE	BASE OF OPERATION
Don Griffith	Vice President NAWC, Salt Lake	Salt Lake City
H. Robert Swart	Project Coordinator/ Meteorologist	Uvalde/Salt Lake City
Dan Risch	Project Director/ Meteorologist	Uvalde, Tx
Arthur Heiden	Pilot	Uvalde, Tx

4.2 Equipment

The various hardware components used during the program are presented in detail below. NAWC's subcontractor, Weather Modification Inc. of Bowman, North Dakota, provided all of the equipment plus pilot to the seeding program.

Radar - One of the most important ground-based systems used during a convective weather modification program is the weather radar. NAWC used an Enterprise Electronics Corporation (EEC) WR-100-2 radar based at the Uvalde, Texas municipal airport. This location was the same as one used for the 1985 program. The maximum range of the radar was 250 nautical miles but the immediate range of 125 nautical miles allowed excellent coverage of the target area. Figure 4.1 shows the area of the state encompassed by the radar. Included in the radar package was a digital video integrator processor (DVIP); Video Integrated Display (VID); and Flitetrack tracking systems. The Flitetrack system allowed the radar operator to observe the exact aircraft position relative to the clouds being treated. Appendix B provides specifications of the radar.

Aircraft - The Edwards program utilized one dedicated seeding aircraft. The aircraft was based at the Uvalde, Texas municipal airport. This location minimized the transit time from the airport to the target area.

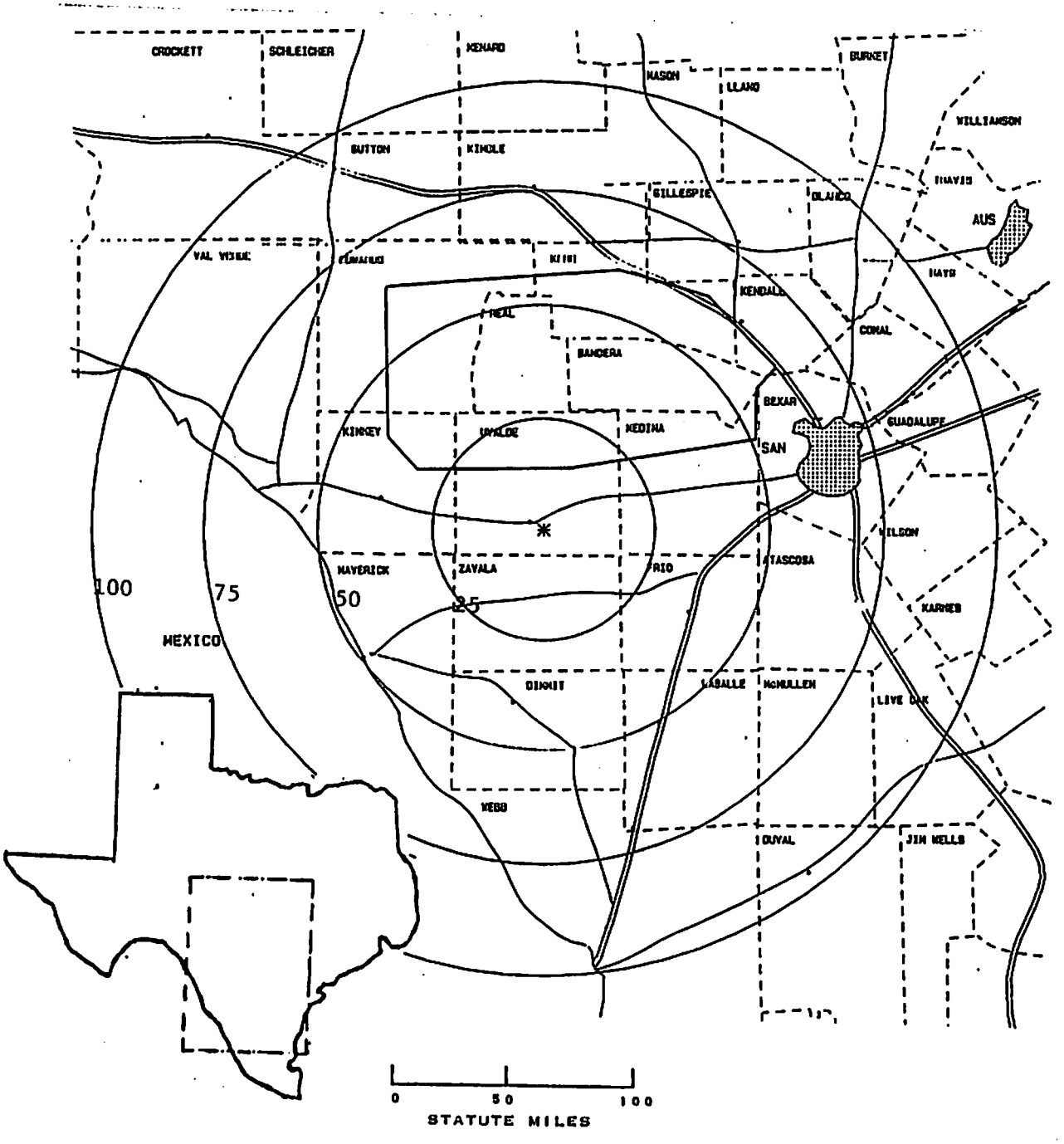


Figure 4.1 Radar Coverage of the Edwards Target Area. (Range rings in nautical miles).

The dedicated aircraft used for cloud seeding was a Cessna 340. This aircraft was equipped with a pyrotechnic (flare) rack which held 102, 10, 20 and/or 30 gram AgI flares along with two wing-tip AgI generators to dispense AgI into updraft regions of the cloud. The wing-tip generators consisted of a tank, a silver iodide-acetone reservoir, an ignition system, and a burner section. Both the wing-tip generators and the pyrotechnic racks were controlled from inside the aircraft by an electrical control box. The AgI was dispensed by the pilot when conditions were correct for seeding as determined jointly by the pilot and project meteorologist. The aircraft was also equipped with a radio to communicate between the aircraft, and weather radar.

Meteorological Data - NAWC acquired hourly surface and upper air observations from National Weather Service locations for Texas and adjacent states. These data were received via a satellite antenna and receiver designed specifically for this purpose (SISCORP System). One of the weather circuits received over this satellite system was processed through an IBM computer system which allowed specific weather observations to be printed for real-time forecasting. An example of the data received appears in Appendix C. Specific weather information such as, flash flood warnings and watches, hurricane updates, and severe weather areas, were available to the project meteorologist. Weather summaries for each program day appear in Appendix D.

5. OPERATIONS

All operational decisions rested with the Project Director at the Uvalde project site. The primary decision was the initiation of seeding operations, but radar surveillance, aircraft dispatching, suspension criteria and seeding location were also important. All decisions were based on the atmospheric conditions shortly before seeding was to be initiated.

