PROCESSING OF THE M-33 SNYDER, TEXAS RADAR DATA LP-120

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16. ABSTRACT

Dual wavelength radar data were collected by Meteorology Research, Inc., (MRI) using a modified M-33 radar unit during the 1976, 1977, and 1978 summers. The data were recorded in a digital format using a special data processor system. The work covered by this report includes the preliminary data processing, the quality control checks, and the development of calibration coefficients for the S-band data section. The data formats, calibration data, errors, and corrective procedures are described. Also included in this report are the daily radar logs for the three data collection points. This document was developed to aid those researchers who will interpret the data.

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1. INTRODUCTION

A modified M-33 radar was operated by Meteorology Research, Inc. (MRI) to collect data for climatalogical and case study analyses during the summer seasons of 1976, 1977 and 1978. The data collected was examined to identify and correct errors and converted into an "A" file format. This final report will describe the procedures used to process and reformat the S-band data collected during three seasons of operation.

The radar set is a dual wave length radar (S- and X-bands) with a digital acquisition system custom built by Illinois State Water Survey. The modifications to the radar have been reported by Carbone, et al., (1976). The radar characteristics are summarized in Table 1. A PDP-11 mini-computer was added to the system for the 1978 field year to perform on-site quality control checks in real time. This modification is outlined in Appendix I. The radar was located near Snyder, Texas, just west of the runway at Winston Field 32° 42' 04" N; 100° 56' 49" W (see Figure 1.1). The site elevation was 2434 ft msl.

2. DATA DESCRIPTION

The radar data were written as one continuous stream of 8-bit words from the start to the end of the day. The stream was broken into blocks of 4096 words onto which a header, prologue and epilogue are added. Thus the physical records on the tape are 4156 words in length.

The data stream is composed of alternating radials from the S-band and the X-band radars (Figure 2.1). The locator group is followed by 0 to 30 data groups, depending on the number of bins above threshold (Figure 2.2). There is a radial on the tape for every azimuth and elevation that the radars traversed. Each radial starts with a locator group identifying the radar, the azimuth, and elevation of the data (Figure 2.3). A data group (Figure 2.4) has a flag identifying the start of the group. The flag is followed by two 8-bit words which form a 16-bit binary value indicating the starting range of the group. The range values are followed by a multiple of 32 data bins which contain coded signal returns in ascending consecutive range bins.

Because the number of data groups and the number of data bins within each group are variable, it is obvious that radials may start and stop anywhere within a tape block. A more complete description of the data format is provided in Appendix II. In addition to the magnetic tape data form, hand written daily operation logs were also made. The daily operations logs and the daily power logs which were extracted from the operations logs are included in this report as Appendix III and IV respectively. A summary of all the

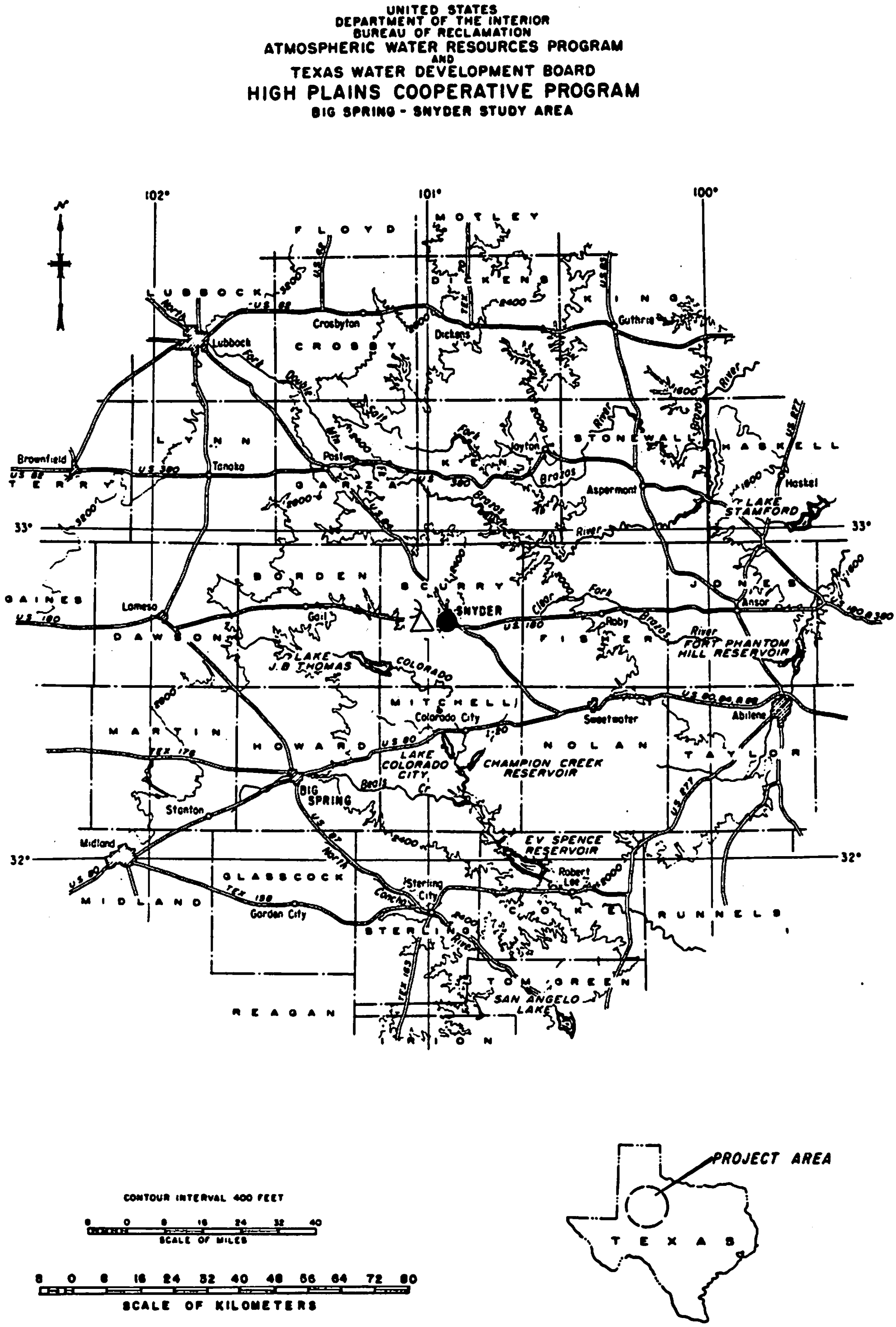


Figure 1. 1. Map of Snyder-Big Spring, Texas study area.

TABLE 1. RADAR CHARACTERISTICS

	M-33 Snyder		
	S-band	X-band	Units
1. Peak transmitted power	500-1000	100-160	KW
2. Frequency	3.1-3.5	9.2-9.4	GHz
3. Pulse duration	1.3	0.25	μ sec
4. Pulse repetition frequency	900	900	Hz
5. Beam width	~1.6°	~1.0°	
6. Antenna gain	~39	~43	db
7. System gain	~37	~41.5	db
8. Min. detectable power	~-98	~-100	dbm
9. Receiver	solid state log IF, 80 db dynamic range	same	
10. Bandwidth	10	10	MHz
11. Range gates	1024, 150 m	1024, 150 m	
12. Video integration	digital, block, 2^n	digital, block, 2^n	
13. Displays	PPI & A-scope, dBz	A-scope, dBz	
14. Scan capability	0-4 rpm, digitally programmed elevation	0-10 rpm, digitally programmed elevation and tracking	
15. Data recording	digital 9T-1600 bpi magnetic tape and time lapse video	same	

Figure 2.1. Radar data tape syntax structure.

Figure 2.2. Format of a radial.

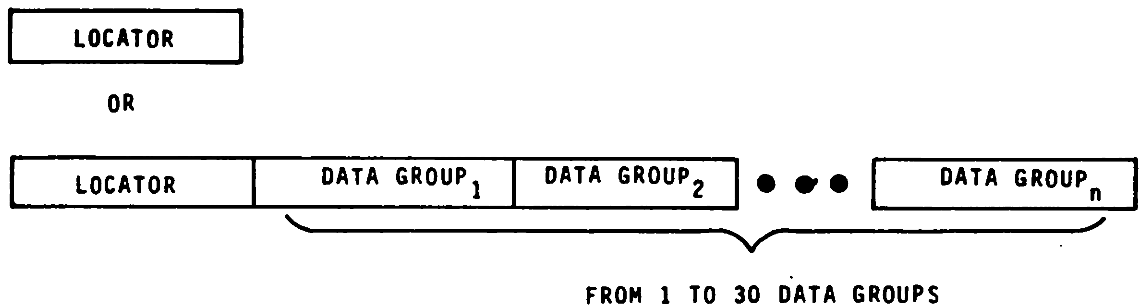


Figure 2.3. Format of a locator.

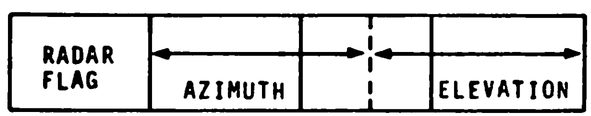
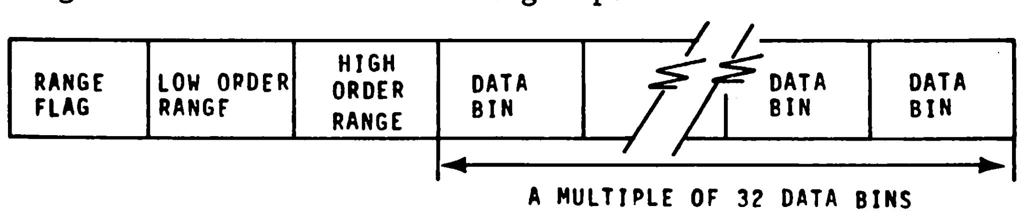


Figure 2.4. Format of a data group.



radar data tapes is provided in Appendix V. The output data tapes are in the "A" file format as shown in Figure 2.5.

3. DATA PROCESSING

The data processing procedure consisted of four distinct stages. These were conversion of field tapes to raw tapes; quality control and preliminary editing; quality control PPI plot production and editing; and data restructuring. The stages are shown in terms of the programs and procedures used in Figure 3.1.

The incoming field tapes were converted from 1600 BPI to 800 BPI tapes called raw tapes. The raw tapes were used for all the subsequent production and quality control procedures. Several different quality control programs (QCP) were used during the course of this project. The first QCP to be used was RDRQC.

RDRQC

RDRQC was designed to check the quality of the in-coming Snyder, Texas radar tapes and identify all of the structural errors within each tape record. It attempted to correct as many of the errors as possible before writing out a corrected tape.

The purpose was to eliminate the vast majority of processor errors quickly and inexpensively so that any further hand error recovery procedures would be minimal in scope. In addition, RDRQC produced a structurally correct tape so that later analysis programs did not need any input tape checking procedures.

RDRQC was written to run an HP 21MX computer operating under RTE-11 operating system utilizing a program partition of 30K octal words. The program requires two tape drives and a line printer. The input tape format is the M-33 tape format.

The output tape format is identical to the input tape format except for the record prologue. The record length varied as a function of how much shifting and filling was done in the correction phase. It ranged from 90 to 5000 8-bit words. The record prologue consisted of words 47 and 48 together form a 16-bit value of (record length - 8) words. Or, equivalently, the word count at the beginning of the epilogue.

The program produced a catalog of the contents of the output tape along with the errors and diagnostics within each record.

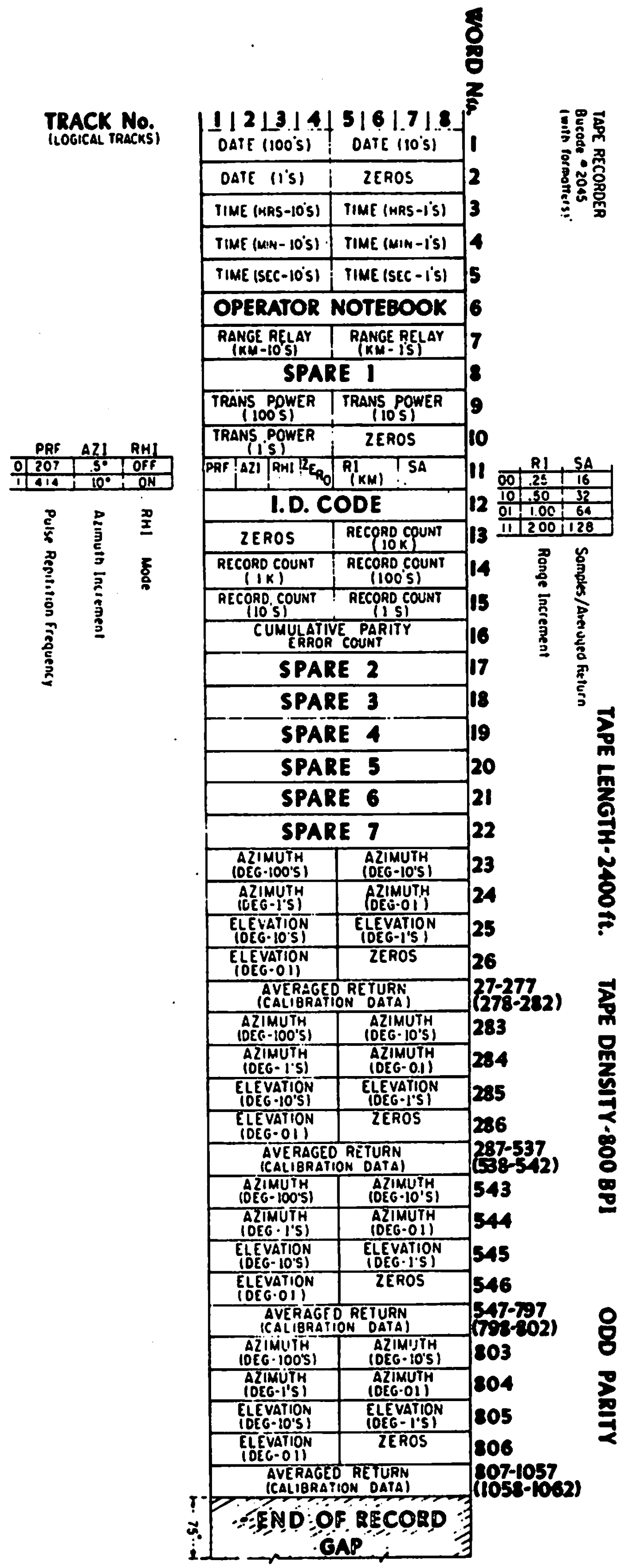


Figure 2.5. "A" file format.

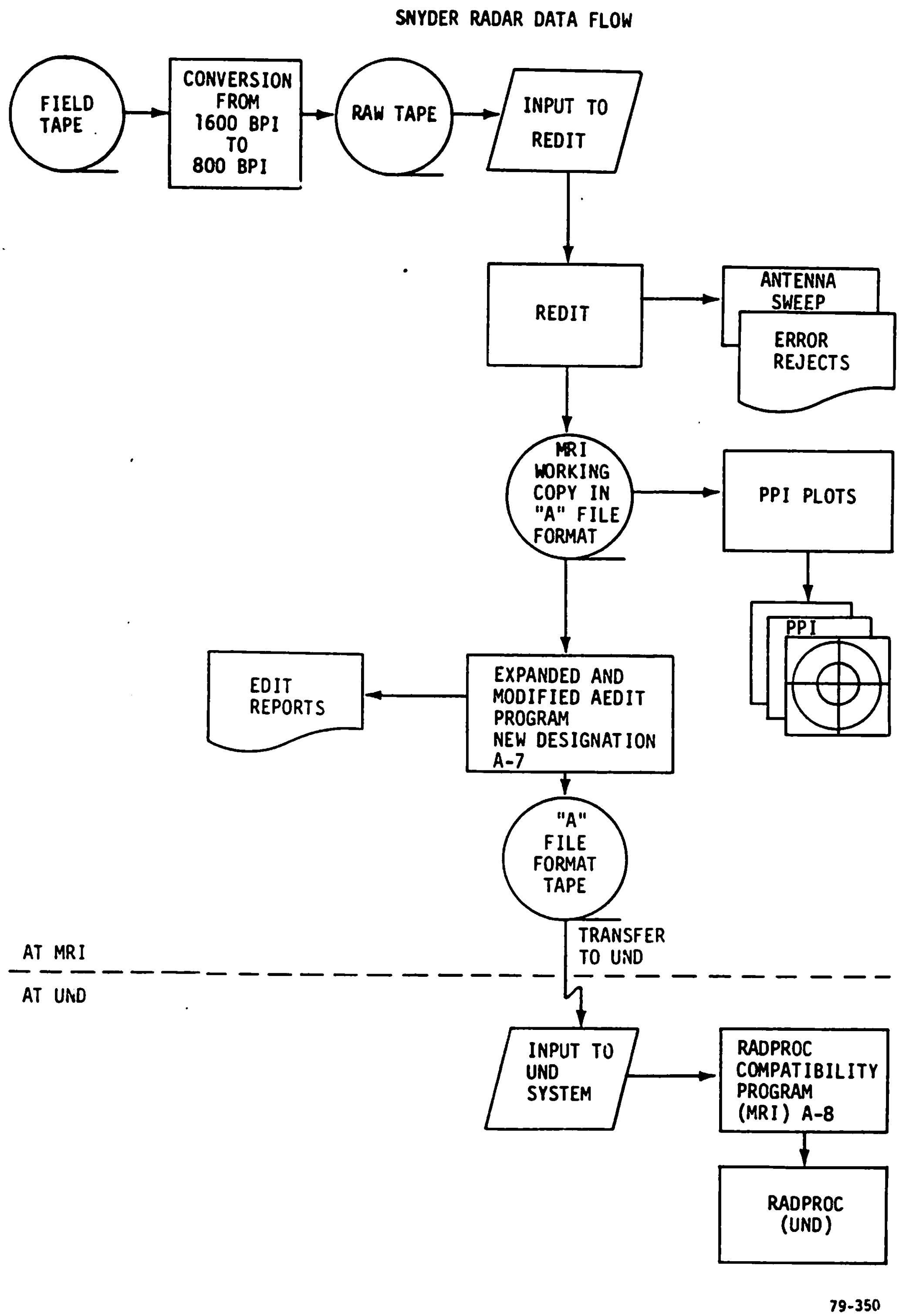


Figure 3.1. Radar processing procedure.

Three types of conditions were check/corrected and reported on. These were structural errors within the record, data errors, and diagnostics of the processor itself.

The structural error checks were all for the proper placement of flags within a record length. It should be noted that one of the characteristic problems of the processor was the occasional dropping (or missetting) of words within a record. These can be flags, housekeeping, and/or data. An attempt was made to ressurrect missing flags and to eliminate extraneous words. If the flags could not be set by examining the word structure, the flags were forced into proper alignment through padding and shifting words. Occasionally the processor inserts three extra words. If it does, the extra three words were stricken from the record and the balance of the record is shifted over. No message is printed.

All of the 1976 and some of the 1977 data was processed through RDRQC. Errors not corrected by RDRQC were flagged and manually corrected.

VSCAN

The output tape from RDRQC was used to create composite "B-scan" plots using a program called VSCAN. VSCAN also contained the logic necessary to reformat the raw tape data into the "A" file format. An example of a "B-scan" is shown in Figure 3.2. These "B-scans" were used for quality control and were later replaced by the PPI plots as such. The 1977 data was much more voluminous and more error prone. For that reason, a new QCP, REDIT was written.

REDIT

All 1976, 1977 and 1978 data was processed through REDIT. REDIT produced antenna sweep and error reject reports for quality control purposes. A further description of the antenna sweep reports is provided in Appendix VI. The data output of REDIT formed the MRI work tapes. These tapes were used to create the PPI plots for quality control. An example of a PPI plot is shown in Figure 3.3

There are five district versions of REDIT. All, except the first version, have been used and their output tapes used as input for A-7. The versions are described briefly below, from the most recent version to the earliest version.

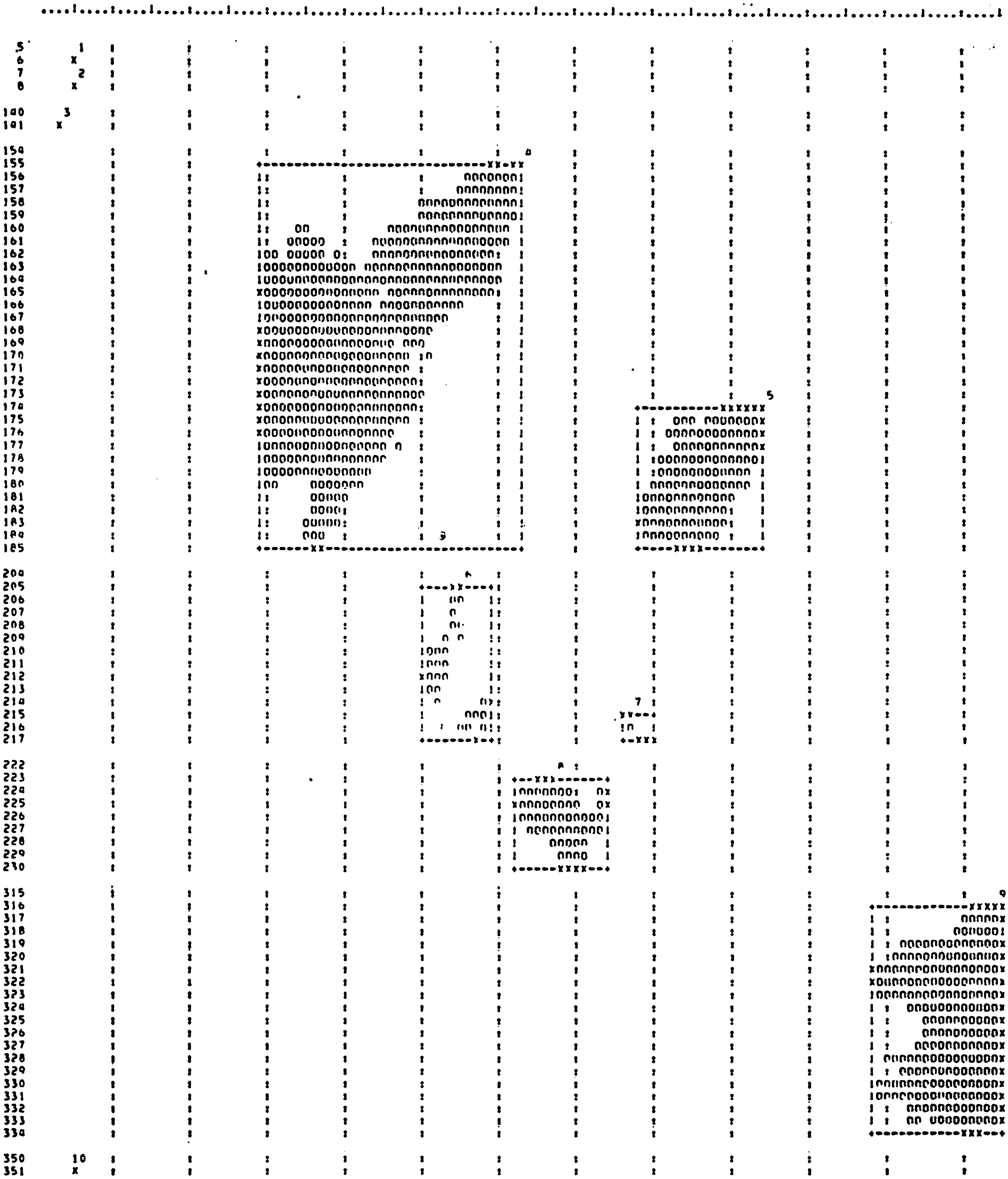


Figure 3.2. Composite Bscan from Snyder, Texas S-Band Radar.