5.1 Aircraft Operations

Aircraft operations were of two types - seeding and observation. Observation flights were flights where no seeding was conducted. The final seeding decision was made by the pilot during cloud penetration. If the cell did not contain liquid water, have updrafts of > 400 feet/minute, and tops to at least the -10C level, then the cell was not suitable for seeding. These characteristics could only be measured by the aircraft during cloud penetration. Table 5-1 is a summary of the aircraft operations.

Table 5-1

Aircraft Operations Summary

Month	Number of Flights			Total Hours	Material Dispensed (grams)
	Seed	Observation	Total		
APR	3	1	4	5.31	197
MAY	5	3	9	17.58	2000
JUN	1	1	2	3.50	1740
JUL	3	3	6	10.33	3917
AUG	7	1	8	20.29	6180
SEP	10	4	13	28.42	5334
SEASON	29	13	42	85.43	19368

Detailed summaries of the aircraft operations and seeding locations during individual flights are on file with the Texas Department of Water Resources.

During the program, a number of clouds suitable for seeding were not seeded because one or more of the seeding suspension criteria was in effect. Table 5-2 is a summary of the seedable periods when no seeding was performed due to those suspension criteria.

Table 5-2

Seeding Restriction Periods

Date	Type of Weather Restriction
Apr 8	Severe Thunderstorm warning issued by NWS
Apr 9	Excessive soil moisture assessment by EUWD
*Apr 10	Excessive soil moisture assessment by EUWD
*Apr 11	Excessive soil moisture assessment by EUWD
+Apr 19	Less than one hour exit time
Apr 30	1" per hour rainfall, hail, slow-stationary, severe TRW warning issued by NWS
May 8	Hail
+May 9	Severe thunderstorm warning issued by NWS
May 10	Flash flood warning issued by NWS, hail, excessive soil moisture assessment by EUWD
May 14	Hail
*May 26	Excessive soil moisture assessment by EUWD
*May 27	Excessive soil moisture assessment by EUWD
+May 30	Manager decision due to expected heavy rains
May 31	Excessive soil moisture assessment by EUWD
Jun 1	Manager decision due to excessive soil moisture
Jun 2	Excessive soil moisture assessment by EUWD
*Jun 3	Excessive soil moisture assessment by EUWD
*Jun 4	Excessive soil moisture assessment by EUWD Flash flood warning issued by NWS
*Jun 5	Excessive soil moisture assessment by EUWD
*Jun 6	Slow/stationary, flash flood warning issued by NWS, 1" per hour rainfall
*Jun 7	Slow/stationary
*Jun 8	Slow/stationary

Table 5-2 Continued

Seeding Restriction Periods

Date	Type of Weather Restriction
Jun 12	Slow/stationary, 1" per hour rainfall
Jun 17	1" per hour rainfall
Jun 18	Excessive soil moisture assessment by EUWD, Flash flood warning issued by NWS
Jun 19	Excessive soil moisture assessment by EUWD Flash flood warning issued by NWS
Jun 20	Excessive soil moisture assessment by EUWD
Jun 21	Excessive soil moisture assessment by EUWD
*Jun 22	Excessive soil moisture assessment by EUWD
Jun 23	Excessive soil moisture assessment by EUWD
Jun 24	Excessive soil moisture assessment by EUWD
Jul 2	Hail
Jul 20	Slow/stationary
Jul 21	Slow/stationary
Aug 4	Slow/stationary
Aug 10	Slow/stationary
Aug 11	Slow/stationary
Aug 12	Slow/stationary
Aug 17	Slow/stationary
Aug 20	Less than one hour exit time
Aug 28	Slow/stationary
+Aug 31	1" per hour rainfall, manager decision due to expected heavy rains
+Sep 1	1" per hour rainfall, less than one hour exit time
*Sep 6	Flash flood warning issued by NWS
*Sep 7	Flash flood warning issued by NWS
Sep 11	1" per hour rainfall, slow/stationary, hail
Sep 12	1" per hour rainfall, slow/stationary
Sep 25	1" per hour rainfall, slow/stationary, hail
Sep 26	1" per hour rainfall, slow/stationary, flash flood warning issued by NWS

Seeding restrictions did not necessarily cover the entire target area nor for the entire day.

* No cells, or non-suitable cells for seeding occurred this day.

\+ A seeding mission occurred before or after the restriction went into effect.

As can be seen above, there were several potentially seedable days that went unseeded due to National Weather Service warnings or project restrictions. There were a number of cases where a storm was located in one corner of the area and seedable cells were located in the other corner. Under the condition that the main storm is separate from the smaller cells, it may be beneficial to allow seeding operations to continue on the smaller cells. The seeding would only continue in counties not affected by the Severe Weather Warning. This operational procedure would have to be approved by the Texas Water Commission in an amendment to the seeding permit. (Such a change was approved by The Commission for the San Angelo project on November 12, 1985).

5.2 Radar Operations

The weather radar (EEC WR-100-2) was operated whenever the forecast indicated a chance of cells developing. The radar would be monitored during all seeding missions and the locations of the cells were recorded. An example of an overlay used to record cell positions is shown in Figure 5.1. All flights were directed by the meteorologist from the radar. Radio contact was maintained between the pilot and the radar so that cell information could be exchanged. Table 5-3 is a summary of radar operations during the 1985 field season.

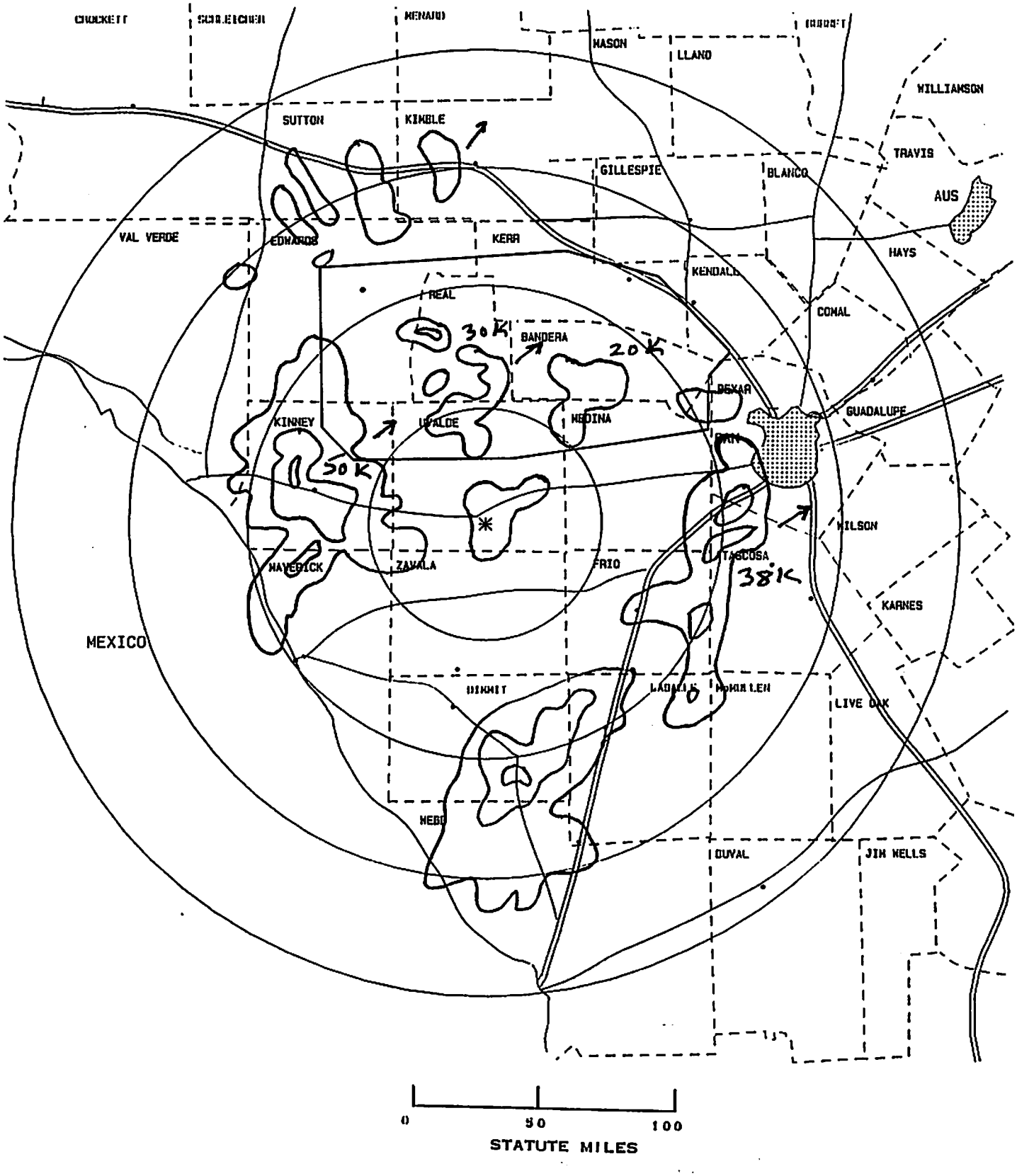


Figure 5.1 Radar Overlay with Cell Positions and Tops. Cloud Tops are in thousands of feet. (28 September, 1985; Time: 1130).

Table 5-3
Hours of Radar Use

Month	Hours of Radar Operation
APR	156.74
MAY	228.50
JUN	167.90
JUL	71.00
AUG	179.73
SEP	177.27
SEASON	981.14

6. SUMMARY

North American Weather Consultants completed it's second weather modification program for the Edwards Underground Water District. The program ran from April 1, 1986 to September 30, 1986. The program was based in Uvalde, Texas where the weather radar, aircraft, and program director resided.

Seeding operations were performed on days and used a total of 19,368 grams of silver iodide. A total of 85.4 aircraft hours and 981 weather radar hours were logged during the program. The project experienced dry conditions during July and the first half of August. Operational potential was further reduced by seeding suspensions due to excessive soil moisture content, as June was a wet month.

No evaluation of seeding effectiveness has been attempted in this operations report. A target-control type evaluation is possible, although the precipitation data for such an evaluation is delayed several months until it becomes available from the National Oceanic and Atmospheric Administration. Even if the data were available, the determination of a seeding effort for a one or two year project is difficult due to the large natural variability in precipitation coupled with the expectation of a relatively small seeding signature (10 - 20 percent). Normally, several years are required to document such a seeding effect with any degree of statistical significance.

NAWC nonetheless believes, however, that this seeding program was effective. This belief comes from experience on similar projects in other areas such as one long term program that has been conducted by the Colorado River Municipal Water

District near Big Spring, Texas. Even though there were a number of seeding suspensions on the Edwards program during the summer of 1986, considerably more seeding was accomplished on the project than the first year of operations in 1985. For comparison purposes, NAWC seeding activities for the Edwards and San Angelo programs are presented in the following. It should be noted that the operational periods of the two projects were slightly different but each project lasted for six months (Edwards - April 1 to September 30, San Angelo - April 15 to October 15).

	Number of Days with Seeding	Number of grams of Silver Iodide used
San Angelo	28	24,400
Edwards	29	19,368

7. RECOMMENDATIONS

As with any field project, experiences during the first year point out changes that could be made to improve the overall project. Following are suggestions for future years.

7.1 Permit Modification

As discussed in Section 5.1, there were several days on which seeding conditions may have existed but were left unseeded due to the severe weather warning suspension criteria. Experience showed that these suspension criteria may have been too restrictive. For instance, the permit required that no seeding be conducted in any part of the target area if a Severe Storm Warning was issued by the National Weather Service for any county in the target area. Figure 7.1 shows an example of a thunderstorm for which a severe weather warning was issued for Kerr County. It is obvious from the positions of the cells in Real and Uvalde Counties that seeding opportunities would be passed up. Imposed suspension in this example would be particularly unnecessary if the cells were moving from the southwest to the northeast. Due to the above concern and experiences, it is recommended that consideration be given to modify the permit to allow seeding in those cases similar to the preceding example.