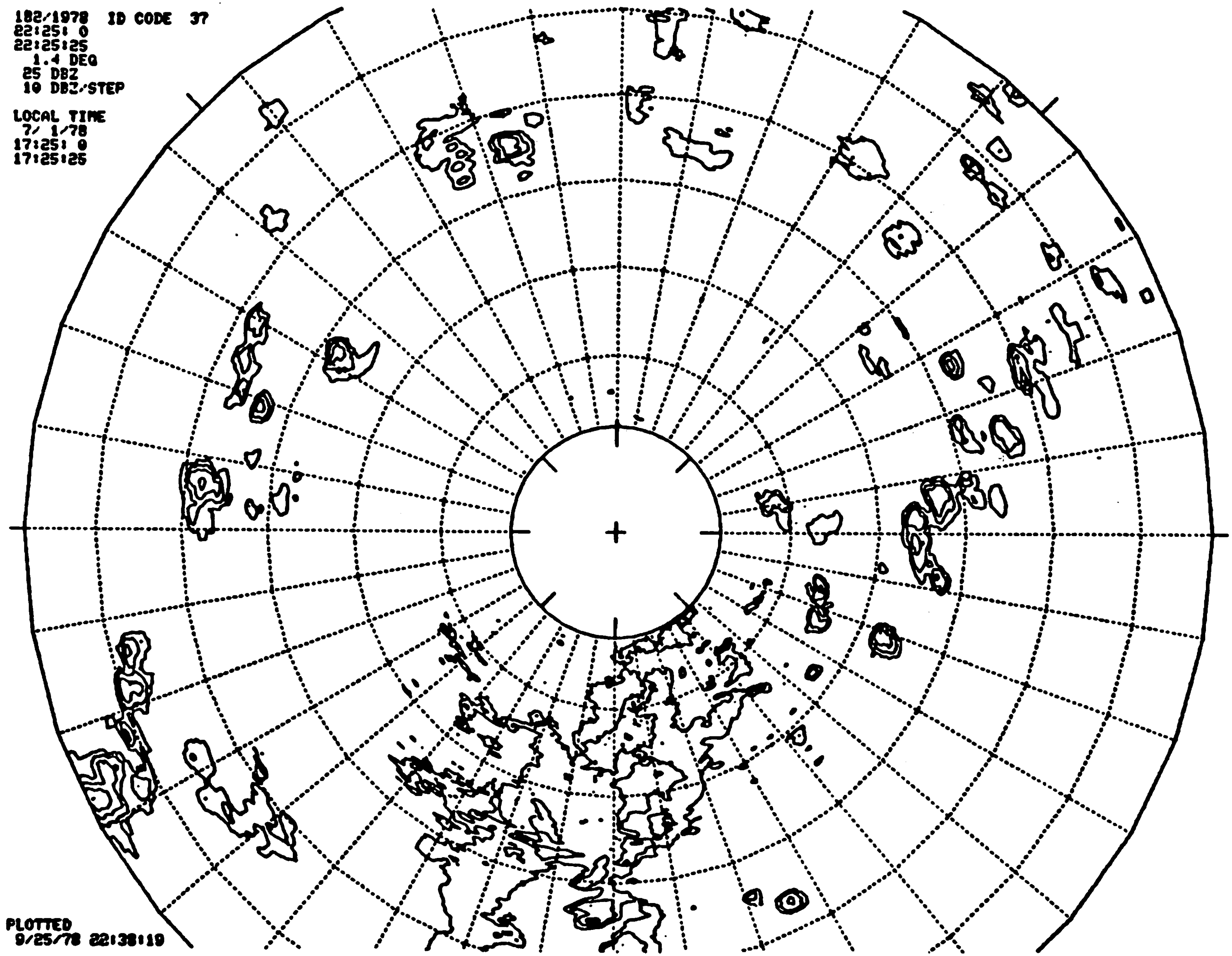


Figure 3.3. Typical PPI Plot.

∧REDIT - Current version of REDIT for the 1976 and 1977 data. (This file is the only loader file that is in the RTE-IV LOADER format. The other load files were for RTE-III.) Attempts to correct the 8- and 32-bit errors in the azimuth, elevation, and radar/data flag were made. Transition data between sweeps is preserved.

/REDIT - Most recent version of REDIT for the 1978 data. There are no bit error fixes in this version. Transition data is preserved.

.REDIT - Same as ∧REDIT, but for RTE-III operating system with %ISHIFT in the system library.

#REDIT - Earlier version for 1978 data. No 8- and 32-bit errors were attempted to be corrected, and transition data between sweeps is deleted.

$REDIT - Early version for 1976 and 1977 data. 8- and 32-bit errors are corrected for azimuth, elevation, but <u>not</u> for the radar/data flags. Transition is deleted.

=REDIT - Earliest version of REDIT. Many of the algorithms are unique to this version.

All the version of REDIT use the same input and output. However, the more recent versions (∧REDIT and /REDIT) conform better to the optimal inputs to A7 and A8.

<u>Algorithms used by REDIT</u>

1. Bin Averaging (Subroutine AVEBIN)

   In all versions of REDIT, three M-33 range bins of 150 m each are "averaged" together into one 450 m bin. (Fewer bins may be averaged together at the start or end of a subgroup.)

2. 8 and 32 Bit Error Correction

   The versions of REDIT that handle 1976 and 1977 data have code that attempts to correct 8 and 32 bit errors. These errors which were addressed are listed briefly:

a. Errors in the radar flags. (^REDIT, =REDIT) The code is in subroutine IWORD of file &IWORD. When a byte is fetched from the data portion of the tape record, it is checked to see if it is a flag (hex E3, E5, or EF). If it is not a flag, a check is made to see if it is a flag with 8 bit and 32 bit error. If one of the possible alternates to the three flags is encountered, an entry is made in the error/syntax log.

b. Epilog bit errors. The epilog recognizer checks for the year in the epilog of the record. Since bit errors can occur here, allowance is made for both the 8 bit and 32 bit error by ORing these bits, and ORing bits that should be clear, and checking the result against an "all bits on" condition.

c. Azimuth bit errors. (^REDIT, .REDIT, $REDIT, ±REDIT) The azimuth is picked up from the raw tape in such a way that the 8 and 32 bit errors manifest themselves in other positions in the azimuth value.

d. Elevation bit errors. (^REDIT, .REDIT, $REDIT, =REDIT) An initial test is made to see if the current tilt angle is within 4°(0.35 degrees) of the preceeding tilt angle. If so, no other checking is done for bit errors. Continuity is then checked by testing the change in the tilt angle between the last and current angle to be less than 4 and greater than zero, and increasing.

3. Tracking Sweeps.

Sweep tracking, that is, finding the start and end of every sweep, is performed by all versions of REDIT. Several distinct functions take place:

a. The tilt angle used by this and subsequent steps is the median value of the current and preceeding two <u>uncorrected</u> tilt angles. This tends to reduce the effect of sporadic bit errors and noise values.

b. The start and stop of each sweep is defined by a sequence of tests. While in a sweep, the start-of-sweep tests are not performed. Likewise, while out of a sweep ("between" sweeps) the end-sweep tests are not executed.

If the data is currently not in a sweep, the following tests are performed:

If the current median tilt angle is the same as the preceeding tilt angle and the azimuth is at the step azimuth, or the current median tilt angle is the same as the preceeding tilt angle and the base angle flag is not set, then the start of the sweep has been found.
At the start of a sweep, a check is made to see if the tilt angle is below 1.58° and the base angle flag is set, the new volume flag (NEWVOL) is set. The base angle flag is then cleared so that "multiple new volumes" do not occur because of multiple base angle scans.

If the radial is in a sweep, different tests are performed for the end of sweep. If the antenna is ascending, and at least 10 radials have been processed for the current sweep, the end-of-sweep has been found; the step azimuth is set to the current azimuth angle.

If the antenna is descending, the end of sweep is noted and the "base angle" flag is set.

If the radial is at the step azimuth, and at least 10 radials have been processed, the end of the sweep is noted.

4. Update and Log the Noise and Calibration Values

The noise level and calibration height are handled two separate ways by REDIT:

a. All versions except the original version. The calibration pulse height is totally ignored and the noise level recorded on the output tape is the same value as a read from the noise level field on the raw Texas radar input tape.

5. Eliminate Unwanted Sky

All versions of REDIT eliminate some portion of unwanted sky. A preliminary version of REDIT eliminated null radials and radials that had no desired data or were transition radials. A later version of REDIT kept the null radials but forced transition radials to null radials. Only the more recent versions would also keep data on transition radials. For all versions of REDIT, all bins that occurred before the start of the range delay read from the card deck, or after the 250th 450 meter bin following that range delay, or from the range of the calibration pulse start location through 31 bins after the start location of the calibration pulse, are removed from the data.

6. Bin Averaging

For the original version of REDIT, before the bins were "averaged together" to form the Bureau bins, the program would run through all the recorded bins in the raw data, and take the median value of the bin's DVIP value and its immediate neighbors, using 30 for nonexistent neighbors.

Note: in all subsequent versions of REDIT, all the bin values on the output A-tape are the three-bin averages (or two-bin average or one-bin raw value, depending on how a raw subgroup lines up with output subgroups) of the raw DVIP values read from the Texas radar tape. No 8-bit or 32-bit corrections are attempted with DVIP values.

CONVRT

The interface program between the MRI "A" file format tapes and the input format requirements of the University of North Dakota RAPPROC program developed through several generations. The first program called CONVRT was developed early in this project but not used because the input data structure requirements changed when the processing responsibility was transferred to the University of North Dakota. The new data structure although still in "A" file format required substantial modification to the radar data. A new program to restructure the data was created to meet the new requirements.

AEDIT

This program was called AEDIT. A trial run of an AEDIT output tape through RADPROC revealed new requirements for the input data itself and for the data structure. These unanticipated problems are listed in Table 2 along with ten previously known problems. Figure 3.4 is a graphical display of an antenna sweep pattern which shows several of the M-33 data problems. Some of the problems shown are:

1. Azimuth wrap around
2. Tilt angle noise
3. Data recording on transition radials (ascent and descent)
4. Truncated sweeps
5. Varying tilt angle increments
6. Azimuth noise
7. Tilt angle bounce.

Two new programs, A-7 and A-8, were designed and constructed to solve these problems.

TABLE 2. M-33 RADAR REDUCTION PROGRESS

	Problem Type	Not Anticipated
1.	Reset lost radar and range flags	
2.	Eliminate data groups at wrong range	
3.	Average bin size to be compatible with UND program	
4.	Correct field tapes for occasional missing bits	
5.	Correct dates as needed	
6.	Correct clock times as needed	
7.	Correct ID's as needed	
8.	Relocation of calibration pulses	
9.	Set EOF's for data gaps	X
10.	Reset new volume flags	
11.	Remove ground clutter	
12.	Remove volume scans when elevation angle varies due to antenna bounce	X
13.	Reset tilt angle for scans with minor variability	X
14.	Set new flags when elevation increment changes	X
15.	Reset spurious elevation data points	X
16.	Define new elevation start azimuth	X
17.	Eliminate transition radials between elevation scans	X
18.	Eliminate azimuth wrap-around	
19.	Eliminate multiple scans of the same elevation	
20.	Eliminate multiple radials on a given azimuth	X
21.	Reassign radials to fixed interval azimuths when wind loading is not excessive	X
22.	Eliminate radials recorded during antenna drop to base angle tilt	
23.	Set calibration pulses to 1's (DVIP)	
24.	Remove null radials	
25.	Maintain first radial of volume	X
26.	Eliminate "caught" calibration pulse	X

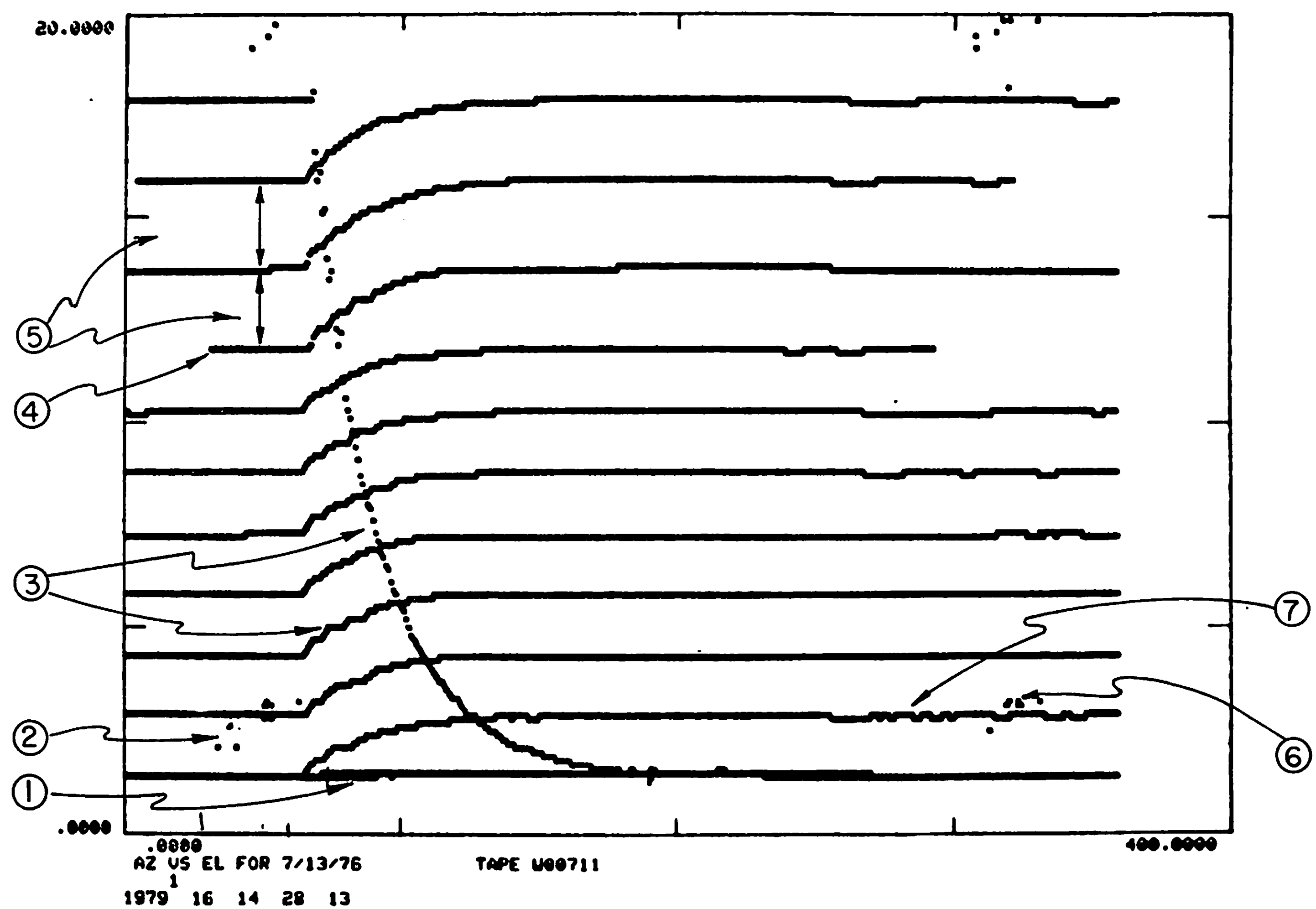


Figure 3.4. Graphical display of an antenna sweep pattern.

A-7

A-7, which replaced AEDIT, included all of the old editing procedures plus some expanded corrective procedures. It was designed for and operated on the MRI HP2100 under RTE-IV. The combination of A-7 at MRI and A-8 at UND was successful in editing and reformating the "A" file format MRI working tapes so that they were acceptable as input to RADPROC.

Program A-7 was developed to build edited data tapes from the tapes produced by REDIT. General problem areas were corrected by A-7. Some problem areas were addressed by A-7, but are not completely resolved until the data was run through A-8.

The A-7 program was developed to be command driven so that an operator can correct problems that involve human judgement and human involvement. There were six problems corrected by A-7:

1. On many records, the recorded date is wrong. Two principal types of date errors have been observed. In the 1976 season data, the date sporadically is garbled. This may have been caused by the "three-word drops" that have been known to have occurred in the Texas Radar Processor. In the 1978 radar season data, some days have the wrong date consistently through the operational day, or the date is wrong except for an occasional correct date. It is not presently known if this is caused by a bit error or loose connection in the radar system date thumbwheels in Texas, or if the same hardware causing the time problems is also causing this date error.

   Results

   An exterior label would have to identify the data because the date would not be reliably retrieved from the records.

   For the 1976 radar season, the programs that key off of the date and time would be unable to check the continuity or data gaps, resulting in exceedingly poor calculations at UND.

   Since A-8 will be using the date for determining data gaps, gaps would be falsely recognized and the data would be multiply sectioned.

   Correction Applied

   At the start of each operational day of data, the operator enters a DATE Directive that tells A-7 the date the data should have.

   All radials processed from this point on will have this date. The date entered as CDT, but the date for the corresponding GMT is written to tape. Also, the program allows for transition between calendar days.

A new date directive will override the current directive, allowing for sizeable gaps in a given operational day when the gap spans midnight. (This is only necessary when the gap is several hours long.)

This correction has no known side effects.

2. The time fields for 1978 data have some serious problems. In particular, it appears that most 5's are recorded as 1's and most 6's are recorded as 0's. (The problem in the hours field is the same when the time is expressed in CDT, the way the field tapes were recorded.)

Results

Programs keying off of the time field will pick up false data gaps and false time backups.

RADPROC and A-8 are just two of the programs that would produce erroneous results.

Correction Applied

The time on the "A" tapes is converted to CDT.

A comparison is made with the time on the last radial (or with the time on the TIME directive if this is the first radial processed) to see if it appears that time backed up. If it did, the time is modified, starting with the least significant digits, converting 1's to 5's and 0's to 6's until the time backup condition disappears. This would then be used as the correct time for the current radial, after it is converted back to GMT.

For example, if the time for the last radial (after the time was fixed on it) was 16:35:45 (CDT), the sequence of modified candidate times would be:

1Ø:31:46 (CDT)

1Ø:35:4Ø

1Ø:35:46

16:31:4Ø

16:31:46

16:35:4Ø

16:35:46

This last value would be used as the correct time for the current radial. The time would be converted back to GMT before being written out to tape.

Since data gaps can lead to the time fix becoming out of step because of its heavy dependence on the time on the preceding radial, an additional TIME directive has to be entered after each data gap between input files. A TIME directive is required at the start of each run of A-7 to set the initial time at the correct value. (Where this particular time fix is not required, no TIME directives are entered.)

There is a minor side effect from this corrective procedure. If a data gap occurs unexpectedly, it is possible that some of the digits in the time will not be correctly updated because of the poor (old) reference value from the last radial processed. The magnitude of the potential error is equal to the magnitude of the gap. However, algorithm will correct itself when digits thought incorrectly to be 0's step up to 7 or higher or 1's step down to 0, or the more significant adjacent digit of the time changes. If the error is more than a minute, a "time gap" message will be generated.

This is not serious because A-8 performs several types of continuity tests on the data, in particular, in checking the tilt angles it checks for three-minute time gaps. The most likely outcome of a small data gap is that some data may be lost, and part of a volume rejected. A large data gap will result in time errors, but an attempt has been made to minimize this by:

a. Producing a listing of the start date and time of every file that will be used by A-7, thus showing where gaps greater than five minutes occur.

b. Performing a preliminary run of A-7 so that other clock errors and time gaps can be detected, and

c. Rerunning A-7, rejecting those files that have a sizable time gap and issuing TIME directives where appropriate.

3. The I. D. codes for 1976 and 1978 data are wrong.
The I. D. codes for the S-band radar in Snyder, Texas, is 37, where y is the last digit in the current operational year.

Thus, the Texas radar data for the 1976 season should have an I. D. code of 36 and for 1978, 38.

Results

The program, RADPROC, keys off of the I. D. code for searching a file of radar calibrations. Radars, whose calibrations change from year to year (e.g., because of different output power) require that their I. D. codes change year to year.

Since the Snyder, Texas, radar operates under somewhat different characteristics year to year, (e.g., different waveguide), using the wrong I. D. code could radically affect various statistics, such as rainfall rate.

Correction Applied

The I. D. code is entered by the operator. A-7 then superimposes this I. D. code onto every radial in the output tape.

There are no side effects to this corrective procedure.

4. The data is not sequentially arranged on the A-tapes produced by REDIT. There are some slight overlaps of data, and a given operational day may be found on various tapes, in the midst of other operational days.

   Part of the cause of the problem is the sequence in which field tapes were processed by REDIT. At one point, the tapes were arranged on a priority basis and were processed in priority order, without regard to sequence of operational days.

   Also, occasional problems have forced a delay in processing one day's worth of data, so processing continued on another day. Sometimes processing would start on a given operational day, and the computer system would fail or REDIT would come across a fatal error (e.g., lack of room for one of the report files). The tape would be reprocessed, leaving a small amount of data repeated twice on the same, or different, output tapes.

   Results

   Cloud tracking and daily statistics would be in error.

Correction Applied

A-7 was designed to be command-driven, i.e., a command would be issued to inform A-7 what files to accept. The command included the tape number, so A-7 can reposition to the desired file, or dismount the current input tape and request the next tape.

Step 1 was to get a preliminary listing of the start date and time of every file on every output tape from REDIT. Since REDIT writes a filemark at the end of every volume, this listing also is a listing of volumes on each tape.

Step 2 involved examining the listings to determine where each operational day's worth of data was located, and in what order the pieces were to be consolidated. Care had to be taken because of the known date and clock problems, resulting in many references back to the data logs kept by hand.

False starts were recognized by two separate files (or volumes) starting on the same date and time, and using the more recently processed file in most cases where the "correct" file could not be determined.

Step 3 involved a preliminary run of A-7. Some false starts of REDIT were not terminated by a filemark, so the duplicated data was not recognized by the preceding step. All files that contained this error were uniformly rejected in the next run of A-7.

Step 4 was the production run of A-7. All files that had overlapping data or other problems that appeared in the first run of A-7 were rejected by the operator in this run. Since the volumes written were to have no tapemarks between them, the program suppressed all tapemarks. (A-7 recognizes two consecutive tapemarks on the input tape as a logical end of tape.) Each operational day was run separately, since each run of A-7 wrote a tapemark at the end of the output data.

On some occasions, there would be several runs of A-7 on an operational day, during different (and non-overlapping) periods of that day, so there would be tapemarks in the operational day. However, these separate runs usually occurred where a large time gap occurs. No attempt was made to delineate data gaps with new runs of A-7 (and thus tapemarks), unless this was convenient for splitting the data up into separate reels.

There are occasional side effects of the corrective procedure. There may be an occasional tapemark occurring where there is no significant data gap, but this should be only occasionally, and, from the 1976 data, is known to occur once, on an 11-minute gap for July 10.

Some data gaps may be larger than necessary because of whole volumes being rejected instead of just the "overlapping" part.

5. Some data is rich in ground clutter (or ground reflections).

<u>Result</u>

Rain and dBm calculations will be too high.

<u>Correction</u>

Initially, it was thought that for days of overwhelming ground clutter, the section of the day containing this would be rejected. The case where this occurred was not a day of interest to the Hiplex project, so the entire day was suppressed.

There is also an occurrence of a tower in most of the 1976 base angle plots. At this present time, UND is considering a procedure whereby the coordinates of the clutter is entered, and that part of the sky will be forced to blue sky.

There are two different side effects possible depending on the corrective procedures used. In the first case, the data will be unavailable.

In the second case, real clouds at the ground clutter location will be suppressed, leading to low dBm and rain calculations.

6. The 1977 Radar Season data for Snyder, Texas, has calibration pulses.

<u>Result</u>

Since these pulses appear as small, heavy clouds, the calculations and cloud tracking at UND will be wrong.

Correction Applied

Step 1. Scan for calibration pulse.

A calibration pulse is recognized by the following criteria:

i. The subgroup containing the calibration pulse is between 5 and 15 bins long (inclusive). (A bin is 450 meters long.)

ii. The subgroup starts within a bin range specified by the operator. (Most of the calibration pulses start very close to the same range on a given day, but this range varies between days. Therefore, the operator usually specified a range that included most of the sky.)

iii. At least 5 bins have DVIP values at or above 8Ø.

iv. A DVIP value of at least 8Ø must occur within the first seven bins of the subgroup.

v. After the first bin ≥ 8Ø DVIP's, the first bin ≤ 50 DVIP's must be no more than 5 bins after the last bin with DVIP value ≥ 8Ø. (For this condition, the bin immediately following the subgroup is treated as if it had DVIP value ≤ 5Ø.)

Step 2. Remcve the calibration pulse.

All bins within the subgroup are set to a DVIP value of 1.

Even though the criteria for detecting calibration pulses is rather stringent, clouds that radically have the same profile as a calibration pulse will be eliminated. It is expected that only a very few number of clouds will be dropped.