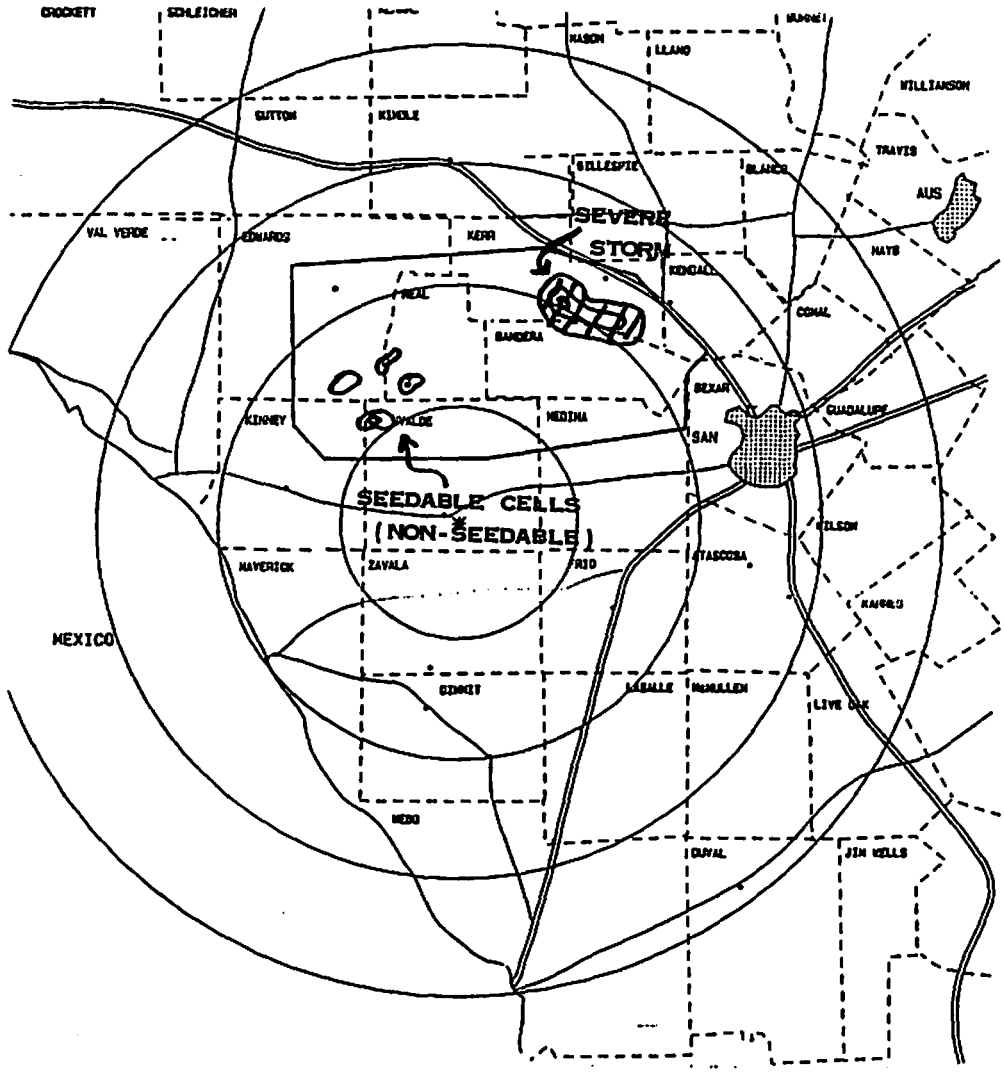


Figure 7.1 Example of Suspended Operations

7.2 Cloud Seeding Capabilities

Even though NAWC was initially contacted during a drought period concerning cloud seeding, NAWC personnel indicated that seeding opportunities would no doubt be less than more "normal" periods. It was NAWC's initial position that cloud seeding not be considered a "cure all" for drought, but rather as one of several water resource development tools, available to concerned water officials. NAWC has long been an advocate of routinely conducted cloud seeding projects assuming water storage facilities are available for carry-over of augmented water supplies into drier periods. It is therefore NAWC's recommendation that the seeding program be continued in future years. One primary advantage in doing so is that the required seeding permit has been acquired for a four year period. In order for this permit to remain valid, some operations need to be conducted each year. The continuation of the program to augment the water contained in the Edwards Aquifer could be viewed as an insurance policy against the likely recurrence of drought conditions in South Central Texas in the future.

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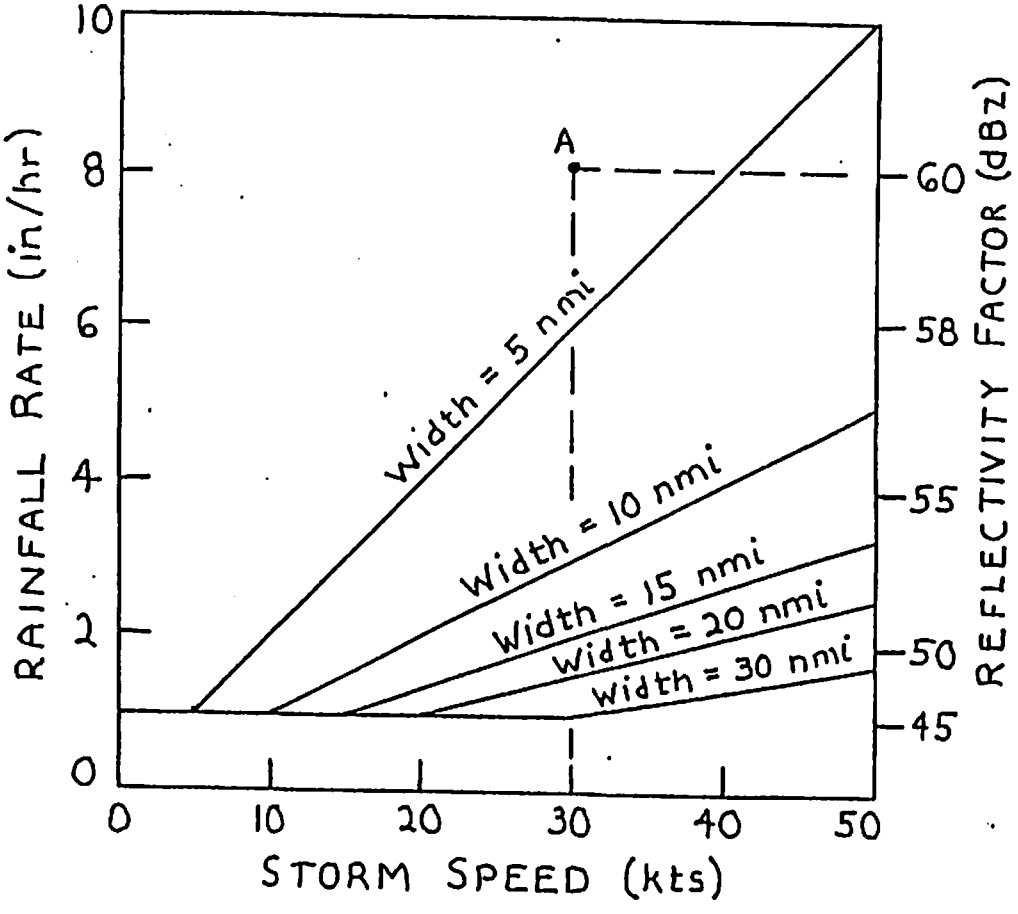
APPENDIX A

Radar Rainfall Rate Determination



Instructions for use of Flood Potential Graph:

1. Measure maximum reflectivity factor of echo in question.*
2. Determine speed and direction of echo (storm) movement/propogation. This can best be done by comparing successive echo positions on the echo overlays. If such information is lacking, request assistance from forecast office.
3. Plot reflectivity factor versus storm speed.
4. Measure maximum width of echo parallel to direction of echo movement (WIDTH).
5. If point plotted in Step 3 falls on or above the appropriate echo width line, a flood potential exists.

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*Reported rainfall rates may be used in lieu of reflectivity factors on

APPENDIX B

Enterprise Radar Specifications

Radar Performance Specifications

C-Band Radar

Construction	All solid state
Primary Power	115 volts, 60 cps, single phase
Wave length	5.2 cm
Frequency	5500-5600 megahertz
Peak Power	250 kilowatts
Pulse width	2 microseconds
Pulse repetition frequency	256 megahertz
Average power output	50 dbm (100 watts)
Minimum detectable signal	-104 db log receiver
Response characteristics	Linear within 1 db
IF frequency	30 megahertz
IF band width	1 megahertz
Antenna size	6 foot (parabolic)
Antenna beam width	2.1° pencil beam
Antenna gain	38 db
Antenna tilt range	-2° to +60°
Antenna rotation	Variable 0-4 RPM

Antenna Control

Azimith	Auto mode, velocity type manual mode, synchro follow up
Elevation	Auto mode, voltage follow up manual mode, synchro follow up

Displays

PPI size	12 inch CRT
PPI sweep range	3 scales: 50 nm, 100 nm, 250 nm
PPI range rings	50 nm - 5 rings, 100 nm - 4 rings, 250 nm - 5 rings
RHI size	12 CRT
RHI range marks	Same as PPI
RHI sweep range	Same as PPI
A-scope	Oscilloscope 6 cm x 10 cm
Range normalization	20 Log (r/r_o)
Directional coupler	Measure transmitter power Measure receiver sensitivity

DVIP Technical Characteristics

VIDEO INTEGRATOR AND PROCESSOR

Type:	All digital with exponential window.
Bin size:	1 or 2 KM selectable.
Range:	450 KM.
Number of bins:	230 or 450.
Integration factor:	15 or 31 samples selectable.
Accuracy:	Better than 1 db.
Range blanking:	Fixed - 0 to 20 KM. Variable - 0 to 199 KM.
Range correction (STC):	Corrected from 20 to 230 KM on displayed video only if selected.
Digital outputs:	- 8-bit T^2L uncorrected integrated video. - Data ready. - Range interval monitor. - Time sample monitor. - IF attenuator bypass monitor. - STC active monitor. - Test mode monitor.
Displayed video:	Normal log or contoured log.
Displayed contoured log levels:	2-cycle 3-level form at: Level 1 - Gray Level 2 - White Level 3 - Black Level 4 - Gray Level 5 - White Level 6 - Black

APPENDIX C

Example of Daily Weather Data

TEXAS
SAT SA 0150 250 -SCT 10 129/89/65/1511/995 **21:09:30
DRT AUTOB CLR BLO 60 BV8 92/61/1204/989 PK WND 11 000 **21:09:28
SJT SA 0150 65 SCT 120 SCT E250 BKN 25 120/88/64/3104/998/ CB WRWU NW **20:56:00

CRP SA 0150 E250 BKN 7 132/83/71/1315/992 **21:09:28
VCT SA 0152 250 -BKN 10 142/85/74/1310/995 **21:09:30
COT AMOS SA 0153 250-SCT 7 92/68/1308/990 PK WND 16 000ALSTG989 **21:09:28
LRD SA 0150 40 SCT 8 95/66/1210/990 **21:09:29
AUS SA 0150 CLR 20 125/89/70/1409/994 **21:09:27

WWUS35 KSAT 062259   **18:03:32**
SPECIAL WEATHER STATEMENT
NATIONAL WEATHER SERVICE SAN ANTONIO TX
557 PM CDT SAT JUL 6 1985
HEAVY THUNDERSTORMS CONTINUED AT 550 PM OVER THE SOUTHERN PORTION OF THE TEXAS HILL COUNTRY. THE ACTIVITY COVERED MUCH OF REAL AND KERR COUNTIES AND WAS MOVING SOUTHWESTWARD INTO NORTHERN BANDERA AND EASTERN EDWARD COUNTIES. MOVEMENT WAS INDICATED AT 10 MILES AN HOUR.
AT 540 PM CDT THE DEPARTMENT OF PUBLIC SAFETY IN KERRVILLE REPORTED THE SIGHTING OF A FUNNEL CLOUD APPROXIMATELY 5 MILES SOUTH OF THE CITY ON HIGHWAY 16. THE FUNNEL DIPPED BRIEFLY FROM THE THUNDERSTORM BASE THEN DISAPPEARED. THE FUNNEL DID NOT TOUCH DOWN AND DID NOT CAUSE DAMAGE.
NO SEVERE WEATHER HAS BEEN REPORTED IN THESE STORMS IN THE PAST HOUR.
IT IS POSSIBLE THAT ADDITIONAL FUNNEL CLOUDS MAY FORM BRIEFLY IN THE THUNDERSTORM ACTIVITY BEFORE IT ENDS NEAR SUNSET THIS EVENING. THESE FUNNELS ARE PRODUCED IN VERY WARM..MOIST..AND UNSTABLE AIR..AND ARE NOT LIKELY TO TOUCH DOWN OR CAUSE DAMAGE. THEY ARE VERY SHORT LIVED AND WILL DISAPPEAR QUICKLY BACK INTO THE THUNDERSTORM.
EVEN THOUGH THEY ARE NOT LIKELY TO CAUSE DAMAGE..THE NATIONAL WEATHER SERVICE SUGGESTS THAT IF A FUNNEL IS SIGHTED..PERSONS IN THE AREA SHOULD MOVE INDOORS INTO A STURDAY BUILDING AND STAY AWAY FROM THE FUNNEL.
EVERYONE SHOULD CONTINUE TO MONITOR A SOURCE OF WEATHER INFORMATION WHILE THE VERY HEAVY THUNDERSTORM ACTIVITY CONTINUES.

APPENDIX D

General Weather Summaries

DAILY WEATHER SUMMARIES

April

2 A mostly fair day with a few fair weather cumulus.

3 Low stratus deck produced some drizzle in the morning. No convective activity occurred within the target.

4 Thundershowers occurred overnight with remnants of this activity in the early morning,which moved out of the target area to the east. The rest of the day was fair. No seeding occurred.

5 A low shallow stratus deck remained over the area through the day. No convection.

6 Low stratus continued today with drizzle/rain over parts of the target. No convection.

7 Low strato-cumulus which broke up by midday. No significant convection.

8 A cold front moved down from the north in the late afternoon. The National Weather Service (NWS) issued a Severe Storm Warning for Kerr and Kendall counties. Due to several suspension criteria being met, no seeding took place.

9 Convection developed, but occurred in areas where heavy rains fell on the eighth, so no seeding due to excessive soil moisture content.

10 No convection occurred.

11 Low stratus until early afternoon, with cirrus and cirro-cumulus through the rest of the afternoon. No convection.

12 Convection developed southeast of target, but none within it.

13 Clear and sunny day, some haze in the afternoon.

14 Stratus deck in the morning with a frontal passage in the late morning. However there was no convection with this front, and no seeding opportunities.

15 Clear skies through the day.

April

16 Low, over-running clouds today. Some echoes developed south of the target, but none within it.

17 Low overcast again today. Weak echoes from this stratus developed west of Hondo, but none in target.

18 Low overcast and drizzle today. Some weak echoes from this stratus formed, but no convection developed.

19 Due to a cold front in the northeast corner of the target, convection developed there, and was seeded briefly. However the echo cells were moving southeast and quickly got into a position where the criteria for leaving the target in one hour was met.

20 Post-frontal conditions caused clear skies the entire day.

21 Clear all day.

22 Clear.

23 Patches of stratus and strato-cumulus in the morning. Fair for the rest of the day.

24 Overcast with strato-cumulus in the morning. A few echoes developed west of the target late in the afternoon.

25 Overcast stratus deck, breaking into strato-cumulus by mid-afternoon, with cirrus visible above. No convection.

26 Strato-cumulus for much of the day. Heavy cirrus began moving in from the west. The thunderstorms causing them to move up to the western edge of the target and died off in the evening. No seeding opportunities.