In some instances, the power in the calibration pulse is low enough that criteria iii is not met, allowing some pulses to be interpreted as data by processes later in the data handling.

A likely source for error is where the calibration pulse and cloud data overlap. In this case, the cloud will appear heavier than it really is, affecting all calculations performed until this date.

The side effect of this corrective procedure is that several clouds in the 1977 season will have high DVIP values. Fortunately, the calibration pulse occurs more frequently on clear days than cloudy, so the error introduced should not be significantly more than the other errors in the system.

The following is an unused section of A-7.

Some azimuths are recorded with values greater than 36Ø.Ø degrees. This error was probably introduced by REDIT when it was checking for bit errors.

Results

The tape no longer met the specs so RADPROC would flag this as an error.

Correction Applied

Initially, it was thought that this error was a bit error corrected by REDIT, without a MOD 36Ø.Ø done on following azimuths that were affected. A-7 was written to allow all azimuths to be MODed with 36Ø.Ø degrees. It was later learned that this error also could be caused by a false "correction" by REDIT of a bit error in the azimuth, resulting in an "azimuth shift".

Because of this possibility, the MOD 36Ø.Ø fix was never used, even though it is still in the program A-7.

The fix, has been relegated to program A-8, as potentially one of several errors (azimuth noise, azimuth shift, and MOD 36Ø). Performing the MOD fix in A-7 will not affect A-8, therefore, the MOD fixes have not been performed at this step.

A-8

A-8 was designed to run at UND on the Interdata 7/32 or 8/32 under CSS. It reads the output of A-7 (the tapes shipped from MRI) and generates tapes that can be used by the statistics programs at UND.

The source code of A-8 was contained in the first file of Tape #A which was shipped to UND in April 1979. The records are unblocked, fixed-length, 80-byte ASCII records. There were no special control characters in the records (e.g., no ASCII CRILF). A $BATCH record preceded the

the source code, and an $END record followed the source. A file mark follows the $END record.

All COMMONs used by A-8 are defined in a BLOCK DATA subprogram. Several of these COMMONs have DATA values. Two subroutines used by A-8 are not included in the source code. These are EXPAND and COMPRS which were available at UND. Great care was taken to make A-8 compatible with the January 1979 UND versions of EXPAND and COMPRS. (A MRI version of these two subroutines have been written, debugged, and used in the testing of A-8.) However, any changes to RADCOM or to the functions actually performed by EXPAND or COMPRS can adversly affect A-8.

A-8 uses no input parameters. The only requirements of A-8 are that the logical unit assignments be made as per the logical unit list, and the proper tapes be mounted. A description of the logical units used by A-8 is provided in Appendix VII. It was suggested that the operator should have a tape containing several EOF's handy. If an input tape should then be run that does not have the two EOF's at the end of the data, the EOF tape can then be mounted on that unit. A-8 would then read two consecutive EOF's and terminate processing. (This technique is frequently used at MRI for programs sensitive to the logical end-of-tape conditions.)

Program A-8 is responsible for performing various types of data reformatting and correction. The corrections are described in order of their processing by A-8. Since corrected results in one step of program execution is used in the next step, the results are affected by the order in which the corrections are performed. There were 17 problems corrected by A-8.

1. In the field, some bin subgroups were recorded after groups of a larger range. The result was that on any given radial there may be subgroups that are not in range order. This error is progagated throughout all of the data processing steps until it is used in A-8.

   Results

   Some A-tape decoding algorithms may detect this improper arrangement of subgroups as an error. The particular EXPAND subroutine at UND notes the starting and ending bin numbers of recorded data, and it will denote the wrong start and/or end bin numbers of data, resulting in some data not being processed.

Correction Applied

The UND EXPAND routine will expand the radial correctly, except for the starting and ending bin numbers. A-8 makes no use of this, so it is not affected. The COMPRS routine also bypasses this information, so that the problem is not felt by A-8. The UND COMPRS routine writes the subgroups in the correct order, so that the next program to process the data will get the correct starting and terminating bin numbers. Since A-8 uses the UND EXPAND and COMPRS subroutines, no explicit code has been needed to handle this problem.

There are no side effects to this corrective procedure.

2. This problem is one of storage and three parts.

   i. On most of the data, a noise byte is written after the data, but before the start of the next logical record (radial). The byte is after all the bytes used for the data bins, and by most decoding algorithms will be treated as filler.

   ii. Where there is a gap or blue sky of one bin in a subgroup, the data is recorded as two separate subgroups.

   iii. The blocking factor is too small.

Result

The data takes slightly more room than necessary on the storage medium.

Correction Applied

The UND EXPAND routine correctly decodes the radials, skipping past the extra bytes between the data and the next logical record. (The logical record length includes these extra bytes.)

The COMPRS routine will generate records with no unnecessary bytes (except for the filler bytes required to bring the logical record length up to an even number of bytes), its subgroup with a one-bin blue sky or hole will be left intact with that one bin set to zero (the value used for blue sky), and the larger blocking factor will be used.

There were no side effects to this corrective procedure.

3. The program, A-7, detected calibration pulses and, where they were found, the DVIP values for the offending bin subgroup were set to 1.

<u>Result</u>

Where no checking is made against the noise level, false readings may be computed. (The UND programs, on the most part, do check all values against the noise level.)

<u>Correction Applied</u>

Where A-8 makes use of the DVIP values, they are checked against the noise level. The UND COMPRS routine also checks these values against the noise level, and treats all values at or below the noise level as zero. The radials written will, as a result, exclude these detected calibration pulses.

There are no side effects from this corrective procedure.

The problems discussed so far are corrected only by passing the data through the UND EXPAND and COMPRS routines, and avoiding the use of variables where they are wrong. These problems are mentioned because they may affect users who wish to use the data directly from A-7 or an earlier step in the radar data processing.

4. Several operational days occur on one tape, with a tapemark separating operational days.

<u>Result</u>

Data is run together on output of A-8, leading to seasonal statistics by the UND programs, instead of daily statistics.

<u>Correction Applied</u>

When a tapemark is read by A-8, the current volume is terminated. When the volume has been processed, the program terminates without repositioning the input tape. The program, A-8, has to be executed once for every input file on the tape.

There are no side effects to this corrective procedure.

5. At times the radar antenna gets stuck at a specific altitude or the radar is operated in an intensive case study.

Result

Too much data is recorded for a specific volume. Usually, this is not a serious problem except that A-8 has limited table areas.

Correction Applied

After a certain number of radials (6000), the volume is terminated.

There are several side effects from the corrective procedure. For the intensive case study, valid data may be lost. The whole volume may be rejected at a later step if only one tilt angle is present. The data is not desired for either intensive case studies or for when the antenna gets stuck. If the antenna is in a transition from base angles to base angle plus higher tilt angles, the volume may be truncated unnecessarily. (This has been observed only on rare occasions.)

Also, some volumes with intensive case studies may end up being processed by A-8 with only a few (e.g., 3) radials written.

6. A time gap is occasionally encountered. These time gaps can be caused by the tape drive not being ready in the field when tape switches occurred, starting up the runs of REDIT in the middle of a volume, or clock resetting in the field.

Result

Since it is not known what, a priori, caused the time gap, the propagation of the error can have an indeterminate result. Where the data were dropped because of a tape not ready in the field, or starting up REDIT in the middle of a volume, the result will be a partial volume processed. A clock error should have no adverse affects except for time-sensitive logic.

Correction Applied

A time gap of AMINLM minutes (three minutes) will be treated as an end of volume.

There are several side effects to this corrective procedure. Where clock adjustments (errors) occur, a false end-of-volume will be generated, causing the volume to be truncated or (at a later step in the processing) rejected. In cases where data was dropped for one reason or another before the A-8 run, the volume will be kept separate.

7. Some of the recorded tilt angles contain noise values because of a 3-word drop problem or bit errors encountered in the field. (See Figure 10.)

<u>Result</u>

All calculations requiring the tilt angle will be wrong where this error occurs.

<u>Correction Applied</u>

A tilt error is detected by scanning the tilt angles for continuity. A valid sequence of tilt angles is a sequence of at least NNOISE (1Ø) radials such that the difference of tilt angles between any pair of consecutive radials is LELTOL (0.2) degrees, or less. All radials following the last valid sequence before the end of file, a time gap, or too many radials (6000) have been read into the tables, are also deleted. When offending radials are detected between two valid sequence to the start of the next valid sequence. If this is its case, the radials are transition radials from one sweep to the next. They are not modified. If both ascending and descending transitions are found, the tilt angles are linearly interpolated, using the end of the preceding valid sequence and the start of the following valid sequence as the end points for the interpolation, and assuming that the radials are to be uniformly spaced over this interpolation interval. (No azimuth checking is done because the azimuths may also have some errors.)

There were two possible side effects to this corrective procedure. When blue sky elimination is present, and data is very sparse the higher tilt angles, the higher tilt angles may be lost or reassigned to a lower tilt angle. (Observation indicates that the radials are usually deleted when this occurs.)

8. The volume, as defined by REDIT, is not always correct. Unusual scan patterns occur that should be dropped. Descent data is recorded. Antenna bounce at the base angle often triggers false

starts of volume in the REDIT logic. (See Figure 10).

Result

The rain estimates will be in error and false sweeps or volumes may be triggered.

Corrections Applied

All data is rejected until a radial is encountered that has a tilt angle of 1.5 degrees or less. (The Texas radar uses 1.4° as the nominal base angle.) This radial is marked as the start of the volume. (A radial after this one may later be denoted as the start of the volume, depending on the fixes required by the following steps.) The radials are then accepted for the current volume until a difference of NDROP (Ø.5) degrees, or greater, is encountered between the tilt angle of the current radial and the maximum tilt angle encountered so far for the current volume. The radial at which this is encountered is treated as a candidate for the next volume, and is excluded from the current volume. The radials preceding the current radial becomes the end-of-volume. (Too many radials read, time gap, and an end-of-file will also be treated as the end of volume.)

By using this criteria, descent data, on the most part, is deleted. By the same token, any extra sweeps between the detected end of volume and the next base angle are also deleted, taking care of most of the "unusual" scan patterns.

Once an entire volume is read, a check is made to see if there are at least MINPTS (2Ø) radials in the volume. If not, the entire volume is rejected.

There are two side effects from the corrective procedures. All volumes that have base angles above 1.5 degrees are rejected. Since the radar operation calls for using a base angle of 1.4°, a base angle above 1.5° represents a malfunction, so the data justifiably are rejected.

The volumes where there are very sparse data and REDIT was eliminating blue sky radials may be rejected. Since most of the interest is where there is a significant amount of clouds, this tradeoff is felt reasonable.

9. Some azimuths contain noise values, probably because of 3-word drops and bit errors. (See Figure 10.)

Result

Location of data is left open to question. (This would also affect the following corrections in A-8.)

Corrections Applied

A valid sequence of azimuths is defined to be at least NAZNUM (8) consecutive radials such that between any two (nondeleted) radials, the azimuth difference is between Ø and LAZTOL (18Ø.Ø) degrees, after 36Ø-degree wraparound is compensated for. (This criteria will catch places where the radar appears to back up.)

All radials before the first valid sequence in the volume are deleted, effectively changing the start of the volume. All radials after the last valid sequence are also deleted, changing the end of the volume. Offending azimuths between two valid sequences are linearly interpolated between the end of the preceeding sequence and the start of the following sequence. 36Ø wraparound is considered in the interpolation, resulting in some internal working values of greater than 36Ø degrees. (The output logic corrects all angles greater than 36Ø° by taking MOD 36Ø.Ø of the angle.)

If no valid sequences are found in the entire volume, the volume is rejected.

A side effect of the corrective procedures occurs when blue sky elimination was performed by REDIT on sparse data. The result is some radials may be falsely detected as having azimuth noise.

10. Occasionally an azimuth shift is detected. Unlike the azimuth noise, these shift conditions appear to be a whole sector of the sky shifted to an inappropriate location.

The exact cause of these shifts are unknown, but they are thought to be a faulty correction of REDIT to compensate for some bit errors.

Because of the nature of the REDIT corrections, it is believed that these shift errors are all clockwise in direction, and all the radials in the shifted sequence are shifted the same amount.

Result

Data is recorded in the wrong location. In a later A-8 step, this can give rise to rejecting valid data when sweeps are truncated at one rotation each.

Correction Applied

A scan for an azimuth "backup" is made. A "backup" is detected by the azimuth difference between two consecutive radials being more than IBACKU (18Ø.Ø) degrees, and the difference in the tilt angles between the two radials is less than or equal to NELTOL (1.Ø) degrees. (The tilt angle test reduces the chances of falsely detecting an azimuth shift where blue sky elimination was used and a step from one sweep to the next occurred.)

Once the backup is detected, a scan through the radials is made, starting at the backup point, and working towards the start of the volume. The scan is for finding the extent of the shifted radials, and it is done by comparing pairs of consecutive radials for a tilt jump (difference) of over NELTOL (1.Ø) degrees, an azimuth "gap" (difference) greater than the "backup" or greater than NAZTOL (2Ø.Ø) degrees, or the start of the volume is encountered. Where any one of these conditions is encountered, the second radial of the pair where the condition occurred (or the first radial of the volume) is treated as the start of the offending sequence, and the end of the offending sequence is the radial of the radial pair closer to the start of the volume where the "backup" was detected. The correction applied depends on the condition at the start of the offending sequence and the number of offending radials.

If the sequence of offending radials starts with the azimuth gap of at least NAZTOL degrees (as opposed to any of the other backward-scan terminating conditions), the average azimuth step between radials in the offending sequence is computed. If there is only one offending radial, the average azimuth step is set to one degree. The whole sequence is shifted (each radial is shifted the same amount) so that the azimuth step between the offending radial closer to the start of the volume and the preceding radial is equal to the average azimuth step size in the offending sequence. After the shift is performed, a scan from the end of the offending sequence is made to find the extent of the remaining overlap.

If an overlap remains after this shift, radials are deleted from the offending sequence, starting at the end of the sequence, until the overlap is eliminated.

When the start of the offending sequence is found by any of the other criteria, the average azimuth steps in the offending sequence are computed. (If there is only one radial, the average azimuth step is set to one degree.)

The shift to be applied is computed to be such that the resulting azimuth step between the last offending radial and the next radial is equal to the average azimuth step in the offending sequence.

In the case where the offending sequence starts with a "gap" larger than the terminating overlap, a check is made to see that this shift constant will not cause an overlap at the start of the offending sequence. If it does, a new shift factor is then computed to be such that the resulting azimuth step between the first offending radial and the preceeding radial is equal to the azimuth step between the last offending radial and the radial following it. The shift constant is then applied on all the offending radials.

The scan for the next "overlap" is resumed until the whole volume has been corrected.

The correction has been designed to minimize errors. Yet, if a shift is caused by something other than a REDIT false bit error correction (e.g., from dropped data), a side effect of false corrections may arise, causing data to be inappropriately shifted or deleted. In the few test cases examined, however, this was not the case. It is expected that all shift errors corrected will result in no deleted radials. If radials are deleted in this step, it is an indication of an error other than a false REDIT bit error correction.

11. Some of the azimuths are recorded on the A-tape with values greater than 36Ø.Ø degrees. A possible source of this error is misapplied bit error correction applied to potential azimuth bit errors by REDIT. The azimuth noise fix and azimuth shift fix may also generate azimuths larger than 36Ø.Ø degrees.

Result

All programs that range check azimuths will detect this problem.

Correction Applied

All azimuths are recomputed to be MOD 36Ø.Ø of their values. (This is also done on output.) This fix is considered to be unnecessary at this step, but is aesthetically appealing because the working messages in later steps are easier to read if the MOD is performed.

There are no side effects from this corrective procedure.

12. The sweeps are not properly defined. Some sweeps contain more than one rotation of data. Transition data from one sweep to the next is recorded. The tilt step between sweeps is not uniform. Also, there are some unusual scan patterns.

Cases of where the antenna steps up, then steps down part way, have been taken care of by an earlier step (i.e., the data after the antenna starts down has been eliminated by one of the first corrections in A-8).

Here, the case of where the antenna is stuck at a given tilt angle, or steps up too far between sweeps, is handled.

Result

Programs that key off the tilt angle alone do not properly recognize a sweep change. Programs that examine both the tilt angles and the tilt modes may reject half of the data at the high tilt angles. Rain calculations will yield excessive values from multiple base angles (where most of the data for over one rotation per sweep occurs).

Correction Applied

The first step is to locate the start and end of each sweep, based solely on the tilt angle.

This is achieved by scanning a table of tilt angles with a variable-width fork.

The fork starts out zero radials wide (i.e., it is examining two consecutive radials), and the leading edge is advanced by one radial before each test. The trailing edge of the fork remains stationary until the fork width is NWINDO (15) radials wide. Then the trailing edge is advanced with the leading edge.

The fork starts at the start of the volume, zero radials wide. Each time the leading edge is advanced, a check is made of the tilt angles between the leading edge and the radial just before it (i.e., the radial next to the leading edge, on the side closer to the start of the volume). If the tilt angle difference is greater than NWNJMP (1.Ø) degrees, the radial preceding the leading edge is assigned to the end of the current sweep, and the radial at the leading edge of the fork is assigned to the start of the next sweep. The fork is repositioned to the last position of the leading edge, with the width of zero.

The transitions found by this process occur when blue sky has been eliminated completely from the incoming data and there is no data at the transition from one sweep to the next.

Since the usual mode of operation is to have data, or at least radials, located at the point of transition, a further refinement of the algorithm is made. The leading edge of the fork is compared with the trailing edge. If the tilt difference between these two radials is greater than NWNDEL (Ø.5) degrees, and the tilt at the leading edge is greater than the tilt at the trailing edge, the trailing edge of the fork is marked as a start of the transition interval. When the leading edge has a tilt angle less than or equal to the tilt angle of the trailing edge, the radial at the trailing edge of the window is marked as the end of the transition interval. The transition interval is scanned for the first radial whose tilt angle is equal-distant between the tilts at the ends of the interval, or closer to the tilt angle at the end of the transition interval. This radial is assigned to the end of the current sweep. The start of the volume is assigned to the start of the first sweep, and the end of the volume is assigned to the end of the last sweep.

Everytime the leading edge of the fork is advanced, both types of transition tests are made, so data with blue sky elimination, as well as data with transition radials recorded, can be properly used in delimiting the sweeps. Once the radials are assigned to a particular sweep, they are not reassigned to another sweep, but they may still be deleted in a later step.

The second step is to reduce the amount of data on any one sweep to no more than one rotation worth of data.

Every sweep defined in the preceeding step is examined one at a time. Starting at the last radial of the sweep, A-8 looks at the radial preceding this radial, and computes the amount of sky seen so far by these two radials. Radials preceeding these are added, one at a time, until the full sweep has been examined, or until over one rotation worth of data has been seen. When 36Ø.Ø degrees worth of data, or more, has been encountered, the radials from the start of the sweep to the last radial added (inclusive) are deleted. The net effect is that radials are deleted from the start of each sweep until there is no more than one rotation of data. (Since the radials generally represent one degree sectors of sky, if the end azimuth equals the start azimuth, the start azimuth is deleted so that 361 degrees sweep of sky is not used, but only a 36Ø-degree sector of sky.)

The third step is to compute the tilt angle of each sweep. The tilt angle is computed by taking the mode of the tilt angles of all radials remaining in each sweep. (If two separate tilt angles have the same number of radials at those angles, the lower tilt angle is used.)

All tilt angles greater than 2Ø.Ø degrees or less than Ø.1 degrees are ignored when the mode tilt angles are computed.

If any given sweep has no radials with tilt angles between Ø.1 and 2Ø.Ø degrees, the whole volume is rejected.

The "mode" tilt angle will be imposed upon all radials in the sweep in a later step.

The transition radials between sweeps will be assigned the tilt angle of the closest sweep. Also, this eliminates the antenna bounce problem.

The fourth step is a "syntax check" of the tilt angles. This is just a check to guarantee that the tilt step between two consecutive sweeps is between Ø.5 and 2.5 degrees, inclusive, and that the base angle is at 1.4 or 1.5 degrees. A variation from these restrictions indicate an unusual scan pattern, so the whole volume is rejected in these cases. If only one sweep is present, it, too, represents a bad scan pattern, and the volume is rejected.

The fifth step is to take the tilt angles of the sweeps, and produce a "base angle" and "elevation mode" for each sweep. Initially, the "base angle" is the tilt angle of the first sweep. The closest "elevation mode" corresponding to the tilt step between the first and second sweeps is assigned to the first sweep.

The "base angle" and "elevation mode" of the sweeps after the first sweep are computed from the preceding sweeps. An "expected" tilt angle is computed by adding the product of number of sweeps since the last assigned "base angle" and the tilt step corresponding to the last assigned "elevation mode" to the last assigned "base angle". Simply stated, the "expected" tilt angle is the next tilt angle expected if the "base angle" and "elevation mode" do not change.

The tilt angle of the sweep is compared to the "expected" tilt angle. If the difference is less than or equal to IELSWT (Ø.3) degrees, the last used "base angle" and "elevation mode" are acceptable for the current sweep.

Otherwise, the tilt angle of the current sweep is assigned to the "base angle" of the sweep, and the "elevation mode" of the current sweep is determined by finding the "elevation mode" that has the closest tilt step to the tilt difference between the last sweep and the current sweep. Both the "base angle" and the "elevation mode" for each sweep will be assigned to all radials in that sweep in the output routine.

There are two side effects from this corrective procedure. The so-called "base angle" and "elevation mode" typically changes twice per good volume, so RADPROC will recalculate its tables twice per volume processed. A straight interpretation of the A-tape format description implies that the base angle and elevation mode are constants. The output from A-8 shows multiple "base angle" values per volume, thus invalidating the precise definition of this field.

The dBz and rain calculations may be wrong by virtue of the different "elevation modes" encountered in each volume.

13. There is no proper delimiter for when data gaps occur. In particular, when a gap of about half an hour, or greater, occurs, a tapemark should be present, but it is not.

Result

Cloud tracking at UND becomes unreliable at the large data gaps. There may be other problems that occur with time-sensitive data, for example, in computing hourly rainfall.

Correction Applied

In an earlier step, when a time gap of at least AMINLM (3.ØØ) minutes occurred, the volume was terminated. At this step, there are no data gaps of AMINLM minutes within the volume, so the only place where a significant gap can occur is between volumes. (Even if a sizable gap ends up occuring within the volume, there is reasonable confidence that the gap does not span volumes, so it is reasonable not to end the file at this point.)

Before the volume is about to be written out to tape, the first radial of the first sweep of the volume is compared to the last radial actually written in the preceding volume. If time backed up (i.e., data is out of sequence) or a time gap of at least GAP-MAX (3Ø.ØØ) minutes occur, a logical record containing all zeroes, with the NEWVOL flag set to one ("yes") is written to the output tape. A tapemark cannot be written out to tape because of the nature of the UND COMPRS routine (it allows only one end-file per program run.)

This "zeroes" record is used by the UND software for flagging logical subfiles, and can later be separated into separate files by the program, ACOPY.

A "zeroes" record is not written before the first volume of the program execution, but it is written after the last volume.

There are two side effects from this corrective procedure. An intermediate step (between A-8 and RADPROC) is required for breaking up the output subfiles into distinct files for such activities as cloud tracking.

Programs that do not recognize the "zeroes" record as a delimiter will have problems reading the output files.

14. The azimuth steps are irregular. The data is assumed to have sky elimination (i.e., all radials containing no data are suppressed except for the first radial of the volume). The incurred problem is that where consecutive radials are present, the step size varies typically from Ø.5 degrees to 1.5 degrees because of wind loading on the antenna, and because data is recorded by the number of radar pulses sent, instead of by radar position.

<u>Result</u>

Since the rain calculations and the dBz calculations at UND use the azimuth step instead of the azimuth difference between two consecutive radials, these calculations may be wrong by as much as a factor of two. (This is a reasonable possibility when all the clouds occur where the recorded azimuth step is Ø.5 degrees when the azimuth step mode corresponds to 1.Ø degrees.)

More dBz space could conceivably be calculated than actually exists.

<u>Correction Applied</u>

For every sweep written, on the first radial of the sweep, the whole degree closest to the recorded azimuth is picked as the starting point. Whole azimuth degrees are written, using the closest radial in the sweep to the whole degree azimuth. If the azimuth of the closest radial preceeds the whole degree output azimuth by less than Ø.5 degrees, or the closest radial follows the whole degree output azimuth by no more than Ø.5 degrees, the radial is written.