27 Stratus in the morning, dissipating by mid-afternoon. A frontal passage in the afternoon developed towering cumulus (TCU) and a few cumulonimbus (CB). Seeding conditions were marginal as tops did not reach very high. However a few cells were seeded.

28 Stratus in the morning. Strato-cumulus in the afternoon. A thunderstorm moved over Uvalde around midnight. No seeding was done.

April

29 A line of convection along a surface trough moved into the south central and southeast part of the target in the evening, moving north. Base seeding was conducted on this line.

30 Low stratus with light drizzle until noon. Convection began forming at around noon in the northern target area continuing into the evening as it moved southeast. The aircraft went on a recon mission, but no seeding occurred as some suspension criteria were in effect due to the strength and slow speed of the cells.

May

1 A cold front passed over the target in the morning. Convection developed only after it had passed south of the target. No seeding.

2 Clear in the morning,becoming overcast in the afternoon. With low stratus. No convection developed in the target.

3 Low overcast with drizzle at times through late afternoon. No convection.

4 Low overcast with drizzle to mid-afternoon.

5 Low overcast through the day.

6 Low overcast in the morning, becoming partly cloudy in the afternoon and evening.

7 Stratus clouds with some weak embedded convection produced light rain at radar in the morning. Aircraft was sent on a recon, but found no suitable conditions, and therefore no seeding was done.

8 Heavy thunderstorms developed in the early morning, moving up into the southern part of the target. These cells exceeded the criteria for hail and no seeding was attempted. No other activity developed or moved into the target.

9 Overcast in the morning with some light rain. Convection began around noon and continued into the evening. Some seeding was done in the early afternoon, but ended by midafternoon. Severe storm warning was issued by the NWS at this time, for several counties in the target.

10 More heavy convection in the morning. However no seeding was attempted due to heavy rains on the ninth and flash flood warnings issued by the NWS.

11 Mostly sunny day.

12 Low stratus in the morning. Clearing around noon.

13 Overcast to broken low clouds all day. No convection.

May

14 Midlevel stratus through the day, with embedded convection developing late in the afternoon. The aircraft was sent on a recon, with no suitable clouds to work with. In the evening stronger thunderstorms developed and moved across the southern part of the target but these were producing hail, and were non seedable.

15 Thick stratus layer through the day. No convection.

16 Overcast all day. No convection.

17 A cold front moving out of the northwest to the southeast in the early morning was briefly seeded, as it died out quickly. More convection developed in the south central part of the target in the afternoon, but was within the range of leaving within an hour suspension criteria and was not seeded.

18 Few fair weather cumulus.

19 Clear and sunny.

20 Clear and sunny.

21 Clear and sunny.

22 Stratus in the morning, clear through the rest of the day.

23 Convection developed near the southern border around noon, but did not move into the target. It then dissipated in the early afternoon. No other convection occurred in the target.

24 Overcast in the morning slowly cleared by evening. No convection.

25 Convective complex moved across the southern part of the target in the early morning. The active part of the complex was on its southern end, outside the target. No seeding was attempted. Later in the day convection developed within the target and the aircraft was sent up twice for seeding. Convection ended in the evening.

May

26 Convective complex moved over the target in the very early morning hours. Seeding was not attempted since the active part of the complex was in the position of leaving within an hour. Due to soil moisture content, Edwards Underground Water District (EUWD), asked that no seeding be done in the eastern part of the target. There was no convection during the afternoon.

27 Convective complex moved over the southern two-thirds of the target in the very early morning hours. No seeding was attempted. Later in the morning EUWD requested that no seeding be done due to soil moisture content. No convection developed after the complex in the morning.

28 Patches of alto-cumulus and strato-cumulus at times. No convection.

29 Mostly fair in the early morning then considerable cumulus development. Convection began in the target in the early evening and seeding was done for a short period.

30 Convection developed south of the target but built northward into it by noon. The aircraft went up and seeding was done through the afternoon. In anticipation of heavy rains that night and next day, seeding was not done that evening.

31 No operations this day as requested by EUWD due to excessive soil moisture. Convection did occur over much of the target area this day.

June

1 No convection in target, though some south and east.

2 A mass of moisture moved up into the target from the southwest today, with strato-form clouds and precipitation. Some embedded convection also occurred. No seeding was conducted due to continuing excessive soil moisture.

3 Continued wet weather. On suspension due to excessive soil moisture. A few mostly small convective sells were noted in the eastern section of the target through the afternoon. Heavy thundershowers moved across the very southeast corner of target after midnight, with heavy rain reported in San Antonio and surrounding localities, causing severe flooding.

4 Suspension due to excessive soil moisture continued today. Another area of heavy rains moved from southwest to northeast, but, only brushed the target area along the south central and southeast border areas. Heavy rains of six to ten inches fell in the San Antonio area.

5 Suspended due to high soil moisture. No convection developed within the target.

6 A few convective cells did develop on the border of the target, and were unworkable, during the day. In the evening a line of thunderstorms moved down out of the north with heavy rains into the target. Seeding was not done due to several suspension criteria being met.

7 Convection began in the target in the early afternoon. However because there was no movement of the cells, no seeding was attempted, although the aircraft did make a recon mission.

8 Convection developed again in the early afternoon, and as with yesterday the upper air steering winds were light and variable, and the cells did not move. No seeding was done.

9 Mostly sunny, no convection in the target.

10 Stratus in the morning with scattered cumulus in the afternoon. No convection in the target.

June

11 A cold front moved through the target from the north in the morning. Seeding was done along this front, ending as the front approached the southern border. No further convection occurred after noon.

12 Convection developed late in the morning, but no movement occurred with the cells,and no seeding was done.

13 Clear in the morning with convection by early afternoon. Movement was slow to none and cells stayed small. All activity died out in the evening. No seeding.

14 Some convection developed south of the target but none within it.

15 A few echoes occurred in the central part of the target in the morning, but these had tops less than ten thousand feet. They lasted until late morning and no further development was seen.

16 Low overcast in the morning becoming fair by late afternoon. Convection developed however just before midnight. This convection was weak, with tops under fifteen thousand feet. No seeding.

17 Woke to a thunderstorm at four am. This activity had moved down from the north during the night. Rainfall rates were at or over one inch per hour. After this line of activity moved through, some weak convection was noted in the northwest and southeast corners of the target, but were not suitable for seeding.

18 Heavy rain occurred today, as radar showed a large area of echo covered the eastern half of the target through the day. Some convective elements also developed in southwest corner of the target. A flash flood warning was issued by the NWS for Bandera County, and the EUWD requested that no seeding be done, due to excessive soil moisture.

19 Flash flood warnings covered parts of the target in the morning, as heavy rain was reported in northern Uvalde and Real counties. EUWD again asked that seeding be suspended due to soil moisture.

June

20 Suspension continues due to excessive soil moisture. Some convection did develop in the target area during the afternoon.

21 Again suspended from operations due to soil moisture. Some convection during the day.

22 Partly cloudy day with some convection in the late afternoon and evening, in the north, east and southeast portions of the target. Suspended due to soil moisture.

23 Scattered small convection developed in the target in the afternoon. Suspended due to soil moisture.

24 Weak convection was noted in the early morning in the south central part of the target and there was scattered convection in the target for much of the day. Some of this convection reached workable size. However, suspension continued due to soil moisture.

25 Convection developed in the western quarter of the target by early afternoon, lasting for a couple of hours. Seeding was not attempted as this convection was too small.

26 No convection through the day. However convection did move up from the south in the late evening, dying out as it reached the south central target border.

27 Clear to partly cloudy day,no convection.

28 Clear all day.

29 Low stratus in the morning, clear thereafter.

30 Few low clouds in the morning then clear and hot.

July

1 Few fair weather cumulus, hot.

2 No convection through the day, but one cell quickly developed along the southern target border and lasted only briefly. However it did show the potential for hail during its lifetime. No seeding.

3 Few clouds in the morning, then sunny and hot.

4 Few clouds in the morning, then sunny and hot.

5 Partly cloudy into the early afternoon, then clear and hot.

6 Partly cloudy in the morning, with a cirrus overcast for the rest of the day. Hot.

7 Convection developed by midafternoon, and aircraft was sent on a recon, but did not find suitable cloud conditions. In the early evening convection redeveloped and conditions were found suitable for seeding the north central and northwest as well as south central and southeast parts of the target.

8 Mostly sunny and hazy. Some weak convection developed south of the target, none within.

9 Clear and hazy.

10 Clear, hazy and hot.

11 Some fair weather cumulus and cirrus,but mostly sunny.

12 Convection developed south of the target, none within. Windy and hot.

13 Lots of mid-level, multi-layered clouds in the morning, with embedded convection, but nothing was found seedable. In the later part of the afternoon,seedable convection was found in the southeast corner but this died out shortly as cirrus moved in and heating was cut off.

14 Some weaker convection developed southeast of the target, and moved into it, but it never reached the stage where it became seedable.

July

15 Convection developed near midafternoon south of the target and moved and built into it by late afternoon. Seeding was done on this convection in the evening.

16 Clear in the morning, partly cloudy by afternoon. Some low level echoes developed in the morning, not lasting past midday. No seeding.

17 Low stratus in the morning with few fair weather cumulus the rest of the day. No convection.

18 Few fair weather cumulus,hot.

19 Very few fair weather cumulus, hot.

20 Convection developed in the afternoon within the target and a recon mission was done. However the cells were moving only very slowly to none, and the suspension criteria for speed was met,and no seeding was done. Convection lasted until evening.

21 Cumulus formed in the morning and some convection showed on radar in the early afternoon within the target. However these echoes were moving none to slowly and were not seedable for that reason. In the evening a slow moving cloud front pushed a line of thunderstorms into the target, these were moving slowly and some showed one inch per hour rainfall rates. No seeding was done in these.

22 Cumulus developed midday, continued into the evening.

23 Few fair weather cumulus and hot.

24 Clear and hot.

25 Few fair weather cumulus and hot.

26 Few fair weather cumulus and hot.

27 Clear and hot.

28 Low stratus in the morning, clearing by noon. Very hot.

29 Low stratus in the morning, clearing by noon. Very hot.

July

30 Clear and hot.

31 Few fair weather cumulus and hot.

August

1 Cumulus developed around noon, cleared in the evening.

2 Few fair weather cumulus and hot.

3 Convection developed along the northern border of the target around noon, slowly sagging southward. Seeding was done until midafternoon,when convection began to die out. Weak echoes lingered along the west, north and east borders of the target until the early night hours.

4 Convection with tops less than fifteen thousand feet occurred from morning into the early afternoon, when it began to grow. However movement was very slow to none and no seeding was attempted.

5 Convection developed in the afternoon, but stayed on the small side through the day, dying out in the early evening. No seeding was attempted.

6 Some echo from stratus type precipitation occurred in the early morning. Convective echoes developed over the target border, north of Hondo, but nothing seedable developed and by mid-afternoon all echoes had dissipated.

7 Stratus overcast in the morning becoming cumulus through the afternoon. No echoes.

8 Strato-cumulus in the morning with cumulus through the afternoon. No echoes.

9 Stratus in the morning with cumulus through the afternoon. No echoes.

10 Convection began forming in the target by midafternoon. Movement at first was northeast at 5-10 MPS but then became stationary. A few cells became large enough to work with briefly but no seeding was attempted because of no movement.

11 Precipitation was occurring within the target upon arrival in the morning, but dissipated late in the morning. Convection began in the afternoon and continued into the evening, some of this convection could have been seeded, however there was no movement noted with any of the echoes this day and therefore no seeding occurred.

August

12 Considerable convection occurred from late morning into the evening, but there was no movement again of the cells and no seeding took place, although there were opportunities to do so.

13 Clear in the morning with small cumulus from late morning into the evening.

14 Patchy stratus in the morning with small cumulus from late morning into the evening.

15 Some convection developed south of the eastern half of the target. These were short lived echoes, and although they moved to the northeast, none moved into the target.

16 A few convective echoes developed south and southeast of the target with a few very small echoes just over the border in the target. Those in the target did not last long, and there were no opportunities for seeding.

17 A few convective echoes within the target in the morning with more and larger convection developing in the afternoon, but there was no movement of the cells, and therefore no seeding was done.

18 Some towering cumulus noted on the western horizon in the morning but these quickly moved west. A few fair weather cumulus developed through the rest of the day. Very hot.

19 Very hot day. Cumulus developed around noon and continued into the late afternoon when large convection began and echoes developed within the target. The aircraft was sent up and seeding occurred from late afternoon into the early evening. By late evening, the convection had either exited the target or dissipated.

20 Few patches of convection along the southern border in the morning, but were going to leave the target as they moved south within an hour. In the afternoon a few cells again developed near the southern target border and again were going to leave within an hour, so no seeding was done.

August

21 Considerable convection occurred this day as four waves of precipitation/convection moved across the target. First wave moved through in the morning, the next moved through in the afternoon, and the last two in the evening and early night hours. Seeding was done briefly in the morning wave.

22 Considerable multi-layered clouds over all of the target today. However, in the early afternoon part of the northwestern corner was not yet covered and a few cells were found there, that were seeded. Other embedded convection lasted into the evening, but no other suitable clouds were found.

23 Large convection developed south of the target in the early evening and one cell moved up into the target, as it crossed the border it was producing greater than one inch per hour of rainfall, but quickly weakened, and fell apart completely within an hour. No seeding done.

24 Considerable multi-layered clouds over the target today, with embedded convection. However by mid-afternoon several larger cells developed in the southeast corner of the target and seeding was done on these cells, until they died out in the evening.