Also, when the radial following the whole degree output azimuth is no more than IOUDAZ (1.5) degrees after the radial preceding the output azimuth (assuming that a radial does not occur at the same location as the output azimuth), the closest radial (or the radial after the whole degree output azimuth if the preceding radial and following radial are equidistant from the whole degree output azimuth) is written. If none of these conditions is true, no data is written for this output azimuth.

The 36Ø-wraparound is handled by taking MOD 36Ø.Ø of the whole degree output azimuth, and superimposing this azimuth angle on the radial that will be written. (Note: even when a radial is accepted at this step for output, it may still be deleted in the next step.)

There are several side effects from this corrective procedure. At true north, the recorded azimuth will be Ø.Ø degrees, not 36Ø.Ø degrees.

Some radials may be written more than once because they are the closest radial to two separate whole-degree output azimuths, resulting in some distortion of the data. Also, data may appear shifted Ø.8 degrees, which is probably insignificant compared to the radar beam width of about 1 degree.

The radial considered to be the first radial of the volume when data gaps of GAPMAX minutes was tested may be deleted in this step, making it possible that for data gaps of almost GAPMAX minutes between volumes, the gap will not be detected by A-8, but a close examination of the radials actually written will show this gap. The likelihood of this occuring is very small.

The antenna sweep report and the new-file messages will properly show the time recorded on the first radial actually written on each sweep.

15. Null radials are recorded in the data. The only null radial that should be present is the radial at the start of the volume.

<u>Result</u>

Data storage takes more room than necessary.

<u>Correction Applied</u>

When the radials are written to tape, if the radial has no data bins and it is not the first radial of the volume, the radial is not written. The first radial of the volume (i.e., the radial closest to the first whole-degree output azimuth of the first sweep) is always written, at UND's request, so that the start time of each volume can be determined without data dependency.

Note: This is the last step that determines if a radial is rejected. The antenna sweep report will reflect the start and end radials actually written for each sweep.

A side effect of this procedure is that there may be no radials written for some of the higher sweeps when data at the higher tilt angles becomes sparse. This can lead to some sweeps appearing to have been skipped.

16. The new volume flag is not always set correctly. This is especially true after the extra radials in the base angle have been deleted. As mentioned before, the error in properly setting the new-volume flag probably occurred in program REDIT when antenna bounce and unusual scan patterns played havoc with the "find new volume" logic.

Result

Programs keying off the new volume flag (such as most of the UND programs) will delimit the volumes at the wrong places, resulting in worthless calculations and poor PPI plots.

Correction Applied

Since one of the first steps of A-8 was to recognize the start and end of each volume, and since subsequent steps have made various refinements on this, A-8 now has the start of the volume well located. The first radial actually written for any given volume will have its new volume flag set. All radials after the first radial in the volume will have the new-volume flag clear (zero).

There are no side effects from this corrective procedure.

17. The "max tilt" field of the records is not filled in with the maximum tilt of the preceding volume, or zero when there was no preceding volume.

Result

There are no presently known effects associated with this problem.

Correction Applied

The tilt of the last radial written for the preceding volume is placed in the "maximum tilt" field of all radials for the current volume. Where there is no preceding volume (at the start of the file) or a "zeroes" record separates the current volume from the preceding volume, the "maximum tilt" field is set to zero.

There are no side effects from this corrective procedures.

Potential Problem

The data bins are defined only for bins 1 through 251. Since there is a possibility that the preceding programs left data in bins 252 through 256, these values would be interpreted as calibration levels.

Result

This problem has no known effects in any of the processing.

Correction Applied

These bins (252 through 256) are set to zero before output.

There are no side effects of the corrective procedures.

Operation

Preceding calculated values of the tilt angle, "base angle" and "elevation mode" have to be applied to the output radial. This is done at this step, where the modified flags and locations are imposed upon the candidate radial before it is written.

4. CALIBRATION

The calibration of the M-33 S-band radar requires two procedures. The first of these is an antenna gain calibration using a metal sphere supported by a tethered or free launch balloon. The second is a daily data recording system (DVIP) calibration.

The antenna gain or sphere calibration was usually performed once a season unless significant changes due to antenna repair were made. The sphere calibration procedure is described in the Texas-HIPLEX Operations Manual, May-July 1976. This procedure was used in 1976. In 1977 and

1978, the target sphere was allowed to freely float and it was tracked by radar.

The sphere calibration data collection-reduction process was improved for each of the three seasons. The first year photographs of the "A" scope returns were used to determine the sphere return signal power. The second year the digital tape recording system was used to record data. The scan was then reconstructed on a computer graphics system. This plot was used to identify the sphere return. A typical plot is shown in Figure 4.1. The actual return power was obtained from the tabulated tape DVIP's and converted to dBm via the daily calibration. The third year a computer search routine was developed to locate and print out the sphere return pulses. This system was made possible by the introduction of an identification code pulse before the sphere return pulse during the field season.

The sphere calibration data analysis procedures generally follow those outlined in the Texas-HIPLEX Operations Manual May-June 1976. The computer program searched a given radial to locate the identification pulse and then searched the 20 range bins after the ID pulse to locate the sphere return pulse. The maximum sphere return of each ten radials which contained an ID pulse was printed out. A representative maximum return was then selected from each range interval. The number of range intervals used varied from 20 to 27. Each of these were assigned a quality factor based on the number of radials which had similar return power for the given range. The return power was then used to calibrate the antenna gain for each range interval. An average antenna gain factor was then computed from consecutive blocks of good quality data. The average was then accepted as the true antenna gain factor. The resultant value was then representative of up to 800 individual return pulses.

Because of a flexible wave guide replaced during the 1978 season, two antenna gain factors were calculated. The results of the sphere calibrations are given in Table III.

The daily DVIP calibration data was acquired in a manner similar to the procedure outlined in the Texas-HIPLEX Operations Manual. These calibrations were recorded using the digital tape recording system.

The 1976 calibration data was obtained by manually extracting the DVIP value for each calibration pulse from computer listings of the returns. The daily calibrations for 1977 and 1978 were derived in the following manner. First a computer program, which was developed, located the daily calibration identification code. The program then searched the first ten calibration

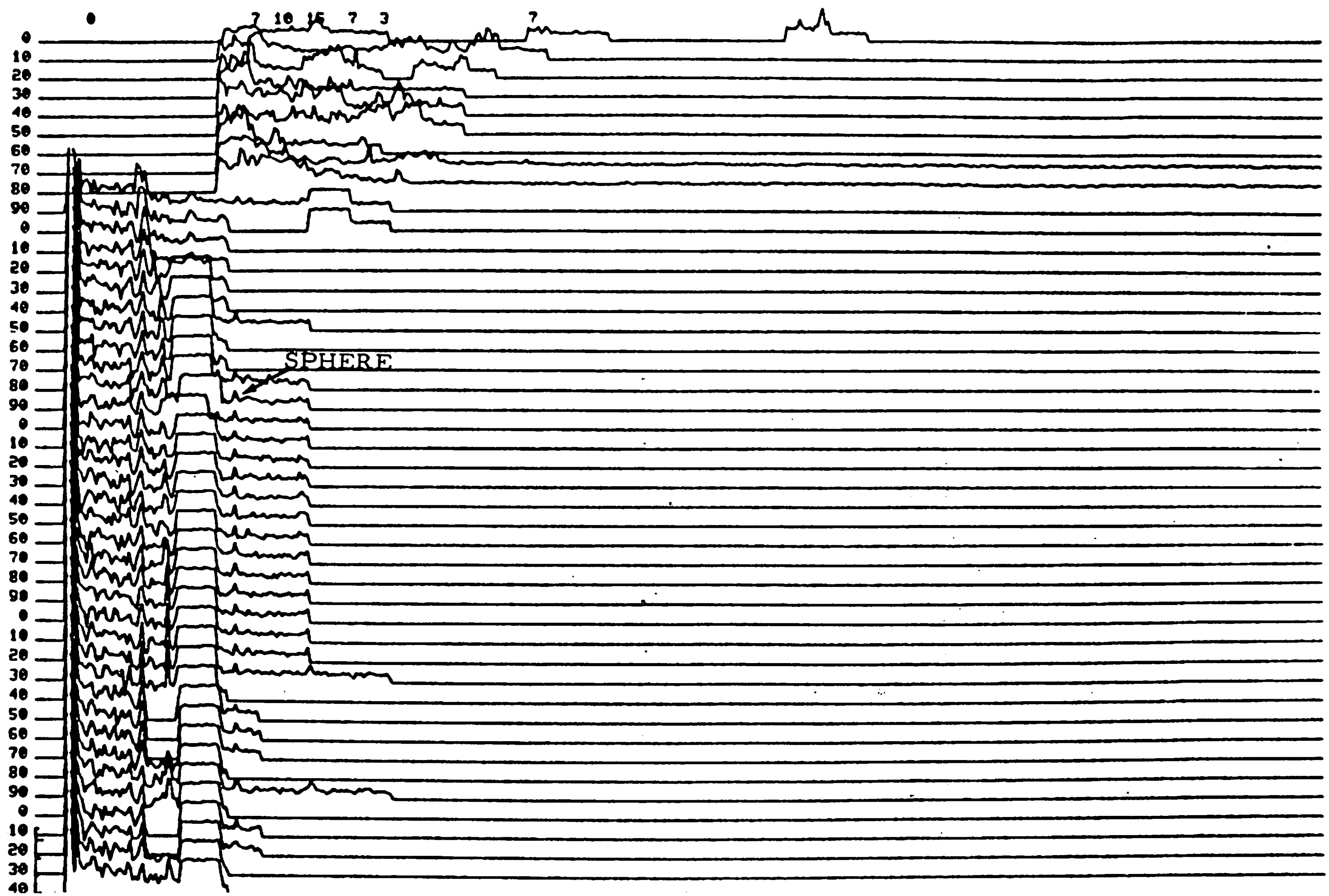


Figure 4. 1. Computer constructed multiple "A" scan plot showing the sphere retain signal.

TABLE 3. SPHERE CALIBRATION 1976-1978

Year	G_o
1976	38.3
1977	38.3
1978 A	37.3
B	38.5

A: Valid before 1430 CDT 6/29/78
B: Valid after 1430 CDT 6/29/78

identification code. The program then searched the first ten calibration pulses to determine the calibration pulse average starting and ending position. The program then averaged the center 5 bins of the pulse. This information was printed out along with the date, time, a quality indicator and other information. The printouts were examined and a maximum or representative maximum value was extracted for each input power level. The resulting calibrations consisted of a series of matched pairs of input power and DVIP numbers. For the 1976 data the daily calibration points were combined into a single data set. A linear curve was fitted to this data set and the curve was used for the entire season. The data for the two subsequent years was used to develop a calibration curve for each day, if possible, to minimize the effects of system drift. A series of polynomial curves were fitted to each data set using a least squares technique. These equations related the DVIP value recorded on magnetic tape to the power returned (dBm). An example of the polynomial curve fitting routine results are presented in Figures 4.2 and 4.3.

The cubic curve was found to be the most economical in that it produced an acceptable fit with a minimum number of equation terms. The daily system calibrations performed during the data collection period covered the range of 35 to 130 DVIP's (-100 to 155 dBm). This range was imposed by the system noise characteristics and by the limited power output of the test signal generator. The cubic curves fitted to calibration data are very accurate over 35-130 DVIP range. Outside of this range, particularly at the higher DVIP end, the curve approaches an asymptotic value and thus the dBm values calculated are over estimates, limiting the range of acceptable DVIP values based on the calibration range produced as unacceptable truncation in the data. To correct this difficulty, a different extrapolation technique was introduced to allow a best estimate of the calibration curve above the in-field calibration data range. This best estimate was based on the linearity of the IF amplifier. The characteristics of this amplifier were reported in MRI 76 FR-1445 (Carbone, et al.). The extended calibration estimates were derived by fitting a straight line to that portion of the curve judged to be linear. Figure 4.4 is a comparison of a typical cubic and linear calibration curve set. A summary of all the daily calibrations for 1977 and 1978 is provided in Appendix VIII.

5. EXPAND

This is a UND subroutine which decodes the data tape and prepares a data file for A-8. It was discovered after UND processed several tapes that occasionally EXPAND would halt the processing because of an overflow in the allowable subfield number. This was apparently the result of a reshuffling of the data sequence in AEDIT to correct for an ISWS DVIP processor problem. This problem which occurred occasionally would record the data out of time sequence. The correction for this problem was accomplished by slightly modifying EXPAND to identify and reject these error subfields.

```
     N =    2
     S =    1.587260
     A  =    -.1213952E+03
     B( 1) =      .6969559E+00
     B( 2) =    -.1396283E-02
M=    1        DY=    -1.73200       YT  =   -54.50000
M=    2        DY=    -1.24343       YT  =   -57.50000
M=    3        DY=      .67603       YT  =   -60.50000
M=    4        DY=      .93144       YT  =   -63.50000
M=    5        DY=     1.41962       YT  =   -66.50000
M=    6        DY=     1.28111       YT  =   -69.50000
M=    7        DY=      .89861       YT  =   -72.50000
M=    8        DY=      .64044       YT  =   -75.50000
M=    9        DY=      .24544       YT  =   -78.50000
M=   10        DY=     -.38931       YT  =   -81.50000
M=   11        DY=    -1.06190       YT  =   -84.50000
M=   12        DY=    -1.53943       YT  =   -87.50000
M=   13        DY=    -1.67610       YT  =   -90.50000
M=   14        DY=    -1.78369       YT  =   -93.50000
M=   15        DY=    -1.49512       YT  =   -96.50000
M=   16        DY=     -.17449       YT  =   -99.50000
M=   17        DY=     1.36862       YT  =  -102.50000
M=   18        DY=     3.63415       YT  =  -105.50000

    N =    3
    S =     .865752
    A  =    -.1422437E+03
    B( 1) =      .1732961E+01
    B( 2) =    -.1644863E-01
    B( 3) =     .6611382E-04
M=    1        DY=      .70861       YT  =   -54.50000
M=    2        DY=     -.90182       YT  =   -57.50000
M=    3        DY=      .39335       YT  =   -60.50000
M=    4        DY=     -.35289       YT  =   -63.50000
M=    5        DY=     -.21588       YT  =   -66.50000
M=    6        DY=     -.27231       YT  =   -69.50000
M=    7        DY=     -.16258       YT  =   -72.50000
M=    8        DY=      .24971       YT  =   -75.50000
M=    9        DY=      .59337       YT  =   -78.50000
M=   10        DY=      .64623       YT  =   -81.50000
M=   11        DY=      .43271       YT  =   -84.50000
M=   12        DY=      .07737       YT  =   -87.50000
M=   13        DY=     -.26993       YT  =   -90.50000
M=   14        DY=     -.92965       YT  =   -93.50000
M=   15        DY=    -1.42914       YT  =   -96.50000
M=   16        DY=     -.74884       YT  =   -99.50000
M=   17        DY=      .14057       YT  =  -102.50000
M=   18        DY=     2.04112       YT  =  -105.50000
```

where

N	= power of the polynomial
S	= average deviation between the fitted curve and the actual data points
A, B(1), B(2), B(3)	= curve coefficients
M	= set number
DY	= difference between the curve calculated value and actual value of the M^{th} set
YT	= input data value of the M^{th} set
Y	= $A + B(1)*X + B(2)*X^2 + \ldots$

Figure 4.2. Typical output from the curve fitting program for quadratic and cubic curve fits.

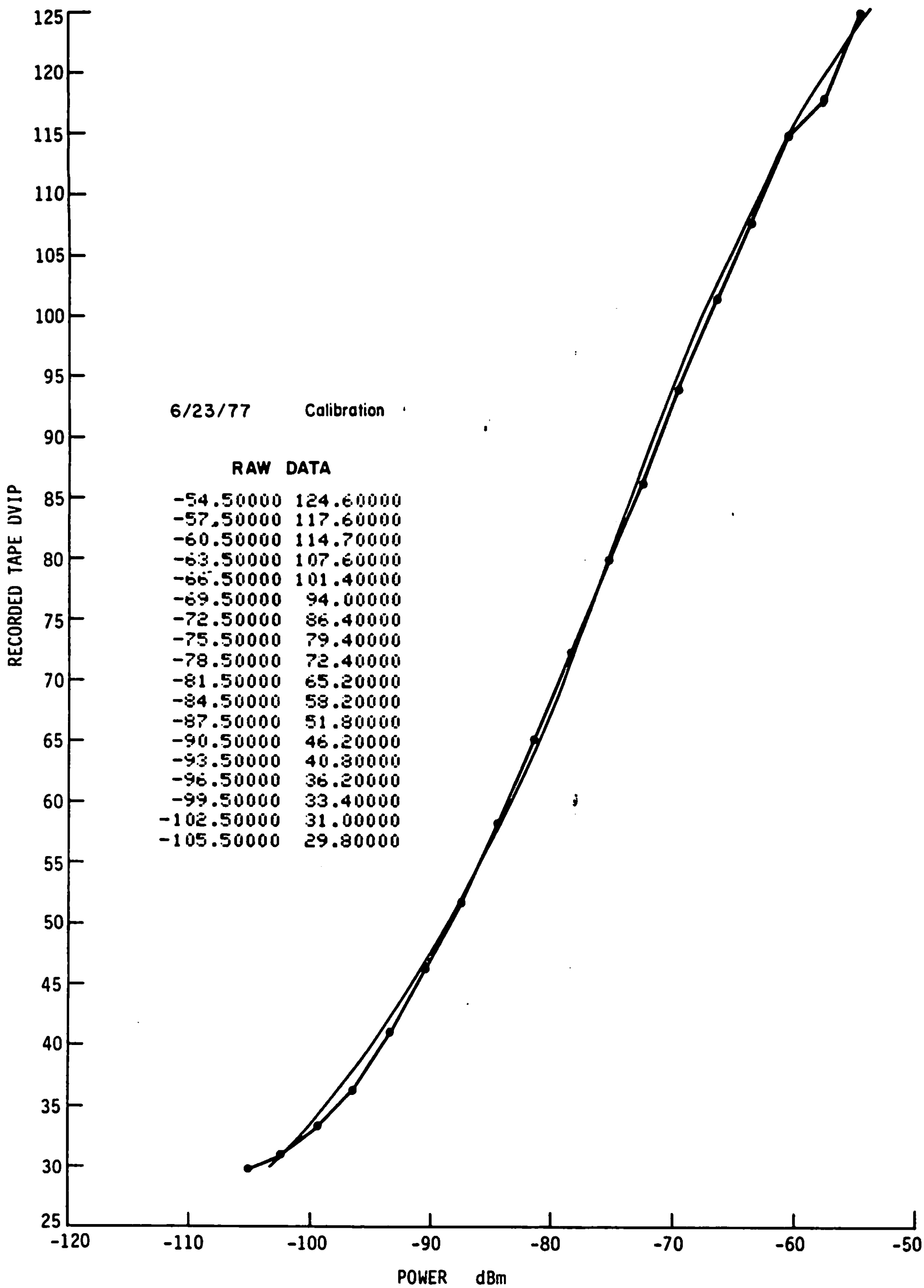


Figure 4.3. A comparison between the fitted curve with the original data curve.

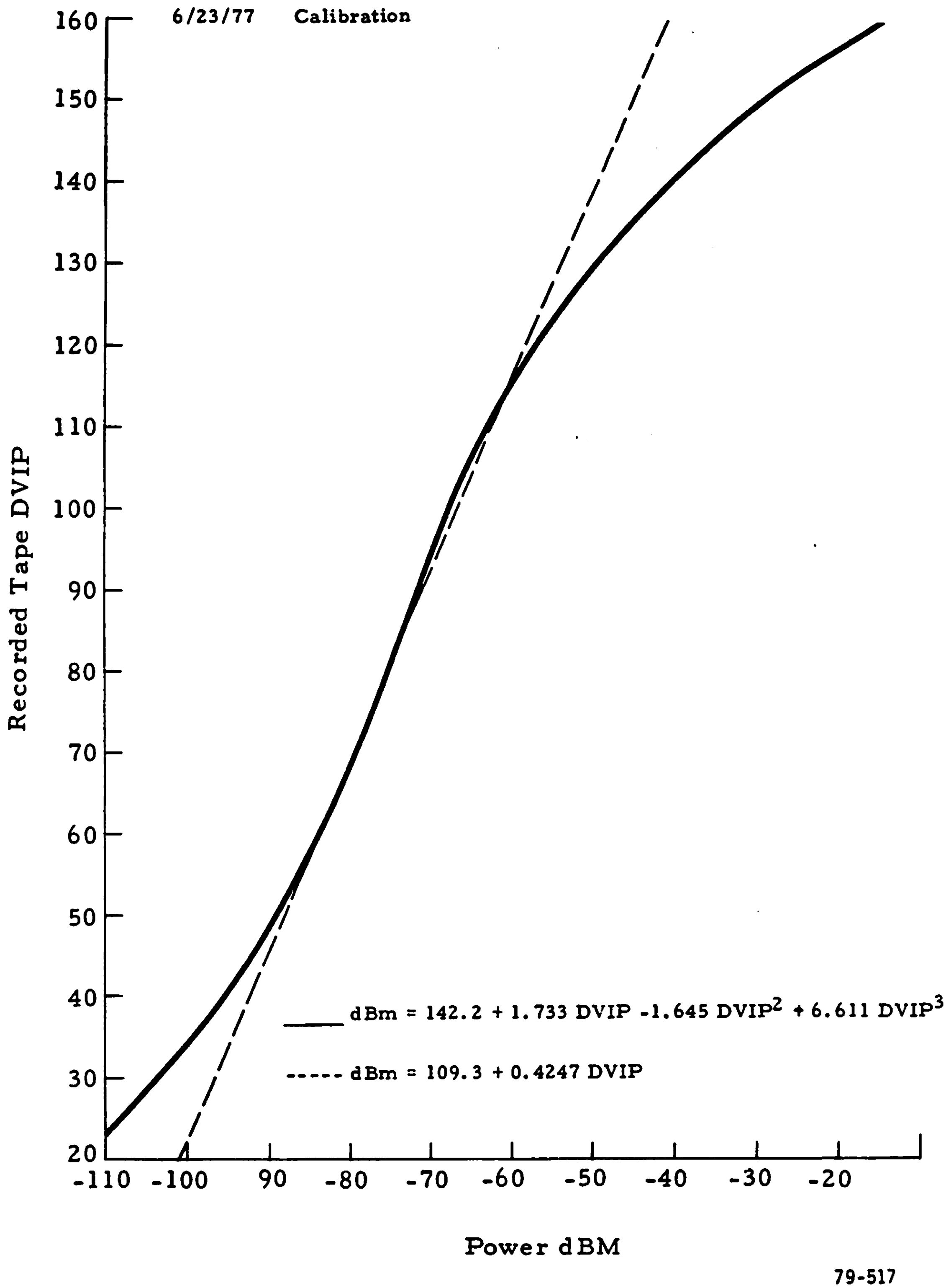


Figure 4.4. Cubic and linear calibration curve comparison.

6. SUMMARY

Dual wave length radar was collected at Snyder, Texas, using a modified M-33 radar system during the 1976, 1977 and 1978 summers. The S-band data was carefully reviewed to insure a high archive level quality. The data was successfully edited and reformated into an "A" file format. A substantial data modification programming effort was undertaken. The resultant programs, which were called A-7 and A-8, modified the data so that it was of an acceptable structure and content to be used as input data for the Bureau of Reclamation's analysis programs. All thirty-three A-7 processed radar data tapes were delivered to and processed through the Bureau of Reclamàtion's analysis program at the University of North Dakota. The analysis program output was archived at the Bureau of Reclamation's Denver facility.

APPENDIX I

LSI-II Quality Control System

APPENDIX I

LSI-II Quality Control System

The LSI-II Microprocessor based Quality Control System, shown in Figure A was used to examine the data collected for correct flags, sequential azimuth and range values, etc. and to diagnose conditions requiring both routine preventive maintenance and corrective maintenance. The Quality Control System also included the capability to play back radar tapes on the Kratos PPI display.

1. The on-site radar meteorologist used this system to check data tapes for consistency with the returns observed during the storm.

The system was used in the field to detect errors through a series of small programs, each of which checks the different types of data recorded.

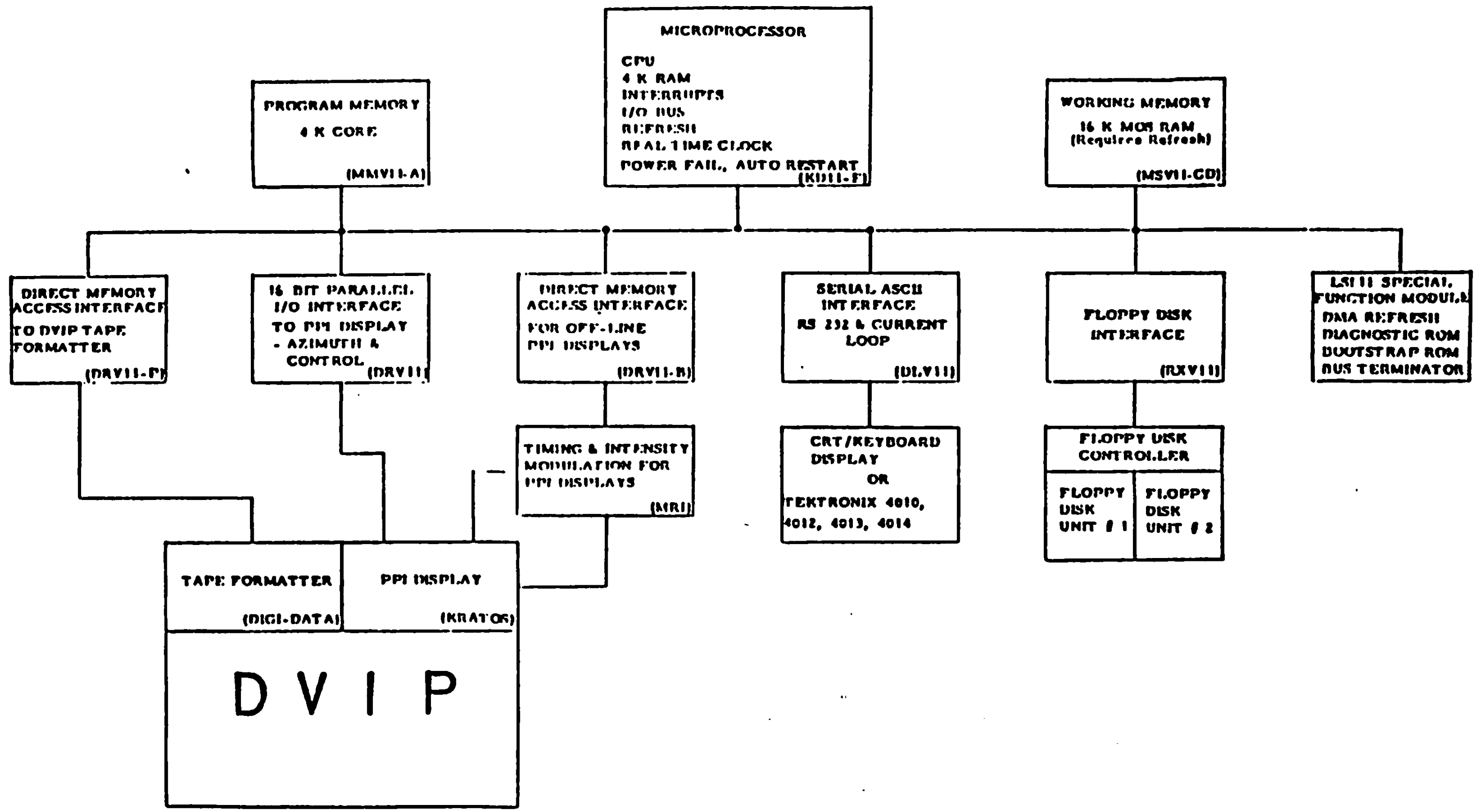


Figure A. DEC LSI-11 Microporocessor Based Radar Hardware and Data Quality Control System.

APPENDIX II

Data Tape Format

APPENDIX II

Texas Radar Digital Processor Tape Format

Tape Characteristics - 1600 bpi, 9 track, 8-bit binary words, 4156 8-bit words per record.

Record Characteristics - each record contains a 48-word prolog (see attached format) and an 8-word epilog (see next) along with the 4100-word data record.

Record Epilog - eight 8-bit words starting with word 4149. The same information as the first eight words of the prolog except the time refers to the time when the record was written to tape.

Data Record - the data record starts on record-word 49 and continues through word 4148. In the present configuration (only 1 radar or 2 radars recording) the data record is structured around three flags.

E3 This one-word flag is used to indicate the start of an azimuth sweep of channel (s-band) radar. It should always be followed by three words of location (1-1/2 words - 12 bits - of azimuth and 1-1/2 words - 12 bits-of elevation).

EF The same as E3 except for the channel D radar (x-band).

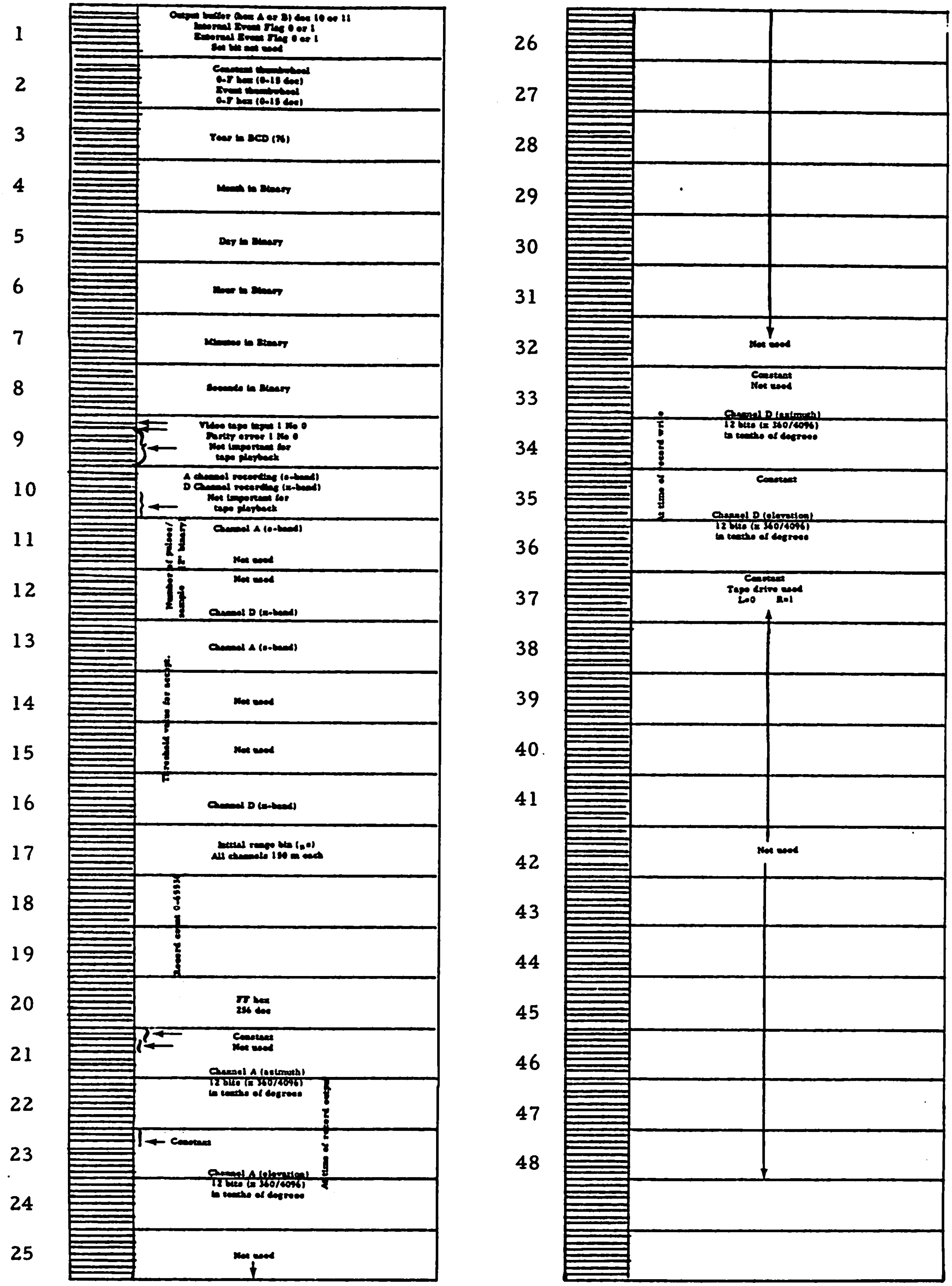
E5 This one-word flag is issued to indicate the start of a block of radar reflectivity 32 N words long where N = 1 to 32. It is followed by a two-word range address of the start of the data block in range. These two words are in reverse order by magnitude with the low order 8-bit word first followed by the high order 8-bits. The actual range in microseconds from the display trigger:

$$\frac{(\text{second word} \times 256 + \text{first word})}{4\text{-}8}$$

from the transmitted pulse in microseconds. The next flag after an E5 should be found 32 N + two words (where N = 1, 32) later in the record or the following record.

$$\frac{x}{4} - 5.5$$

TEXAS RADAR DIGITAL PROCESSOR HOUSEKEEPING FORMAT
(PROLOG)



CDC WORD	CDC BITS	IBM WORD	IBM BITS	LENGTH	FIELD	DESCRIPTION
1	59-52	1	0- 7	8	YEAR	Year
	51-40		8-19	12	DAY	Day
	39-20	 2	20-31 0- 7	20	TIME	Time
	19- 8		8-19	12	IAZI	Azimuth
 2	7- 0 59-56		20-31	12	ITILT	Tilt
	55-44	3	0-11	12	MTILT	Maximum tilt of recorded data
	43-32		12-23	12	IBTILT	Base tilt
	31-24		24-31	8	IDCODE	Radar ID code
	23-16	4	0- 7	8	RNGDEL	Range delay
	15-12		8-11	4	RI	Range interval
	11- 8		12-15	4	AZMODE	Azimuth recording mode
	7- 4		16-19	4	ELMODE	Elevation mode
	3- 0		20-23	4	SA	Sampling average
3	59-56		24-27	4	PRF	Pulse repetition frequency
	55-52		28-31	4	SM	Antenna scan mode
	51-40	5	0-11	12	XPWR	Transmitter average power
	39-36		12-15	4	(spare)	
	35- 4	 6	16-31 0-15	4 x 8	(spares)	
4	3- 0 59-24	 7	16-31 0-23	5 x 8	LPLANE	Aircraft locations
	23-16		24-31	8	NEWVOL	New volume scan
	15- 8	8	0- 7	8	NOISE	Noise level
	7- 0		8-15	8	NSUB	Number of following subfields
5		8½			Subfield #1	
					⋮	
					Subfield #NSUB	

NOTE: for bits in a word
CDC address right to left
IBM address left to right

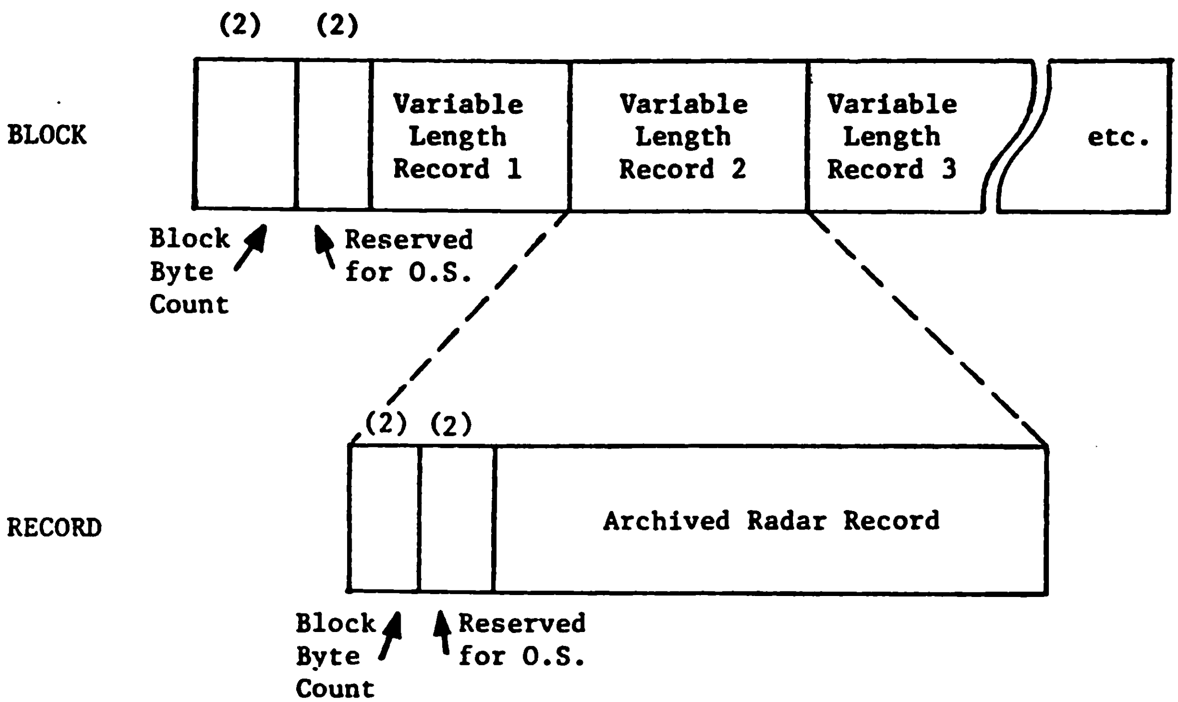
	RI	AZM	EL	PRF	SA	SM	NEWVOL
0	0.25	0.5°	0.5°	414	16	A&B	No
1	1.00	1.0°	1.0°	207	64	A	Yes
2	0.50	2.0°	2.0°	259	32	1	
3	2.00	1.8	3.0°	900	128		
4	0.150	--	0.8°	--	--		
5	0.300	--	1.3°	--	--		
6	0.450	--	1.5°	--	--		
7	0.600	--	--	--	--		

All fields are in binary.
Tilt, azimuth, and maximum tilt are all multiplied by 10.

SUBFIELD LAYOUT

Length	Field	Description
8	Location	Bin number of first DVIP value
8	Length	Number of DVIPs in subfield
8	DVIP 1	
8	DVIP 2	
8	DVIP 3	
8	DVIP 4	
8	DVIP 5	
	⋮	
8	DVIP N	

Archive File Format



*Numbers in parentheses indicate the length in bytes of fixed length data.

APPENDIX III

Daily Radar Logs

1976

RADAR DAILY LOG

Snyder M-33 Date: 21 May 1976

Time*	Comment
1731:00	Manual scan shows no echo 30 min. scans
1801:40	Set automatic timer for 30 min. scans
1802:00	Start tape M6 142E RC = 000
1947:00	Vol. scan
	End Record Count 620
2002:00	Start Vol. Scan
2006:42	RC 764 no echoes
2007:00	Rezero power meter (from 197 to 208)
2236:45	No echoes
2306:45	No echoes
2336:45	No echoes

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 22 May 1976

Time*	Comment
0002:00	Start vol. scan. Echoes observed
0006:46	RC 1793
0008:00	Operator change
0032:00	No echoes RC-01921
0102:00	No echoes RC-02012
0202:00	No echoes RC-02230
0302:00	Vol. scan, no echoes RC-02444
0402:00	Vol. scan, no echoes RC-02719
0502:00	Vol. scan, no echoes RC-03019
0602:00	Vol. scan, no echoes RC-03337
0637:00	End tape M6 142E Friday RC-03489
0645:00	Secured Radar
1730:00	Radar on
1742:00	Vol. scan, no echoes RC-00095
1802:00	Vol. scan, no echoes RC-00194
1902:00	Vol. scan, sm. echoes RC-00454 will start 5 min. vol. scan at 1912:00.
1912:00	Start 5 min. vol. scan Echo A2-170°, range 45 km, el 30,000' DBZ-0.4
1946:25	No echoes RC-01849
2001:40	No echoes RC-02402

*Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 22 May 1976

Time*	Comment
2006:40	No echoes RC-02578 Going back to 30 min. vol. scans
2008:00	Power out meter reading high Reset. Recorded time wrong
2032:00	Vol. scan, no echoes
2102:00	Vol. scan, no echoes RC-02894
2132:00	Vol. scan, observed scope for 1st 6° - no echoes observed 10 code + range delay for remaining scans, no changes.
2202:00	Vol. scan, 1st 6° no echoes, clock readback wrong, range delay + 10 code reg. wrong for 1 reg. count RC-03234.
2232:00	Vol. scan, 1st 6° no echoes, clock, range delay, 10 code OK.
2302:00	Vol. scan, 1st 6° no echoes, clock wrong, range delay and 10 code wrong for 9° Rec. count. RC-03557
2332:00	Vol. scan, 1st 6° no echoes, range delay, 10 code, and clock OK. RC-03708.

*Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 23 May 1976

Time *	Comment
0236:44	No echoes
0302:00	Start Vol. scan.
0306:44	RC-4532. One small echo, 100 km SSE. Will start 5 min. scan.
0311:40	Start timer.
0312:00	Start Vol. scan.
0312:33	Accidently switched point of control switch from "Auto" to "Radar" instead of display mode switch from "Recorder" to "Bypass".
0317:00	Start 5 min. Vol. scan.
0321:45	RC 4679
0326:44	RC 4798, echo is visible only at 1.1° scan very low and weak < 20 DBZ
0602:30	Echoes are breaking up
0704:00	Range delay read 00, and ID code was 68 for a few seconds and then changed back to normal
0726:40	End tape M6 143 A
0727:00	Start tape M6 144A
0727:40	Recorder did not put 1° scan on tape
0751:40	Shut off radar, next tape will be M6 143 B. M6 144A RC 856.
0800:00	Radar off

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 25 May 1976

Time *	Comment
17:35	Check instruments and take manual scan. AZ set to 310° rather than 360°. Nice echoes 5 min. auto scans.
1751:40	Start auto timer - set for 5 min. intervals.
1752:00	Start tape M6 146 B RC = 000.
1756:40	RC 394
1852:00	5273 Transponder code CSI
1852:30	CSI time rt. on with radar.
1853:00	Into "Bypass" - can hear lightning static on VHF Manual AZ continued on 310° 1st time today.
1856:00	Gave time to MRI
1856:44	MRI over us. 5272 MRI code. Will attempt to switch off IFF for each 1° scan for 1st time today.
1857:15	Gave time to MRI.
~ 1914:45	MRI going to tape - apparently not CSI. FAA center tops at 39,000'.
1925:01	End tape 12,760 RC - new tape on B recorder.
1929:15	OK in recorder, FAA center has tops to 41,000'.
1936:00	Now see both a/c - some tops to 45,000'.
1937:00	Left IFF off last vol. scan.
2022:00	IFF was left off for awhile.
2031:00	Took 13 photos (1st 2 top steps) of general cloud cover - 1, 0, 1, 1st raindrops today starting to fall on radar.

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 25 May 1976

Time*	Comment
2035:15	IFF on.
2046:40	End of tape M6 146 C. RC 12713.
2047:00	Switching to A recorder. Start tape M6 146 D.
2127:40	Turned IFF off.
2128:00	MRI time check.
2129:00	CSI time check. Second tape on.
2142:15	MRI trans. looks good.
2142:30	CSI trans. looks good.
2150:00	Took 13 photos, 1st 2 from steps.
2205:20	IFF back on ~9° scan.
2206:40	End of tape M6 146 D RC 12872.
2206:50	Switched to recorder B.
2207:00	Start tape M6 146 E, recorder B.
2215:40	IFF system off.
2218:20	Radar 1 sec. ahead of CSI, MRI. End of mission.
2219:00	Switch to "recorder" from "bypass".
2326:40	End of tape M6 146E RC 13049.
2327:00	Start tape M6 146 F, A recorder.

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33

Date: 3 June 1976

Time*	Comment
0011:00	Radar on.
1150:00	Manual vol. scan 125 km. 1° - nothing; 2° - echo from east; 3° - upper level northwest.
1155:00	Check instrument settings, turn on radar, manual scan shows echoes so will use 5 min. scans.
1815:40	Set auto timer for 5 min. scans.
1817:00	Start tape: M6 155A RC = 000.
1858:00	No echoes were seen during this scan so will switch to 30 min. scans starting with 1902.
2012:00	Started 5 min. vol. scans on tape M6 155A.
2017:00	Recorder looks OK.
2020:00	Photo 5 to east from a/c end of radar.
2021:00	5216 - trans code MRI - south MLS 5217 - trans code CSI - south MLS
2050:00	Photo 6 to east contains all growing - evident from radar.
2055:00	Severe TMTS watch from MLS eastward and from Marion from NWS.
2057:30	MRI now getting echo on cell; they are working when at close range. NWS called TMTS watch at ~1400 MDT to last until 10 pm.
2108:00	122 km echo - 035° at 75 DME.
~ 2108:00	Lew has a/c on his IFF - will take some photos, asked that 16 mm be pointed at 040° true.

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 3 June 1976

Time *	Comment
2109:00	Clouds shearing . Our echo estimated to be cirus anvil.
2109:30	Photo 7 toward ENE.
2125:00	Photos 8 & 9 to NE.
2129:00	11 km top (max) area being worked by a/c.
2133:30	11 km max tops still in a/c vacinity. Bases rising - losing bases.
2136:30	Photo 10 to NE.
2143:00	Most of area of echoes within 150 km - 1 echo just beyond 150 km.
2145:00	A/C to move to another case - present one leaving our 150 km range. Dying - bases way up.
2155:00	Photo 11 to NE.
2206:30	Photo 12 to NE.
2211:15	Shifted to 35 km range delay. Just before 2212:00 vol. scan - necessary to follow target cloud (life cycle study - super) moving beyond 150 km.
2214:30	47,000' max top.
2230:30	Photo 14 to NE. Time for photo 13 was not logged.
2234:00	Range delay switch moved for a moment by mistake. O. E.
2237:00	Recorder looks good.
2244:30	Photos 15 & 16 to NE. They overlap.
2249:10	Range delay reading 45 although set to 35.

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33

Date: 3 June 1976

Time*	Comment
2251:45	RC 4359 - Reset Range Delay to 50 km - still some cirrus blow off beyond 175 km on log.
2256:15	1200 trans. code on - a/c forgot to tell us they shifted.
2303:00	Photos 17 & 18 to NE. Saw rain against cloud.
2317:00	Start new tape with 25 km range delay on recorder A - back into recorder mode - looks OK.
2321:40	RC 130 Current tape; M6 155 B, is on A recorder.

* Note all times noted in the 1976 log are in GMT.

RADAR DAILY LOG

Snyder M-33 Date: 4 June 1976

Time *	Comment
0001:40	RC 1166
0003:00	Operator Change.
0132:00	Photo 19 toward rain gauges.
0136:20	Time back to both a/c. 5273 Trans. CSI 5274 Trans. MRI.
0155:00	Recorder looks OK.
0156:00	Photo 20 to SW.
0211:55	Early stop to scan. 9388 RC.
0214:00	Recorder looks OK.
0225:45	Photos 21 & 22 to SW - powerline in
0236:45	17.6 km 252° 45 - CSI.
0237:00	Switched to B recorder. 12849 RC - end B tape Start A.
0247:00	Gave radar summary to NWS.
~0252:00	Just a few drops in air.
0310:00	Called GTF-NWS w/radar update echoes to W & NW have intensified rapidly.
0351:40	End of tape M6 156 A, Friday, RC 12940.
0352:00	Start tape M6 156 B.
0501:00	Echoes are in NE, NW, SW quadrants, tops 50,000' DBZ - 740.

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date:

Time*	Comment
0521:41	End tape M6 156 B, Friday, RC 13657. Started tape M6 156 C.
0553:00	Echoes in NW and NE quadrants (mostly).
0559:00	System is starting to dissipate.
0706:41	End tape M6 156 C Friday, RC 12710.
0801:44	End tape M6 156 D, Friday, RC 02823
0802:00	Secured radar, air conditioning on cool.
1735:00	Radar on, checked switches.
1741:40	Started timer.
1742:00	First vol. scan M 6 156 E Friday have small echoes to the west so will start 5 min. vol. scans.
1746:00	Started 5 min. vol scans, RC 00107.
1755:00	Echoes in NW, SW quadrants, DBZ $<$ 14.6, tops 18,000' isolated coverage, very unstable.
2136:42	RC 6805. Echo AZ-70°, range 130 km, tops 45,000', DBZ - $<$ 40.
2326:42	RC 10192. Line AZ 165°, range 100 km, tops 40,000 Line from NE to NW, DBZ - $<$ 30.