25 Similar day to yesterday. Lots of multi-layered clouds over the target, with a break in this cloudiness in the southeast corner, where convection developed and we were able to seed from late afternoon into the evening.

26 Some non-convective echoes occurred over the target during the day, and a few convective cells developed south of the target. However nothing workable showed up in the target, and no seeding was done.

27 No convection occurred within the target today. Skies were partly cloudy with cumulus and cirrus.

28 Convection began in the target around noon with little or no movement, spreading through the afternoon. Several cells reached the one inch per hour suspension criteria. No seeding done. Convection ended in the evening hours.

August

29 A few strato-form echoes were observed in the morning. By early afternoon, convective echoes developed in the western quarter of the target, however these remained small with tops less than fifteen thousand feet. There was no movement of these cells. No seeding done.

30 No echoes developed in the target today.

31 Convection began mid-afternoon with seeding done until early evening, when the cells began producing one inch per hour rainfall rates.

September

1 Strong echoes started out the morning with a few cells producing one inch per hour rainfall or better. These died off by mid-morning. The aircraft did fly a recon in this area, but no seeding was done. In the early afternoon convection began again in the target and seedable clouds were found until mid-afternoon, when rainfall rates again met the suspension criteria. Strong cells continued into the nighttime hours.

2 One small echo in target in the morning which lasted briefly, then none into the evening. In the early nighttime hours a few cells, which had developed south of the target, moved up into the very southern portion, and died out. No seeding.

3 Convection developed south and southwest of the target by noon, and by later in the afternoon occurred in the target. The aircraft found a few cells to seed in the late afternoon, then returned at 1800CDT. Convection ended later in the evening.

4 Non-convective echo in the northeast, near Kerrville early this morning, then none through the day. A few convective echoes developed south of the target but none within. No seeding.

5 Considerable mid-level moisture from strato-form clouds, caused echoes to occur within the target today. Some weak embedded convection did occur in the southwestern corner of the target and a recon mission was launched, but no seedable clouds were found.

6 Heavy rain developed overnight in the northeast corner of the target, due to an over-running situation. A Flash Flood Warning was issued for Kerr and Kendall Counties through 8 AM. By mid-afternoon, very little echo was left in the target and what was, was weak strato-form precipitation that quickly died out. Rain was pushed back up into the target after midnight as the over-running situation returned. No seeding.

September

7 Rain from an over-running situation continued until around noon at radar. A Flash Flood Warning was in effect until noon for Medina County. The strato-form precipitation slowly died out through the day, but some weak convection developed in the south central part of the target by midafternoon. This convection did not grow to a workable size and was embedded in the layered cloudiness. No seed day.

8 Some echo south and southwest of the target in the morning, with convective echoes embedded in the layered cloudiness developing in the south central part of the target by midafternoon, continuing into the evening. This convection did not grow to a workable size. No seeding.

9 Convection began south of the target by early afternoon with rainshowers at the radar. By midafternoon these showers built into the target and seeding occurred until late afternoon, mostly in the western one-third of the target.

10 Morning stratus developed into fair weather cumulus in the afternoon. No deep convection, no seeding.

11 Skies were clear in the morning, but convection developed by midafternoon, with a line occurring in the southeast corner of the target along a weak front. The aircraft was deployed but no seeding took place as the cells became strong enough to produce greater than one inch per hour rainfall, and at times hail. Also, movement was slow to stationary. These heavy showers and thunderstorms continued past midnight.

12 Showers and thunderstorms overnight continued through the day with echoes appearing over most parts of the target. These showers were intense, with greater than one inch per hour rainfall, and there was no movement for much of the time. No seeding was attempted.

13 Stratus in the morning developed into fair weather cumulus in the afternoon. No deep convection.

14 Stratus in the morning developed into cumulus in the afternoon. No deep convection. Some echoes were noted well south and east of the target.

September

15 Stratus in the morning developed into cumulus in the afternoon. No deep convection. Some echoes again occurred well south and east of the target.

16 Patches of stratus in the morning developing into cumulus through the afternoon. Showers and thunderstorms developed east and southeast of the target during the afternoon, but none within the target.

17 Morning stratus became cumulus by late morning and continued through the afternoon. No deep convection developed within the target, however there were echoes south and east, with a strong complex in the evening between Uvalde and Pearsal.

18 Stratus in the morning became cumulus by noon. No deep convection developed in the target although towering cumulus and thunderstorms occurred east and southeast of the target during the afternoon and evening.

19 Convection developed by midafternoon south and east of the target as well as in the southeast and along the south central border of the target. Seeding was conducted in these areas from late afternoon into the evening. Convection died out by 2000 CDT.

20 Convection began south and east of the target by noon with convection moving up into the target in the late afternoon. The aircraft was sent up, but only one cell was seeded as conditions were very marginal on the few cells that developed in the target. Convection dissipated soon after the seeding took place.

21 Overcast skies kept convection from developing until midafternoon, when echoes occurred south and east. By late afternoon some convection developed in the south central part of the target and the aircraft was launched. Convection continued past dark, and seeding occurred until around 2130, in the central and southeast parts of the target. Convection slowly died off into the early nighttime hours.

22 Convection began east and southeast of the target by midafternoon, and grew into three large cells in the early evening. No growth occurred in the target. No seeding.

September

23 Stratus in the morning became cumulus by noon which slowly dissipated through the day, becoming clear in the late afternoon and evening.

24 Stratus in the morning, clearing and very warm in the afternoon.

25 A front was lying across the target from Kerrville to Uvalde through the day. There was weak convection along it in the morning, with strong development occurring by late afternoon and through the night. No seeding was done, though the plane was sent up during the late afternoon. Very heavy rains fell in the area around Leakey, and some of the cells in the evening and early night hours showed the potential for hail. Radar tops were as high as 55,000 feet.

26 Heavy rains occurred in the Kerrville area over night. Flash flood warnings were issued by the NWS for Real County until 6am and for Kerr County until 11 am. However, there were no echoes in the target area from 0900 CDT through the evening. The rain amounts were as much as nine inches in some places over night. No seeding was done.

27 Stratus in the morning with cumulus and some small towering cumulus in the afternoon. Few echoes developed southeast of San Antonio briefly in the late afternoon. Nothing occurred in the target.

28 An upper level disturbance brought convective activity into the target early in the morning. The aircraft was launched and some seeding took place briefly in the southeast section of the target before the convection died out. By late afternoon heating caused convection to develop again, and the aircraft went up and seeding occurred from Medina south. Seeding ended as storms reached the 1" per hour rainfall rate, even though speeds were 20 25 MPS to the north. Later in the evening, the storm cells weakened to below 1" per hour rates and the aircraft was launched again, working into the early night hours. The cells increased their speed to 30 MPS during the evening and into the night, and continued fairly strong. Seeding on this third mission was north and south of Leakey. Total flight time was six hours.

September

29 Stratus in the morning became cumulus late morning, and this continued until early evening. No deep convection, no echoes.

30 Stratus in the morning. Flat cumulus afternoon. No development. End of 1986 season.