*Note all times in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 5 June 1976

Time*	Comment
0005:00	Noticed clicking sounds coming from tube going into transmitter. Called Herb and he is on his way out.
0016:15	Lost radiate.
0022:00	End of tape M6 156 E Friday, RC 12187.
0035:00	10,000 138°31 CSI - holding
0041:00	Ed. H. reports CSI radar inoperative.
0048:00	Radar backup - MRI to T.O. soon. 5242 code for CSI.
0053:00	16.2 162° 69 DME.
0057:00	Start 1st vol. scan on M6 157 A on B recorder.
0058:10	Finally started recorders - hadn't cleared properly.
0058:45	17.3 163°81 - CSI circling so. side of storm.
0059:15	101° 08 MRI 5274 Trans. code MRI.
0119:30	MRI 8300' 106°32 DME Both aircraft now heading for a cloud selected by MRI.
0120:00	Radar summary to GTF-NWS.
0123:00	CSI completed anvil penetration
0123:50	17,900' 136°59 - CSI.
0125:00	9,000' 090°41 - MRI closing on test
0129:00	17,900' 120°56 - CSI head to cloud area.
0133:50	18,000' 103°56 - CSI.

* Note all times noted in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 5 June 1976

Time *	Comment
0136:45	18,400' 94°58 - CSI.
0140:00	18,100' 084°62 - CSI.
0141:30	7,300' 075°59 MRI - just made 2nd pass - turrets aloft all growing out of common base.
0145:40	077°62 MRI.
0147:15	6,500' 077°60 - MRI- 6 mi. west of Baker.
0147:45	074°71 - CSI
0150:00	MRI at 7,000' - 2 mi. west of Baker. CSI over center of Baker.
0155:30	14,000' 067°54 CSI climbing - dropped earlier to shed ice. Recorder OK.
0201:45	15,200' 064°55 CSI
0206:00	Have excellent return on airliner at 37,000' - have had from 100 km west to 49 km north to 125 east.
0206:10	8,500' 065°85 MRI.
0206:30	17,000' 062°49 CSI.
0209:45	18,200' 056°43 CSI - about to penetrate cloud- badly sheared.
0210:15	8,600' 056°40 MRI
0215:30	CSI leaves cloud.
0216:20	Painted MRI under echo we have maybe a bit north of center.
0218:45	18,300' 046°33 CSI - got rime & graupel.

* Note all times in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 5 June 1976

Time*	Comment
0219:15	8,500' 041°30 MRI - over gauge 2G moving toward 3F. Both aircraft apparently on same cloud - no precipitation yet.
0221:45	039°32 MRI.
0222:30	6,900' 037°30
0223:00	Asked Simon that 16 mm be pointed 060°
0224:45	17,700' 035°35 DME-CSI- on whole chain of single puffers.
0226:00	6,500' 037°30 - MRI - no updrafts - last pass.
0227:45	6,600' 037°30 DME-CSI.
0233:00	MRI heading home - CSI flying line of cloud.
0238:40	CSI done with passes and coming home.
0244:00	Recorder looks OK.
0360:00	Mesosystem moving NW and should come over radar.
0406:43	End tape M6 157 A. RC 13367.
0407:00	Start tape M6 157 B.
0416:00	Finished Vol. scan early.
0441:43	RC 06559.
0506:43	Storm starting to dissipate.
0510:00	Lost power.
0515:00	Unable to get correct time on WWV.
0520:00	Set clock to Arlin Super's watch - should be within

*Note all times in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 5 June 1976

Time*	Comment
	one minute of correct WWV time.
0526:40	Started timer.
0527:00	Started Vol. scan, didn't record will try again at 0531:40. Pushed stop, playback, stop twice, record.
0531:40	Started timer.
0532:00	Started OK - is recording OK.
0616:41	Storm breaking up, echo dissipating, moving NE.
0656:42	End tape M6 157 C. RC 12870.
0657:00	Start tape M6 157 D.
0801:41	End tape M6 157 D. RC 09504. Secured radar.

* Note all times in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 10 July 1976

Time *	Comment
1730:00	Radar up, set clock, checked switches.
1737:00	Made 1st Vol. scan - no echoes so will make special settings and start recording on new tape.
1802:00	Started tape - SM 6 192 A on recorder A.
1805:43	No echoes.
1835:19	No echoes.
1904:55	RC 00701. Small echo - will switch back to normal settings.
1907:00	Start M6 192 F on recorder B.
2011:25	RC 04158. Skipped 12° scan.
2021:27	RC 04895. Skipped 12° scan.
2026:26	RC 05262. Skipped 12° scan.
2041:48	RC 06407 - will stop 5 min. Vol. scan as echo has dissipated.
2107:00	No echoes.
2120:00	Made adjustment to radar.
2206:53	No echoes.
2306:50	No echoes.
2336:50	RC 08278. No echoes.
0536:31	RC 11128. No echoes observed since 2041:48.
0547:00	Started special tape SM 6 193 A on recorder A. Storm AZ - 145° range 250 km.

* Note all times in the 1976 log are GMT.

RADAR DAILY LOG

Snyder M-33 Date: 10 July 1976

Time*	Comment
0550:29	RC 00186 on special tape.
0620:00	RC 01474 on special tape.
0625:24	End special tape SM 6 193 A. RC 01708. Secured radar and air conditioning.

* Note all times in the 1976 log are GMT.

1977

Date 30 May 1977 Page 1 of 2

Start Time 1233

Stop Time

Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1233	24	24			X and S on and recording - 1st echoes. SSW quad.
					Stepping to 6.0 degrees
1237					Checked power
1242					S band kicked off
					Thyratron still stabilizing
1245			+4		Checked power on 431C
1247					Generator brush problems - RF and recording off
					No end of file here - tape was restarted
1538					Recording back on/no echoes
					Stepping to six degrees
				≈ -20.5	
1554					Checked and adjusted TS-403
1558			+3.4		Checked power
1612					Adjusted TS-403
1632					Echoes NW and W to 3° elevation
1721					Reset Auto Controller to step to 16°
					Occasional Parity errors on DVIP
1730					X band Grass level shift briefly
					X band recording off
1743	30				X band recording back on
					All 33 displays removed from X band PRE IF
					output after demonstrating grass level change
					caused by step attenuator in line to M-33 IF
1802	29				Dummy 75Ω hung on output of X band video (log IF)
					Threshold down
1805					More occasional parity errors

Date 30 May 1977 | Page 2 of 2

Start Time 1843

Stop Time ______ | Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1843					Recording continues - Echoes to 16° - begin stepping to 18°. Echoes all western quadrants
1919					Adjusted TS-403
1936					Reset and hold stepping cycle
1940					Stepping cycle on
1951					Recording off

Date 1 June 1977 Page 1 of 2

Start Time 112645

Stop Time

Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Shake Down Day - Tapes 2 and 3
					Tape 2 sent to Mark Gardner
112645	2A	25			Start record X and S. Min. range 12
					Antennas stepping
1155					End tape 2
	2A	25			Start tape 3
					Min. range 12 Antennas stepping
					Tape 3 (enclosed)
121530				-70	Adjusted, zeroed, and tuned TS-403
121800			+3.7		Checked S band power 431C
1220			+4		Adjusted and checked S band power -
1222					431C
1355					X band off momentarily - interlock fired
140600					Checked S band power
140720	29				Threshold to 29 briefly, then back to 2A
140832	29				
140937					Stepping reset to 1.5° and hold
					Some Cal Pulse Jitter
141104					Resume stepping
1436					Adjusted and checked S band power -
1438			+3.8		431C
1523					Tuned and zeroed TS-403
153454					Reset stepping cycle
1815					Adjusted and checked S band power -
1820			+3.7		431C

Date 1 June 1977

Start Time 182130

Stop Time

Page 2 of 2

Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
182130				-70	Adjusted and tuned TS-403 3285 mhz
1921					Reset stepping
195706					Stop recording
					Radar down briefly for test
					No action - continued monitoring until ≈0945
					then power down

Date 8 June 1977

Start Time 1115

Stop Time ________ Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Test tape W/S and X Cal at end
1115	29	25	+3.6		Tape start Min. Range 06
1117					Cal Pulse off - checking power
112030			+3.8	-15.4	Checked and adjusted TS-403 Freq. = 3385 mhz
					Tape writing ≈ 1/second
1125					Antennas stepping
113600					Cycling Data Van A/C
113634					
113640					Cycling Radar Van A/C
113800					
113950					KKT478 t Test (158.19)
114035					
114100					KNTU Tx Test (123.3)
114133					
1218					Stop recording
122221					S band Cal.
		21	+3		Begin A1 - AF step, then B1-B2 on last step
		0			First step
			-48		Last step
1230					Stop tape/with EOF

Date 9 June 1977 — Page 1 of 2

Start Time 134030

Stop Time ______ — Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					This Data all noisy on DVIP Tape
					Tapes 1 and 2
134030	35	2C	-15		Recording Min. range 12
					Cal Pulse on TS-403 dial
1343					Antennas stepping
1348					Adjusted X and S power
					Notes Generator Brush arcing again
					Parity errors on DVIP
					Range Jitter in Cal Pulse - Stand
140055-					Adjusted TS-403
140100					Freq = 3285
141213					Recording off
142700					Recording on
					Note - Moved PWR cable to 3 cm mux + El preamp over to Isotrans - Parity errors seem to stop
143040					Reset antenna cycle
1440					Sprayed MG Brushes - noise should decrease
					Still very occasional parity errors
1445					Adjusted S and X power. X = 40 ma. S = 34 ma.
1448					Checking power - Cal Pulse off
1450					RF (S band) off
					Recording off - Maintenance
145945					Recording on
150656					X band level shift - X band record off
151600	35				X band record back on. Parity errors regular
					1450 - 151600 noisy on DVIP
153530					X band - lots of hash - record off
153700					Few echoes at 40 miles at 270°

Date 9 June 1977

Start Time 155900

Stop Time

Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
155900					X band record back on (1/2 hour of maintenance
					while on phone w/M.G. - all data here suspect)
163500					Finished Debug (power supply on DVIP out of spec.)
1734					Reset stepping (Should be quieter after here)
1738					Adjusted TS-403
175250			+3.7		Checked S band power
194600					Reset stepping
2123					Adjusted TS-403
2252					AP appearing at 260 - 280° at 1.5°
0014					Antenna program changed
0113					Significant drop in noise clutter
0116					Back to normal noise spikes
0120					Programmed 1.5 - 7.5° inclusive
					Spikes in video gone (outboard log)
0122					Spikes back intermittently
0138					Recording off
0140			+4.3		S band Cal. - Antenna still rotating El at 21.5°
					Cal same as for 6-1

Date 11, 12 June 1977 Page 1 of 3

Start Time 1413

Stop Time Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1413			+3.8	-15	Tape on S band only Tapes #1-7 Antenna stepping to 6°
1425				-20	
145351					Set Const. from "B" to "1". Beginning of tape will have Const. = B
1455		21			
1457					Checked and adjusted TS-403
1500			+4		Checked and adjusted S band power
1505					Highest step on antenna moved to 7.4 degrees
1551					Reset stepping
1624			+3.6		Checked and adjusted TS-403 and S band power
			+3.9		Power down; brought up to +3.9.
		22			Set threshold up to 22 due to slight has level increase
1629		24			
1721			+3.9	-3.7	Checked and adjusted S band power
1803					Noticed stepping off - Reset
1805			+3.9		Checked power S band
1853					Reset stepping
2040		22			
2124					Tuned and zeroed TS-403
2159					High limit on antenna program 7.5 → 8.9
2203					High step to 10.4°
2208					Adjusted and tuned TS-403
2210					High step to 11.9
2213					High step to 14.0°
2217					High step to 18°
2223	28				X band record on Threshold = 28

Date 11-12 June 1977

Start Time 2225

Stop Time ____

Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2225	27				
2227	28				
2235					X band level shift to 32
2237					X band back to 28
2327					Three 1/2 second power losses
2330					X band off due to wind - Exitation of S band out and down
2335					X band rec. off (Some AFC hunt) Resetting S antenna
2337					Antenna stepping
2340					Adjust Freq. zero - TS-403
0045			+4.6		Checked and adjusted TS-403; checked power
0104					Lowered max elev. to 10.8
0128					Elevation max to 8.8
0131					Const. set to 3 - was "one" for all before
0205					O hit data
020600					1 hit data
0207					End O hit on the 1.5° score
0213					Lowered program to 6.0°
0222					X band level set up
0225					Noticed antenna not restepping → Reset
0226					Functional
0228					Constant set to 1 since X and S
0229					Range Jitter in Cal Pulse
					Note - Antenna rotation 14% slow due to winds throughout night
0253			+4.5		Checked power on S band; checked and adjusted O and power set on TS-403

Date 11-12 June 1977 Page 3 of 3

Start Time 0317

Stop Time

Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
0317					Tuned TS-403 - Freq. = 3310 mhz
					Gone through 5+ tapes so far
0349					Lots of A. P. all quadrants - time to shut down
035230					Record off
0356					Start second Cal
					Cal starts at A1 = Odbm
					↓ AF
					B1
					↓ B3 = -51 dbm
0402				-51	Last value on 403
0403			+4.4		XMTR power S band
					(9335 6hz x band Freq.) X band info
					(+14.5 dbm x power)

Date 13 June 1977

Start Time 2330

Stop Time 0130

Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Const = B for all but Cal Data
2344				-20	Record on S only
2349					Stepping
2352			+4.6		Check S power - 3.31 Ghz
0002		22	+4.6		Check power
0018					High step to 8.9°
0036					Ref azimuth to 130°
0045	22				X record on
0101	29				After disconnecting M-33 scopes
0122					High step to 11.4°
012915					Recording off
					S band Cal
					A1 0 dbm Pwr = 4.6db
					AF 42
					B1 45 X band + 14.5 dbm
					1 48 9.335 Ghz
					B3 51 dbm

Date 20 June 1977 | Page 1 of 3

Start Time 2000

Stop Time ________ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2000					Tape on - all second return
					All echo 90 mi + to W and NW
					90 → 110 NM
2004					Checking power
2008			+4.4	-20	Freq = 3310 GHZ
					Antenna level 1.5°
2011		21			
2013					Twist time 2250 40 mi
2015		20			
2023		22			
2041					NEW TAPE - Tape slowed ahead so new tape mounted
					1st time around data now appearing at 260 → 280° 80 nm
2052				-20	493 adjusted and set
2054					Antenna stepping to 30.0°
2059					Step set to 4.5° max elev.
2100					Max antenna RPM
2101			+4.6		Zeroed TS-403 - check power
2104					
2112					Elev. max to 7.5°
					Echoes spotted over western edge of project, tops to 45 XFT.
2137	26				X band on - Constant = 1
2158					Record X band switch noticed OFF - turned on
2235					10.5 has been on for a while
2242					X band elevation synched
2248			+4.5		Adjusted TS-403
					Program antenna for 12.0

Date 20 June 1977

Start Time 2308

Stop Time ______

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2308					Program to 12°
2345					Tape 3 - start
2354					Los X band Synch for a minute
0000					Echoes very small and spotty
					Rain started at sight
0014	28				
0019			+4.95		Zeroed TS-403 - checked S power
0021	29				
0034	22				Rains increasing
					Raised Thyratron heater voltage
0036			+4.85		Checked S power and adjusted 403
0048					Ref azimuth to 90° for next vol scan
					Heavy rain
0052					End tape 3 (approx.)
0103	28				
0110			+4.6		Adjusted and checked S Power - zeroed 403
0120	29				
0122					Stepping reset w/Ref λz = 0°
0139	28				
0155					Start tape #5
0200					Power out
0209					Recording back on - S and X
					Antennas slowed and stepping
0210					Zeroed and tuned 403
					Note - Tape restarted in middle - NO EOF after 1st block
0218					Antenna stepping finally
					X band down - const = 3

Date 20 June 1977

Start Time 2220

Stop Time

Page 3 of 3

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2220			+5		Checked S power
0230					Ref λz set to 250°
0235					High step to 11.9°
0340					Radar off

Date 21 June 1977 Page 1 of 2

Start Time 1225

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1225			+4.8		Record on - S only
					No Cal Pulse - still warming up
1230			+5.0		Antenna step to 4.5°. Ref Az 30°
1312				-20	
1314					Record off
1554			+4.6	-20	Record on S band - Antenna step to 4.5°
					Zeroed and tuned 403
1609					High step to 6°
1712		21			(Lowered Xtal current in Tabs)
1719					Elev. program at 10.5
1723			+4.4	-20	403 checked and set
18p4					High step to 14°
1820					Time check shows Processor is -20 min on Big Spring Time
1918					High step to 8.9°
1930					End tape #1
1948					S band off for test
1955					S band back on
1957			+4.6		Tuned and zeroed 403
2020			+4.6		Tuned and zeroed 403
2118					Speed up antenna rotation to max
					Increase max elevation to 10.5
2155					Elevation program reset
2215					Reference Azimuth to 70°
2214					End Tape 2, start Tape 3
2226					Rain started

Date 21 June 1977 | Page 2 of 2

Start Time 2231

Stop Time ____ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2231					Tapes on after failure
					After failure, no EOF - data continues
2234					Rain onset again
2241					Lots of processor beeps
2246					Echoes seem to be in a definite NS line whereas earlier it seemed to be random cloud propagation in every direction
2352			+4.7		Adjust 403
0117			+4.6		Adjust 403
0118					Change max elev. to 7.5
0121					Change Ref Azimuth to 30°
0125					Max elev. to 4.5
					After the pearl string echoes merged into a NE-SW line, the echoes in the north more or less faded while the echoes from the BST area moved due north crossing the project area from ≈ 2200 until now. Presently, very little remains. All echo north of SNY with very weak echo NE of Lamesa.
0200					Record off
0210					0 dbm = A1
					-51 dbm = B3
0211			-4.5		

Date 22 June 1977

Start Time 1102

Stop Time ____ Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1102			+4.7		Record on - S band only
					No Cal Pulse - TS-403 warming up
					Stepping to 4.5°
1107					Constant for B to 3
1111					High step to 7.4°
1141					AFC on S band dead - stop recording
1236					Record back on - S band
1248					Record off - AFC setup
1337					Extensive AFC adjustment - replaced Tack/Gen.
					Morning data recorded w/no ring in tape
					AFC tack/Gen ng in morning so data may drift
1342			+4.8	-20	Record on S band only
1345					Echoes all Quadrants 20-40 miles and 60-80 miles
1355					Stepping
1412					Program reset to 12° max
1431					Elev. program to 18.5°
1434					Antenna rotation 2.5 RPM
1444			+4.2	-20	Adjust 403
					Rain at radar site
1448					Winds W 30 G 35 Rain at site
1452			+4.8		After Bob adjusted Mag current
1458		22			
1504					Antenna speed reduced slightly
1515					Total precipitation accumulation .08 in Wedge gauge on fence post (emptied 1200, cancel 1500)

Date 22 June 1977

Start Time 1521

Stop Time ____

Page 2 of 6

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1521					Broad area of spotty echoes extending N → S, all E of SNY about 40 mi across. This is probably the storms in the area during AFC problems. Currently, there exists a small amount of echo in the project area. Diffuse, amorphous low reflectivities between SNY and Lamesa.
1524					Full 18.0° scan taking 4 min, 55 sec.
1532					AFC flaked a couple of times
1535					AFC intermittent
1540					Two photos of W face of E area clds looking ≈ 130° from radar site. 35 mm lens
1545					AFC unlocked
1546					AFC back in
1552					AFC OUT
1615					Radar high power down for AFC checks
1620					Two slide composites of data in East
1631					AFC up - program started
1632					Adjust 403
1635					Sensitivity seems low by 10 db or so judging by the amplitude of the Cal Pulse on the A scope
					AFC out of lock
1636					Record off
1638					Shelf cloud photographed at 1620 now moved to a position 2 mi W of radar - dark, indicating W progression of precipitation activity

Date 22 June 1977 Page 3 of 6

Start Time 1639

Stop Time ________ Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1639					Radar on briefly
1642					Radar on
1646					Radar sensitivity low MOS ≈ -95.
				-20	As usual
1652					Radar off to change
1658					Radar on
					Rain at site from the East
1700					AFC gone
1702					AFC back in
1704				-20	Record on, recycle antenna program
1709					Very heavy rain at site
1712				-20	Pulse still contouring bright as normal so the 10 db mds is doubtful
1715	20				
1718					Antenna program max to 12.0°
1733					Leon in the W of LTBT awaiting for SNY to clear - Present field indications: Winds E ≈ 15 2∅ 5∅ TRW VIS 3 mi
1740					Winds now S 10 R - ceiling as before
1801			+5		Zero - 403

Date 22 June 1977

Start Time 1802

Stop Time

Operator Anderson

SNYDER M-33 RADAR LOG

Time	Threshold		S-Band	Calibration	Comments
(LDT)	X-Band (dbm)	S-Band (dbm)	Power (dbm)	Pulse (dbm)	
1802					Checked power output of 403
					Pulse 0 dbm
					Duration 17 μms 1.7×10^{-5}
					PRλ 900
					0 dbm x $1.7 \times 10^{-5} \times 9. \times 10^{2}$ = -18 dbm
					0 $-10 \log 1.5 \times 10^{-2}$ = -18 dbm
				-17	Difference could be PRF $\neq$ 900 or any instrument cal or pulse width actually wider, say 19 μms.
18p3					90% of the echo in the NE and SE quadrants now
					- some echo on all sides of project area, virtually none in target area
					- when it came time to fly after radar problems - no VFR conditions
1824					Reference azimuth to 200°
1833			+5.0	-20	Zero the 403
1837					Record off while check LO input
1850					Record on after retuning LO parity
1854					Off record - peak on ground clutter
1900					Record ON
1902				-20	MDS OK 403 checked

Date, 22 June 1977 | Page 5 of 6

Start Time 1904

Stop Time ______ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1904					Installation of a new mixer diode resulted in the need for readjustment of the LO cavity (gears) Between the time of the diode change and 1904, all data will be low by 10 db or so. This occurred because the IF frequency generated by the mixer was not in the center of the IF band (center 60 MHZ). Since the IF was off center frequently, the IF amps had lower gain (due to band pass filters).
1910		IF			
1925		IF			
1930				-25	
1932					Wedge rain gage emptied, .84 inches when read
1944					Ref az to 275° Echo now in two areas 1) all of NE quadrant to 120° 2) South 150 - 200° 40-80 nm 3) few small isolated cells southeast of LaMesa
1950					Start tape #4
1955					Gap in data for 5 min since tape drip not on line during rewind of other tape
1956					Reset elevation program
2012					Ref az changed to 330°
2015			+4.8	-25	Zeroed 403
2057					All the echo that covered the NE-SE quadrants has all moved eastward now, so is nearly out of range Substantial echo now towards BST

Date 22 June 1977 | Page 6 of 6

Start Time 2101

Stop Time ________ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2101					Ref az to 0°
2114					Elev. program lowered to 7.5° max
2129			+4.8	-25	Zeroed TS-403
2135					Contour set at 6 db
2137				-25	
2148					Funny looking strobe at 350° on the 1.5° scope
2156					Video went nuts - shifting all over
		21			Then level rose so threshold set to 21
2155					Power fail on RF of S band for 2-3 seconds
2207		1E			
2213					Echoes now all between 150° → 250° 60 → 80 nm i.e., S and E of BST
2231		1D			Threshold to 1D then back to 1E
2236			+5.1	-25	403 set
2239					Since last report, two small echoes formerly on the N border of the target area have moved further north and out of area completely. South of BST only due south seems important now, the easterly part is decreasing.
2249		30			O hit data for 1 revolution at 1.5°
2250					All normal
2257					New Tape #5 - Start
2332					Large echo S of BST moving NW slowly - basically all echo gone in E
2342					Full volume scan at O hit
2343					All normal

Date 23 June 1977 (late 22) Page 1 of 1

Start Time 0006

Stop Time ________

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
0006			+5.0	-25	TS-403 adjusted
0007					Today's echoes moved in a very peculiar fashion - first eastward, then westward and now little or no motion. Echoes now are quite large but relatively weak and gradient free. It seems, however, that there is some persistent precip formation mechanism active in the BST area since, if the echo were from precip suspended there from earlier activity, it would have fallen out much earlier. 2200 Rigao phoned and said we should hang it up at 2300 The echoes persisted a little too much for me, so here we are.
0017					There is a second weak each on the NE quadrant ≈ 45 mi. This has developed since the complete departure of the earlier echoes to the E.
0031				-51	Record off AE used for 39 + 42 A1 → B3 = 0 → -51 dbm in the 403
0040			+4.7		EOF

Date 23 June 1977 　　　　Page 1 of 3

Start Time 1401

Stop Time ______ 　　　　Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1401					Record on
1406					Elevation program On
1410					Begin Calibration with data logging as normal
1427			+4.6	-25	403 checked - Cal finished
1433		1C			
1445					Elev. max to 14°
1445					Echoes currently in NE - SW line through SNY to BST - pearl string echoes in wide bunch - more widespread echo at E hemisphere 40 mo. Echo also around Lubbock line through SNY extends from 60 nm NE of SNY to 60 SW of SNY, 5 mi in width, small echoes.
1451					Will shut down for X band Xtal change
1453					Record off
1505					X band and S band record on
1509					X band slaved
1511			+5	-25	403 tuned and zeroed
1520	38				X band Threshold to 38 after disconnecting M-33 scopes
1524					Top step to 16°
1538	34				Lowered Pre IF Gain on X band - Thres band down to 34
1553					End of Tape #1
1600					Zeroed 403
1606	35				
1625			+4.9		Zeroed and adjusted 403
1628					High step to 18°
1645				-20	
1650				-25	After fiddling
1659					High step to 16°
1702					Post supply transients in M-33
1708					Power down to replace 220V rectifiers

Date 23 June 1977 | Page 2 of 3

Start Time 1715

Stop Time ________ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1715			+4.8		S band back on. Record. Tuned and checked 403
1718					X band record on
1722	33				
1725					High step to 10.4°
1728	34				
1731					End Tape 2
1800	35				
1824					Play with Thresholds S - 1D Y_i - 35
1839				-39	
1929					Thresholds adjusted S band - 1E X band - 35
1930					Tape 3 end. Note: about 20 min ago Cal Pulse to -36 dbm
1956					Max elevation to 10.5
1959				-25	
2020					Found X band problem in connector downstream of processor so no data lost except when record switch off (≈ 5 min)
2040			+5.2	-25	TS-403 zeroed

Date 23 June 1977 | Page 3 of 3

Start Time 2044

Stop Time ______ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2044					Residual low intensity, low height echo in E hemisphere. Residual light rain and anvil from the line which passed still over BST and northward (anvil) over target area. Few very weak echoes in W of project area. One growing system 25 W of Lamea moving ≈ 0
2103					Antenna program lowered to 4.5° The echoes in the W of target are are definitely ducting 1) not seen by eye 2) not seen by X band even though they appear high enough in the S band 3) not there at 3°
2112					Record off
2123			+5.1		Cal A1 → 0 dbm ↓ B3 → -51 dbm

Date 24 June 1977 Page 1 of 4

Start Time 1250

Stop Time ______ Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1250					Record ON X band - S band
1251					Record Constant set to 1 to signify both radars on
1252					Elevation program to 7.5° max
					Antenna synch right on the money
1253					4-ten air unit in radar van inoperative - may expect power supply problems
1254	35	1E			
125822		1C			Cal to B3
130255			+4.6	-25	On last step
1340	33				Play games with X band video
1402					Max elev. to 4.5°
1405			+4.2	-25	Zero the 403
1452			+4.2		Zeroed and adjusted 403
					Checked and adjusted power (4.7) dbm on S band
1602					Cu congestus at 140° 60 nm
					Second time echo 300° 35 nm
					Very little else
1611			+4.5	-25	TS-403 zeroed
1710			+4.6		Tuned and adjusted 403 - zero was way out
1726					Zeroed 403
1733			+4.5	-25	Zeroed 403
1800					Tape 1 - end
1816			+4.5	-25	Tape 1 - end

Date 24 June 1977 Page 2 of 4

Start Time 1818

Stop Time ____ Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1818					All echo in project area is second return, no doubt - clear by eye - only 1.5° elev. has any echo.
					Throughout the period, X band and S band very, very solid
1833					Max elev. to 6°
1841					Max elev. to 7.5°
1845					Seems to be considerably more ground echo on the S band. This echo particularly in the project area is high enough in intensity that it should be seen on the X band also. It is not so; therefore, the lower sidelobes on the S band are probably much larger on the S band dish.
1846					Max. elev. t0 9.0°
1915					Antenna max elev. reduced to 6.0°
1934	34	1E			
1937					Antenna program to 7.5°
					Echo 270° 10 → 60 mi = second return
					Big storm over Odessa moving NE
					Two Tcu 185° 40 nm looking good
1939					Max elevation to 9.0°
2000					Echoes intensifying
					200° 45 mi - few cells growing
2014				-25	403 zeroed
2026					Elev. max set to 12°

Date 24 June 1977 | Page 3 of 4

Start Time 2029

Stop Time ______ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2029	35				
2034	34				
2039					Max elev. t0 10.5
2110					Hail reported at Howard County Airport
2128				-12	Both radars up, synch good. Throughout the period, X band and S band very, very solid
2134				-25	
2145	34				Threshold up from 35
2159					Program reset
2216			+4.8		Set TS-403
2227					Elevation program jamming at certain elevations
2245	35	IF			
2308	34	IE			
2310			+4.5	-25	TS-403 reset
2313					The small echoes along the W edge of the project area developed into a line starting ≈ 25 nm 5 W of Colorado City and extending NW all the way past W of Lubbock and off screen. Later line broke into two regions: 1) North of Lamesa - Grail 2) NS line W of BST The N system remains vigorous at this ------ The BST system has more or less dissipated. Some isolated single cells extending over SW quadrant at this time.
2319					When noise level shifted ≈ 2300 - adjust line voltage

Date 24 June 1977 Page 4 of 4

Start Time 2320

Stop Time

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2320			+5.0		Magnetron current and tyratron heater voltage adjustments account for power increase Freq = 3310.0
2325	35				
2331	34				
2336	35				
2341	34				
2344	35				
2350	34				
0006	35				
0014	35				
0020					Antenna max to 10.5°
0036					S band record back on
0045					Trigger restored
0048					X band video noise caused by faulty T connector
0107	34	IE			
0113					Elevation program flaky - sticking at 1 elev. Ref az - set to 200°
0115					Ground echo to 30 miles in SW quadrant
0118			+5.0		
0127	35	IF			Cal. A1 = 0 dbm → B3 = -51dbm
0128				-25	
0137					System trigger intermittent, caused parity beep
0151					Significant ground echo out to 40 nm, indicating A. P.
0155					Lots of AP in all S quadrant out to 40 nm 1) Clear sky over all project areas by visual inspection
0200					Record off

Date 25 June 1977 | Page 1 of 6

Start Time 1100

Stop Time ____ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1100					Arrived at sight first, rain in area, CRMWD flying but terminating due to lack of organization of clds. Forecast, front across N of target area, expected moving slowly SE into area causing TRW, etc.
1110					Power failure for 1/2 second,will have to restart filaments, etc.
					Rain at site
1130					Decided Magnetron shot
1210					Radar back on, new magnetron (same one as earlier this year)
1312					3275 Freq
1315					S band radar recording
					Antenna cycling to 7.5°
1323					Pulse on 403 adjusted to closer range
1325					X band Pre IF Gain adjusted to restore noise level to that used previously (Bob and I played games with this control last night after operations)
1327					X band off - Constant still at 3, i.e., not changes while X band was on
1331					403 pulse set as far out in range as possible and still record on the log integrated video
1332		IE			
1342					Cal. A1 = 0 dbm → B3 = -51 dbm
1344			+4.4	-25	403 zeroed
1354					Elev. max to 6.0°

Date 25 June 1977 | Page 2 of 6

Start Time 1357

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1357					Two TCU at 060° 50 nm
					Two echoes at max range ≈ 140°
					Peculiar echoes 1.5° 090° 10 mi → 40 mi's
					either AP on second return
1410					New echo E of BST 2 mi
1413					Reference az to 90°
					Max elev. to 7.5°
					Echo at 095° looks like second trip
1421	35				X band on (adjusted pre IF)
1423					Synch on antennas excellent
1424	35	IE			Checked
1425					Zeroed TS-403
1426					X band spectrum look first rate a few minutes ago when
					checked with the spectrum analyzer
1427					Max elevation to 9.0°
1439					Max elevation to 10.5°
1441					S band transmitter went down
1443					Reset antenna - S band back up
1445			+4.8	-25	403 adjusted
1448					Record S band on
					Reset antenna program
1449	35	IE			Checked
1451					Program max to 14°
1457	35	IE			Grass levels went ape for a minute, now set
1459	34				
1505					Reference az to 10°

Date 25 June 1977 | Page 3 of 6

Start Time 1506

Stop Time ______ | Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1506					Echoes at this time confined to two Cu. congestus E of BST
1508					Antenna stack 1.5° for last fan
1516					Max elev. to 18.5°
1523			+4.2		
1525				-25	Power boosted to +4.8 dbm
					TS-403 checked
1532				-12	
$\approx$ 1600 - 1620					X band video will disappear briefly about 2-3 times for maintenance
1632				-25	
1657					Record off - magnetron blown
1822					Record back on
					Both radars up
					Antenna program cycled
1826			+5.2	-25	TS-403 zeroed
1828					X band noise level gone ape
1830					S band noise level to 21
1834					Constant set to 3 corresponding to only S band data
1836					S band radar down
1840					Both radars up
1841					Constant set to 1
					Antenna synch good
1844	35	20			
1847			+5.2	-25	TS-403 zeroed
1851	36				
1854					Ref az to 280°
1858	36	20			Thresholds checked and left at 36,20

Date 25 June 1977

Start Time 1900

Stop Time

Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1900			+5.0		
1901	35				403 tuned and checked
1918					X band down
1919					X band on
					At 1918 Bob plugged something in over in the radar van which caused the video level to increase momentarily
1933			+5.0	-25	TS-403 zeroed
1934	36				
1936					Ref to az to 300°
1939	37				
2009	36				
2010					Intense echo has been seen Gail for the past 2 hrs - now dissipating and moving east.
					A line formed near BST in an EW direction 40 mi either side of BST. This tag intensified and moved ENE into S of target area.
					All of SW quadrant covered with echo.
2044			+5.2	-25	Checked
2107	35	20			Sensitivity of the X band seems to be far better than it has been until this day. This may indicate that in the past 1) Threshold was set too low 2) Pre IF gain too low 3) S band is flaky today

Date 25 June 1977 | Page 5 of 6

Start Time 2119

Stop Time

Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2119					Max elevation set to 14°
2122					Max elevation set to 10.5°
2123	36				
2125	35				
2126					Echo mostly Lake Spence to S of BST, some in NE quadrant and new echoes around Lubbock
2141				-25	403 pulse returned after a short period of -20 dbm
2148					Check made with pulse height to try and establish if termination would improve amp performance
2152					Second return appearing at 070° now as an echo moves off to the Northeast
2158	36	20			Ran one each 1 hit data at 1.5° scan
2159	35				
2202					Evidence of S band attenuation at 220°, storm behind hard area has flat edge due to attenuation behind the core
					Lower S band video level to record full range to check dc level shift with range
2222					Tape drive on line
					May have lost 10 min data
2233					Reset max elevation to 12.0°
2241	35				
2246			+5.1	-25	TS-403 z eroed

Date 25 June 1977

Start Time 2326

Stop Time

Operator Schaff/Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2326					Echoes in N hemisphere are relatively sparse, small, few and new. There are two big CB's in Seminole, and their anvils merge to the NE and cover the project area. The W edge of this cirrus shield is visible, stands more or less 10 mi to the W
2337	36				
2343	35				Ref az to 270°
0000					Approx end of Tape 4
0012	36				
0018	36	20			Checked
0022					Elev. max to 12°
0045	35				
0045	36				
0049				-25	TS-403 set
0145					Record off - Begin cals
2155			+5.2		Cal finished - to B4. Thresh to IE last two steps. 3280 Freq.
0235					X band cal over (False start on X cal, then OK) C1 = -9 dbm dial. + 25.9 coupler + 6.0 cable CE = -45 dmb Test Scale CF = -45 dbm Recv. Test Scale D1 = -48 DG -66 dbm (There is one 3 db step missing in here. Probably -60 db.)

Date 26 June 1977

Start Time 1644

Stop Time

Page 1 of 2

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1644					Record on
1645					Elevations synched
1649	36	IE			
1653					S band centered integrated video shows change in noise level with range, as appeared on CRT since I came.
1658			+4.4		Start Cal.
1710					End calibration: A1 = 0 dbm B3 = -51 dbm
1713	35	IE			
1806					Jump in video due to removal of load on system
1820			+3.8		Zeroed +3.8 Lower S band video level to record full range to check dc level shift with range
1850					Cal pulse moved in to avoid interference with data
1906			+3.7	-25	403 pulse cycled in range to allow us to back out the change in noise level with range
1907	35	IE			
1909					At this time, all echoes TCU in SW quadrant may range
1922					Antenna synch improved.
1933					Pulse played with a bit
1939					One TCU now in W of target area
1940					Pulse moved in to clear area ≈22 nm
1942					Max elevation to 9.0°
1955					Max elevation to 7.5°
1956	36	IF			
2000					Tape 1 end

Date 26 June 1977 | Page 2 of 2

Start Time 2012

Stop Time ____

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
	35				
2022	36				
			+3.7	-25	S band magnetron constant = 31 ma. No good echoes only anvils will close down
2037					Record off
2042					Run at low threes on S band to record grass level. Run pulse back and forth to get any gain variation calibrated
2053					Cal over A1 = 0 dbm B3 = -51dbm total $\Delta \simeq 5$ cntz Set integration to 2^{10} B3 = -54 dbm
2055					IF at 2^{10} gives 1 or 2 gates at max R IC at 2^{10} gives 1/2 R in 0 max, 1/2 R in 1st level 1B gives 75% 1A gives 90% 19 gives few spikes close in

Date 27 June 1977 | Page 1 of 3

Start Time 1524

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1524					Record
1525			+4.6	-25	Stepping/Constant = 1 4.5° high step
1530					Antennas saved in EL (X was free)
1539			+4.6		Finished adjusting power
1644					Ref az to 090°
1645					Pulse moved in to 25 nm
					Max elevation to 7.5°
1648	34				
1650					Some echo to north but all section return
					Some echo to SW but most second return
					Two TCU in area
					1) 270° 75 nm
					2) 240° 60 nm
1706					Max elevation to 9.0°
1707					Slight video noise increase due to change in receiver crystal current
1718					Video check for a minute
1721					Record on
1749			+4.5		Check and zero 403
1752					10 μms pulse 200 μms out
					There is still the same apparent AC coupling in the video that there was on the video last night
1814					Series of developments at 270° just outside the project area. Some other echoes but all second return
1817					At 090° there is a dip in the noise level, consistent with AC coupling since there is the danger and water tower exactly in line in that direction
1907					Elev. reset to 1.5° since Tape drive 2 not on line when Tape 1 finished ≈ 1 min of data lost

Date 27 June 1977 Page 2 of 3

Start Time 1922

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1922	.		+3.8	-25	TS-403 zeroed
1923					Spoke to Mike Gannon; he suggested TR tube or gassy 6AK5
1936					Get few strobes of base line at 2^{10} integrations, low threshold.
					To check slope
2031	35	20			Thresholds adjusted
2038			+4.0	-25	TS-403 zeroed
2122			+4:9		Due to increase in magnetron current from 35 to 39 ma
2206	36				
2208					Record a few hits at 2^{10} low threshold to characterize base line
2209	35	20			
2211			+5.0	-25	TS-403 zeroed
2231					X band integration to 5 for few sec
2252					S band calibration A1 = 0 dbm Bd3 = -51 dbm
					Made changes in integration constant at B2, B3
2255					S band record off to change 6AK5's
2309	35	10			Thresholds adjusted
					Record on after change of tubes in S band pore IF in the tubs
					Small improvement in the slope of the grass level
2319					Half way through Cal, noticed cal pulse may have been too far out
2329	34	1C			

Date 27 June 1977 | Page 3 of 3

Start Time 2329

Stop Time ____ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Cal end A1 = 0 dbm
					B3 = -51 dbm
					B4 = -54 dbm
					Integration increased in B2, B3, B4
2330			+50	-25	
2332	35				
2348					S band record off
2352					Start X band cal.
0012					Cal end C1 = +9 dbm
					D9 = -69
					-42, -45, -48 repeated due to step attenuator

Date 28 June 1977 , Page 1 of 2

Start Time 2245

Stop Time ______ Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2245					Both radars on
2257			+5.2	-25	Cal A1 = +0 dbm B3 = -51 dbm
2304	35	1D			
2307					Max elevation to 7.5°
2313					Max elevation to 9.0°
2324	36				
2349					Max elevation to 12.6
0111					Off radar record
					No EOF on tape; 1/2 tape used*

* Min Range EA
Integration 6
Threshold 07

Antenna Pattern:
403 at beacon tower
≈8-10 db of attenuation in cables
Wave meter antenna
Freq. 3250
MFC 1 mw = 0 dbm
Pan antenna from 100 - 160°
center ≈ 130°
Elevations 0.1° to 4.0° in 0.1° steps
4.5, 5.0, 5.5 → 12.0°
Then 6°, 3°, 1.5°, maybe others
Rotation ≈ 1°/sec

Date 28 June 1977

Start Time 0111

Stop Time

Operator An derson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Speedup rotation to 2.5 RPM Do complete 360° pans μm 0.1°, 0.5°, 1.0°, 1.5°, 2.0° . . . EOF

Date 30 June 1977

Start Time 1525

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1525					Record on, both radars
					No Cal Pulse in here - checking equipment
1605			+4.8		
1607			+4.8	-25	403 set
1623					Max elev. to 14°
					Cable attenuation 3.8 dbm since Antenna Pattern day
1626					Max. elev. to 12.0°
1636	34	1B			
1648					Max elevation to 10.5
1703					Line of echoes ≈ NE-SW dri ≈ 1/2 way between SNY and LUB. One large cell, the best one lies 50 nm on 330°, Top ≈ 10°, 50 nm. Large gap in line where it intersects project area. One more nice cell at 240° 70 nm. Few TCU small in W of project area
1724					X band antenna synch improved
1725	33				
1728			+4.7	-25	Range adjusted 30 min earlier to max possible
					The attenuation the 403 agrees well with the power meter at high attenuations, however, at less than -15 dbm the power output of the 403 drops as the attenuation is increased.
					Setting ... Actual
					-15 ≈ 15.3
					-10 ≈ 10.8
					- 6 ≈ -7
					at less than -6, the Klystron appears to be loaded quite severely. This condition has apparently always existed (Bob says Ed claimed this always existed).

Date 30 June 1977

Start Time 1737

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1737					Power down momentarily
1739					Reset all systems
1854	34				
1859					Max elevation to 7.5
					Line sort of fizzled out, some echo left in W hemisphere
1903					End of Tape 1
1914			+4.7	-25	TS-403
1915					Constant set to 1, has been 3 all day, however, all systems go
2010					Antenna synch tightened up
2020					Momentary interruption
2022					
			+4.9	-25	TS-403 zeroed
2049		1C			
2103					Max elev. to 0.0°
2111	35				
2120					End Tape 2
2124	34				
2222	35		+5.0	-25	403 adjusted
2226					synch antennas
2235	34				
2244					Max elevation to 6.0°
2250					Cal A3 = -6 dbm
					B3 = -51 dbm
					Extra at B3 integration = 9
2314					Record off

Date 7 July 1977	Page 1 of 2
Start Time 2010	
Stop Time	Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2010					X band on
					S band warming
2020			+5.1	-25	S band on
2024	21	IE			
2026					Max elevation to 6.0°
					X band at 1.4° due to malfunction in elevation synch
2031					Small line of single cell echoes E of Lubbock
2032					X band elevation synch ok
2046					Cal finished
					A3 = =6 dbm
					B1 = -45 dbm
					B2 = 4.8 with int = 7
					B3 = -51 with int = 7
2050			+5/1	-25	
2148	22				
2151	21				
2154			+5.1	-25	
2200	20				
2204					S band video tape started
2212					Starting elevation to 1.4°
					X band having elevation synchro problems when stepping to 3.0°
2227					Azimuth synch touched up
2234					Max elevation to 5.9°

Date 7 July 1977

Start Time 2245

Stop Time ____ Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2245					Cal
					A3 = -6 dbm
					B1 = -45 dbm int = 7
					B2 = -48 dbm int = 8
					B3 = -51 dbm int = 10
2247	20	IF	+5.1	-25	
2255					EOF

Date 8 July 1977 | Page 1 of 3

Start Time 0943

Stop Time ______ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
0943					Radars on
0954			+5.8	-25	Checked
0955	21	1E			
1000					X band off for few seconds due to video level shift caused by playing around in radar van
1006				-25	End Cal
					A3 = -6 dbm
					B3 = -51 dbm
					Pulse reset to -25 dbm
1017					S band video still displays change in base line with range and at 90°, 110° as noticed before
1022					Having similar elevation synch problems as last night. X band elevation drive goes ape when stepping to 3.0°. Starting elevation set to 1.4°
1027					X band fixed 1.5° elevation. Program min elev. set back to 1.5°
1104			+5.1	-25	
1146	21				
1157					Checked 403
1235 - 1241					Checking cloud tops at B.S. at request of CRMWD - 31.5 KfT 10 W of B.S.
1243					Stepping normal to 9.0°
1256					Back on sight
1300					Max elevation to 18.5
1325					Ref az to 0.0°

Date 8 July 1977

Start Time 1330

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1330					Wind at sight from outflow
1335					End tape 2
1346					X band elevation to 3.0°
1348					Rain at sight plus soft hail
1350	22	1E			Large drop heavy rain, adjusted thresholds
1353					S band back up, elev. program reset
1355			+5.2	-25	
1356					AC power outage. Whole system went down,400 cycle went down
					3 end of files taps continues
1404					Still heavy rain. X band up. S band on
1422					S band on - antenna ok
1425			+5.1	-25	
1432	23	23			
1438					Video tape on. 8.0
1439					Still raining
					Cause of antenna problems was blown circuit breaker on the pole.
					Thresholds are a little high but otherwise OK
1449	?				
1458					End tape 3
1513			+5.2	-25	
1514					Excellent dual wavelength data
1520		24			Rain accum so far → 1.25 inches
1521		26			
1523					Ref az to 300°
1549					End tape 4
					Some 0, 1, 2, 3 bit data on tape 4

Date 8 July 1977 | Page 3 of 3

Start Time 1643

Stop Time ______ | Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1643					Back on site
1645			+5.2	-25	
1648					End tape 5
1653					Ref az to 10° Max elevation to 14°
1713			+5.2		
1720					Max elevation to 10.5°
1724					Max elevation to 7.5°
1744					Good day for estimating rain in the drainage area for the day
1754					End Tape 6
1815			+5.3		
1824	22				
1900					"and all is well"
1916	22				
1929	21	25			
1930	22				
1939	21				
1940	22				
1943			+5.2	-25	
2034					Cal A3 = -6 dbm B3 = -51 dbm at $2^{1\circ}$
2035					Down

Date 9 July 1977 Page 1 of 2

Start Time 1250

Stop Time

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1250					Radars on
1257					Antennas synched
1305			+5.6	-25	Small TCU ≈ 020° 20 nm
1310					Max elev. to 14°
1336					EL to 16°
1341					EL to 18°
1415	21	1D			
1417			+5.0	-25	
1421	22	1E			Down for short period
1423					S band back up after power down
1435					X band back on
1445			+5.0	-25	
1446					Cld base 7.0 K ft
1448	38	1D			
1453					Suggested to 37T to descend to 5 K ft upon termination of present pass.
					Major cell 7 mi N of SNY
					37T making E-W passes ≈ 3 mi S of storm, were at 6.5 K ft, now at 5.0 K ft
1459					Program stuck at 18°, reset echo height exceeds 18°
1520					37T doing loops under small cell at 32 nm 010° BST
1537					Move to a point 10 mi north of Snyder
1600					End tape 1
1704			+5.1	-25	
1709					Ref az to 270°
1710					Ref az to 250°

Date 9 July 1977 Page 2 of 2

Start Time 1750

Stop Time ______ Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1750					No activity threatening the target area, Leon sent home
1805					End of Tape 2
1814		1F			
1817					Max elevation to 12.5°
1900					Freq. 3275
1920					Cal Pulse second image showing up in data some times.
					Cause: Delay trigger amp also passing few triggers
					Will be interesting to see if the Cal Pulse has same amplitude in close.
					1) Range grass level shift
					2) Cal pulse not coming in on every hit
1922					Cal Pulse restored
1940			+4.8		
1949					Cal Pulse still having problems. Removed
1952					Elevation max = 16°
					Program reset
2006				-25	Max elevation to 18.5°. Cal pulse back in -25 dbm
2011					Cal pulse out
2033				-25	Pulse in - 25 dbm
2048			+4.8		Cal A3 = -6 dbm
					B3 = -51 dbm
					B2, B3 at int = 10
2054					EOF

Date 10 July 1977

Start Time 1511

Stop Time ____________ Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Sphere Calibration
1511					End Cal A3 = -6 dbm
					B3 = -51 dbm
					B1, B2, B3 at int = 8, 9, 10
160500					28 μms Ranges
160530			+4.7	-10	
160700					35 μms
					First pulse in front of Cal pulse
1614					Elevation too high
1628					Min range always at 02
1643			+4.6		Cal starts at 164530
					Cal A3 = -6 dbm
					B3 = -51 dbm
1650				-25	
					Cal pulse earlier in range for now on
1700				-25	Excellent data
					Just beyond cal pulse
17062-				-17	
1725					Record off. EL too high
1802				-30	
1805				-33.2	295 μms
1807				-35	
1815				-40	
1817				-30	
1834			+4.4		Record off
					Calibration next

Date 12 July 1977

Start Time 114703

Stop Time

Page 1 of 1

Operator Anderson/Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Range clock calibration Based on 453 time base which before the taps starts agrees very well with the PRF
114703					250 μms from leading edge to leading edge
120258 -					132 μms
120308					
120422 -					279 μms
120430					
120525-					363 μms
120535					
120555-					399 μms
120615					
120740-					506 μms
120750					
120825-					618 μms
120835					
120900					753 μms
121000-					868 μms
121010					
					EOF
					All times from leading edge of main bang to leading edge of cal pulse, data begins in next range gate. Scope time base indicates range gate spacing actually 1.04 μms long not 1.00 μms

1978

Date 2 June 1978

Start Time 0930

Stop Time

Page 1 of 2

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
0945	29	31	+4.8	-20	X band record off
					min range 10 hex
1027					X band on 1 V scan
1033					X band off
1035			+4.6		
1038					start CAL
					A2 = -6 dbm
					-9 dbm
					A7 repeated at -24 then set to A8
1045					EOT #1 AF = -45
					B1 = -48
1047					B2 = -51
1048				-20	
1100					MAG CURRENT adjusted up now power +4.9
1130					X band on
1142			+4.8	-20	
1145					X band off
1210					EOT #2
1227			+4.8	-20	
1230					X band on
1244					X band off
1312			+4.9	-20	
1350					Off since X band AFC repairs
1450					On
1454			+4.8	-20	Tape erased baseline shift as in AM this day
1511					Off all echoes NE will work on drives
1840			+4.5		On S band elevation step to 30°

Date 2 June 1978

Start Time

Stop Time 2128

Page 2 of 2

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1854			+4.5		Short period at 8.0°
1900				-20	Short cal pulse period
1904					X band on elev + az synch antenna dry
	26	32			Range delay 1.0
1910					X band off
1912					Max elevation to 12.5
1920					X band record on light precip at site, cal pulse on momentarily
1926					X band off 1 full volume scan
1937					Range delay to hex 30
1953					Max elevation to 8.0°
1956					X band on
1958					X band off
2110			+4.5		EOT #3
2128					Cal
					A2 -6
					B1 -48
					B2 -51

Date 3 June 1978

Start Time 915

Stop Time 2359

Page 1 of 1

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
915					Radar on - no echoes
2359					Still no echoes

Date 4 June 1978 Page 1 of 1

Start Time

Stop Time Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					No echoes

Date 5 June 1978

Start Time 1108

Stop Time

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					Range delay 5A = 90 µs
		39			Int = 6
					S band only Constant = 1
					Max Elevation = 80
					92/4 23 1
1120					Range delay set to 17 = 90µs
1217					Cal
					A2 = -6
					A3 = -9
					A9
					AA -30
					AB
					AC -36
					AD
					AE -42
					AF -45
					B1 -48
					B2 -51
					Found bad preif amp last evening, now no range effect, found one of cap. on gain line probably installed when generator was arcing - it caused range slope. Now pot disabled by 10 K resistor put in preamp
1228				-20	then off
1245	27				X band on 1.5°
					Recycle antenna

Date 5 June 1978 | Page 2 of 3

Start Time ______

Stop Time ______ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1246		37			X band off
1247					X band on
1250					X band off azimuth read out bad but visual looked good
					No X band elevation synch, set to 25 mils
1312				-20	
1348		38		-20	
1437			+4.1	-20	Since AM
1700					Power raised to 42 mg
1705			+5.0	-20	
1706					Cal pulse off
1722					Prepare record dual wavelength at base ang.
1805					X band off after several base angle scans
					Elevation synch board shot
1810					High power went down, recycle antenna + back up
1814					Same ringing occurring when log IF saturates
					No X band azimuth reference today
1822					Record off for 5-min to reload tape and check drive
1828					Radar up
1922			+5.4		Set to +4.4
1926					Rain at site
1929					North wind ≈ 30 G 40 knts
					Severe hook echo to SW ≈ IRA AREA
1938			+5.4		
1942					Off due to power out
1950			+5.2 to +5.4		Radar on

Date 5 June 1978 Page 3 of 3

Start Time

Stop Time 2052 Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1952				-20	
1955					Few -10 db steps set in on IF attenuator
2006				-20	
2049				-20	
2052					END TAPE 2
2056			+5.4		Tape #3 start
2123					Start Cal
					A2 -6
					AA -30
2127					Start again
					A2 -6
					AF -45
					B1 -48
					B2 -52
2131				-20	
2135					Lots of ground clutter to SW over center of target area since rain stopped
2137					Will adjust video gain
2145					IF attenuation increased 10 db and DC offset
2150					Record off

Date 6 June 1978 | Page 1 of 3

Start Time 940

Stop Time ______ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					30 db IF attenuation ringing still apparent
945			+4.8		
947				-20	Int = 6
					S Threshold = 2B - 2A
					Const = 1
					Range = 17 = 90 μs
1010					Rain at site
					Elevation program
					(1.5, 1.5, 3.0 → 12.0, 14, 16, 18)
					≈ 5 min
					= 15°/sec X 1.1° per integration
1021					X band on constant = 2
					Azimuth elevation synch good
	25				Rain at site
1024			+5.1		
1025				-20	
1032					X band record off
1105					Back on after 5 min
				-20	to insert 75 ohm video term.
1107					Lost AFC arcing?
1111					Back up, cycle antenna
			+5.1		Apparent problems, power line input wrong
1137					Cal pulse in
1150					End Tape #1
1154					Tape 2 start

Date 6 June 1978 Page 2 of 3

Start Time

Stop Time Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
120					Power dropped out
1212					X band on
1214				-20	X band off
1218					Record off for 14° scan
1218					X band on synch good
1218					X band off 3 scans recorded
1219					Light rain at site
1222				-20	Start cal
					A2 -6
					AF -45
					B1 -48
					B2 -51
1229					End cal
1242					Parity error light went on
					powered down, probably cause several parity errors on tape
					recycled antenna program
1242					High power lost - inadvertent turn off X band recorder off
1244			+5.4	-20	Back up -
					Light rain at site
125500					Parity error light came on
					no action taken
					air conditioner set very low at time
					Thermostat moved up to shut it off and soon parity error light stopped
125750					Parity light again

Date 6 June 1978 | Page 3 of 3

Start Time

Stop Time 1645 | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1300					Parity light on, no visible errors
					Cal pulse on
1302					Cal pulse off
130035					Parity light extinguished
1350					Arcing - S band
1356					S band back on
1402				-20	
1403			+5.1		
1454			+4.5		Set up to +5.2
1500					End cal
					A2 -6
					B2 -51
					Set cal pulse to -20
1511					End Tape 2
1516					Tape 3 record
1602					Max elevation to 10.5°
1645					Record off
					Scratch file inserted

Date 7 June 1978 | Page 1 of 1

Start Time 1705

Stop Time ______ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1705					Radar on
1741			+4.6		
1746			+4.8	-20	= 5A amps
1750					Both radars on
					Small Cbs 20 mi NW of Snyder
1813					X band off
1818					Cal pulse on
1855					Cal pulse
					5A -20
					No precip Just VIRGA
1915					Cal pulse
					5A -20
1917			+5.2		
1918					Cal
					A2 -6
					B2 -51
1926					Record off End of File

Date 10 June 1978 | Page 1 of 2

Start Time 120000

Stop Time ______ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
120000					Sphere calibration

	Dial	Counts
A2 =	-6	79
A3 =	-9	72
A4 =	-12	6B
A5 =	-15	64
A6 =	-18	5C
A7 =	-21	55
A8 =	-24	4F
A9 =	-27	48
AA =	-30	40
AB =	-33	39
AC =	-36	33
AD =	-39	2D
AE =	-42	29
AF =	-45	28

Date 10 June 1978	Page 2 of 2
Start Time	
Stop Time	Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1304					Just after cal pulse
1305					
1306					Cal
1308				-10	
1315					A2 10 deg higher
1318					A2 10 high cal OK
1321				-15	
1403			4.1		
					Range went to 280 μs and elevation to ≈40° gave up, abandoned
1425					Cal
					A2 = -6 74
					A3 = -9 6D
					A4 = -12 66
					A5 = -15 5F
					A6 = -18 58
					A7 = -21 50
					A8 = -24 49
					A9 = -27 42
					AA = -30 3A
					AB = -33 34
					AC = -36 2F
					AD = -39 2A
					AE = -42 28
					AF = -45 26
					End of file

Date 12 June 1978

Start Time 1730

Stop Time ____

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1730			+4.6		Radar on
					INT =.6
					MIW RNG 17 hex
1810					Radar off tape rewound
					No echoes

Date 13 June 1978 | Page 1 of 2

Start Time 1415

Stop Time ____ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1400					Call from Girdzus
1415					Radar to go on
1422					Record on - both X and S
1430	24	26	+5.0		Int X - 6 S - 6
					Min range 17
1442				-20	
1447					Azimuth step to 230°
					Only cloud in sky over Snyder
					-20 = 53
					Elevation change to 330° azimuth
1507					PROC 1 not finding any errors
1508					X band off
1512			+5.2		
1523				-20	-20 = 54
1616			+4.8	-20	-20 = 53
					So far:
					1. Cell over Snyder when we came on has moved E ≈ 20 mi and a new cell is now forming SE of Snyder
					2. Small Cbs forming in western part of project area
1640					Rotation rate increased
1720					X band radar went down
1721					Back on
1723				-20	-20 = 53
1442					Elevation change to 1° (NORTH)
1743			+4.0		
					Power set to +4.8

Date 13 June 1978

Start Time

Stop Time 2020

Page 2 of 2

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1754					X band off, no echoes close enough to radar
1818			+4.9	-20	
1905					High power went down, few empty records in the digital tape
1909			+5.1		Back up
1911				-20	
1930			+5.0		
1936					Start calibration
					A2 = -6
					AF = -45
					B1 = -48
					B2 = -51 int set to 8
2020				-20	Only Virga left now and second return
					End of Tape

Date 20 June 78

Start Time 2201

Stop Time 2210

Operator

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2201					S band on
					Small Cu ~ 60 miles 10 mi east of Lamesa
2210					Off - no recording

Date 21 June 1978

Start Time 2046

Stop Time 2148

Page 1 of 1

Operator

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2046					S band on record
2110		5.2			X band on also
					All video is second return 280° ~ 140 miles
2130					~ 130 miles
2145					X band off
2148					S band off 28 sec full 360° scan

Date 25 June 1978

Start Time 1830

Stop Time 1925

Operator

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1830					Cbs W & N of Lubbock
1925					Radar off all second return
					No Tape

Date 26 June 1978

Start Time 2115

Stop Time 2134

Page 1 of 1

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					1100 am
					Tapes sent to MRI
					1 Sphere Cal 6/10
					2 1705-1926 Data tape 6/7
					3 1400-2020 Data tape 6/13
2115					Radar on, second return at 350° plus one cell
					000° 70 nm small
2134					Radar off
					No Data

Date 28 June 1978

Start Time 1600

Stop Time 1807

Page 1 of 1

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1600			+5.0		S band only
					Int = 6 hex
					Min = 29 hex
					Rng = 17 hex
					Const = 01
1612					Rotation rate increased
					Max elev = 8.5°
1617			+4.7		Power reduced
1619				-20	Two tiny echoes in extreme west but also second return at 20 mi
1627					step set to 1.5° was 1.0°
1630					Range delay cycled 07 hex
					17 hex
					27 hex
					17 hex
1632			+4.7	-20	
1645					Some peculiar sparking at 030° of unknown origin
				-20	Cal pulse moved out and set to -20
1652					Radar went down
1653			+4.7	-20	Back on
1710					Power went down
					Arcing problems
1737			+3.7 (36 mils)		Back on the air
1742			4.0		≈ 38 mils
1752					Power went down
1807					Record on. arcing off
					Tape rewound

Date 29 June 1978

Page 1 of 2

Start Time 1507

Stop Time

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					After 1800 an investigation of the problem indicated that the big piece of flex had blown so, repairs began. As of 1430 we are back up with a new combination of wave guide pieces. Will have to run a new sphere calibration for all data from this time forward.
					Frequency before June 29 1500 2995 MHz
					Frequency June 29 1500 3005 MHz
1507			+4.6		Record on
1510				-20	= 52 hex
1551					Threshold 27 hex Min Rng 17 hex Int 6 hex Const 01 hex
1557			+4.7		Power set back to +4.7 after short period at +3.9
1639					Power went down
1641			+4.7	-20	Back on
1645					Area of precip on cap rock with north hemisphere full of popcorn
1655				-20	
1657					Power went down Gone to check wave guide
1707			+3.2		Back on at 28 ma.
1708					Power went down
1743			+4.8	-20	Power up after opening a flange

Date 29 June 1978

Start Time

Stop Time 2124

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1806					Hot in van
1822			+4.6	-20	
1848					Power went down Record off
1850			+5.0		Record on
1855					Power went down
1858			+3.4		Power on
1858-1/2					Power out
1903					Power on
1905			+2.0		
1906					Power off
2106					Radar on
2109					Max elevation to 9.0°
2111			+6.0		Lowered to +5.2 - power surge to 52 ma
2113				-20	
2119			+3.6		Power reduced to +3.6 at 36 ma
2124					Power went off
2136					Cal on new tape
					A2 = -6
					B2 = -51

Date 30 June 1978

Start Time 1420

Stop Time

Page 1 of 2

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1420			+3.5		Radar on
					Frequency = 3305 MHz
1423				-20	This data is with slight mod to wave guide since last data. This involves removing the adapters used with the old flex this morning.
1425					Thres 26 hex Int 6 hex Const 01 hex Min range 17 hex
1436					Both radars on
	23				Const 02 hex
1437				-20	
1445					Mag current 34 ma
1450					≈ S band went down X stayed on
1454			+5.0		
1502				-20	
1503					It seems X band azimuth elevation readouts are gone however
1508					Elev synch restored
1509					X band azimuth elevation went out but antenna synched well
1511					X band elevation set to 25 mils and held steady
			+4.7		Since restart
1519				-20	
1532					Will record X band on base elevation only
1534					X band not elevating
1537					X band elevation drive finally set to 25 mils elev

Date 30 June 1978

Start Time

Stop Time 2055

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1539					X band 25 mils only
1539			+5.2		S band power surge restored to 41 ma
1542					X band AZ EL information inserted
1545					to give reference, elev set to 1.5°
1546					Power went down on S band
1548					Came back up
1549					Power went down
1557					X band only, echo synched
1558					Shadow evident at 350° i.e., behind S band dish
1612			+5.1		S band power up
1615					X band elevation on manual at 25 mils
1623					X-S elevation synch
1626			+5.2		
1627				-20	
1628					No rain at site yet
1637					S band power went down
1657				-20	Both radars up
			+5.2		Antenna recycled
171340					New tape rewound interim segment on tape 2
1755					Power off
1758					On
1807					Down
1819					up megatron readjusted
1923					S band 42 ma with new reverse current diode
2008					S band on 42 mils
2055					S band off
2108					Cal at end of tape #2 by mistake
					A2 = -6
					B2 = -51

Date 1 July 1978 | Page 1 of 1

Start Time 1447

Stop Time 1900 | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1447			+4.6		Record on
					New magnetron
1455				-20	It seems as if MDS is worse by ≈5 db - today
1508					X band to be brought up
1517					S band off for new X-tal
1522					New X-tal installed Record S band recycle antenna
				-20	MDS looks good
1534				-20	
1552			+4.3		Freq - 3285 MHz
1605					X band off, no echoes in range
1634			+4.0		Power decreased gradually to 22 mills = 4.0 dbm
					Power brought up to ±5.0 37 mills
1638				-20	* MDS good
1744			+4.6		Power 37 mills
1747				-20	MDS looks good
					Some aircraft flow early on today so this data may turn out to be some of the more important of the tapes so far
					Presently there are two lines of cells, one east of Snyder and one over western boundry of the target area, also large area south through southwest
1852			+4.4		Everything dying
1859					End of File
1900					Cal
					A2 = -6
					B2 = -57

Date 2 July 1978 Page 1 of 2

Start Time 1452

Stop Time ________ Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1452					Recording on/S band only
			+4.0		Steps to 12°
1510				-20	= 51 hex
1544			+4.0	-20	May have been -25
1706			+4.2		
1709				-20	
1721					Hundreds of small echoes in a 40 mi wide band through Snyder. Aircraft have landed and apparently spent little or no time near the Snyder radar
*1724			+3.8		Meter set to 200 r
1727				-20	
1745			+3.7	-20	= hex 52
1827					AFC having problems
					Record off
1839					Record on
				-20	= 52 hex left on to identify AFC problems
			+4.2		
1854			+4.2		AFC good at +4.2
				-20	= 51 hex
1912				-20	= 52 hex
1927			+4.1	-20	= 52 hex
2022			+4.4		
2042					AFC losing it again
					End of File

Date 2 July 1978

Start Time

Stop Time 2050

Page 2 of 2

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2050					Cal after 1 EOF A2 = -6 B2 = -51 EOT All data this day at a less than optimum frequency where spectrum is poor

Date 3 July 1978

Start Time 1327

Stop Time

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					FREQ 3295 MHz
1327		+4.6			Tape on
					3300 Hz
1332					Ref Az 90°
1620					Ref Az 60°
1718					Min range to 07 hex ≈ 30μ s
1718			+3.6		
1721				-20	= 52 hex
1727					Slight gap as Tape #1 ended.
					Some data on small tape X band record
1810					End Tape 2 when power pulled from processor
1812					Two minute gap trying to get tape loaded
1832					X band elevation went ape for a minute
					Ref Az returned to 30°
1837					X band elevation went out. Record off
1837				-20	
1842					X band back up
1848					Light rain at the site just a trace
1904					X band integration reduced to 4
1908 *					Vol scan with X band int = 5
1912					Min range moved to 17 hex
191234					End tape 3
1923					Start Tape 4
					EOF on tape B after end of this short data set
					Second small piece of data then record EOF
1927			+3.5		
1946			+4.7		

Date 3 July 1978

Start Time

Stop Time 2347

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1953				-20	= 55 hex
					First time so far to see 55
					Rain dampened the ground but not measurable amount
2112			+4.7		
2114				-20	Herringbone on A scope video
2125					X band off for balance of day
2142			+4.9		
2144				-20	
2225			+5.3		Power up to +5.3
			+4.5		Reduced to +4.5
2251					Ducting apparent at 300° 70-90 miles
2255					Tape 5 end
2323			+4.5		
2346					Record OFF EOF
2347					PPI's 1.5° at various int 0, 1, 2, 3...
					Fixed as 1.5° at various int 0, 1, 2, 3 ...
					Few PPI's at 1.5° INT =6
					EOF
2359					Cal
					A2 = -6 two errors A3
					B2 = -51 AC
					3 EOF's

Date 8 July 1978

Start Time 1230

Stop Time

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1230					Bad tape drive Ground clutter map R4 = corrections # 1 slow antenna scan Int = 7 1.5° EOF #2 Normal scan rate 1.5° Int = 6 EOF #3 0.5° Int = 7 slow scan EOF #4 X band 1.7° Slow scan at Int = 6 ≈ 1 rec/day EOF #5 0.5° slow scan ≈ 1.5 deg/rec

Date 15 July 1978

Start Time 1637

Stop Time 2008

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1637					Record on
					Very hot in recording van
1649			4.1		Van cooling now
1652				-20	MDS looks good
1712			+4.3		
1750			+4.1		Power reduced from +4.4
					Ground clutter - gust front kicking up grasshoppers ahead of storm at 140° 20 NM
1815					Aircraft in the air now
1855					Power went down momentarily
					Antenna recycled
					Lost antenna controller
1909			+3.3		
1911			+4.4		Power increased
1914				-20	
2007			+4.7		
2008					Record off 3 EOF's
2011					New tape
2014					Cal
					A2 = -6
					B2 = -51
					3 EOF's

Date 16 July 1978

Start Time 1900

Stop Time ______

Page 1 of 1

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1900					Air conditioner not working properly
					Processor van went to 120°
1930					Processor unplugged
1935					Temp down to 90° by cycling thermostat each time compressor goes off

Date 20 July 1978 | Page 1 of 1

Start Time 1500

Stop Time 1833 | Operator ____________

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1500					Set bottom clock to correct time (Big Spring)
					couldn't set processor clock (leads correct time 3 min)
1505					S band on
					Recorder on
1515					Tape drive dropped off line
1526					New tape record S band
			+4.3		Full sweep 27 sec
1600			+4.2		
1705			+3.9		Power increased to 4.3
1740			+4.2		
					Most return at 350° ~ 10 mi outside area to north of Post
					Moving north
1800			4.0		
1823					A1 = -10
					B1 = -55
					B2 = -58
					A5 = -22
					AB = -40
					AF = -52
1833					Tape off

Date 22 July 1978 — Page 1 of 2

Start Time 1349

Stop Time ______ — Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1349			+4.5		S band on
1350					Down AFC problem
1355			+4.3		Recorder on radar on +4.3 pwr
1410			+4.6		Light rain Snyder
					Read out storm position to Bob Anderson in Big Springs
1414					Second return 300° at 20 miles
1435			+4.4		Second return still present 290° 20 to 30 mi
1455					Tape dropped off line
1500					New tape on
1530			+4.1		
1538					X band on
1615					Wind NE ≈ 20 G 30
1615			+4.5		
1622					Seeding
					355 26 mi BST
1630					Signal generator gone
1654					New tape on drive 2
					(small one 3 min worth)
1657					New tape drive 1 - begin before load point
			+4.4		EOF near beginning of tape
1722					X band off, elev drive went south
1737					X band on
			+4.3		403 is bad ≈ 6 db too high for indicated power setting

Date 22 July 1978 Page 2 of 2

Start Time ______

Stop Time 2020 Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1800			+4.1		Max antenna height to 12°
1805					Rotation rate slowed down
1817					X band off
					130° 30 nm power line 160° 23 nm
1834					End tape
1838					New tape on
1851			+4.6		
1903					Rotation rate increased
					Max elevation to 16
1927			+4.2		
2020					Ground echo evident out till 50 nm ≈ 500 μs
					in entire SW quad
					Will be evident in the average range derivitive
					EOT

Date 23 July 1978 | Page 1 of 3

Start Time 0830

Stop Time ______ | Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
0830					X band on
0845					S band on
			+4.5		
0942			+4.1		Maximum elevation 14°
1030			+4.2		
1104			+4.2		Fluc.
1137					X band off
1210					There has been some sort of power offset in the TS-403 over the last few days, July 20, July 22. The output from the 403 for some reason increased ≈ 6 db, however, as far as one can tell, the linearity of the attenuator has remained the same. This AM I loosened the indicator dial and reset the faceplate and adjusted it so that a dial reading of -20 dbm is in fact -21 dbm, as existed for the early part of the season. The calibration was set as follows TS-403 HP 431 C -9 -10 -14 -15 -19 -20 -24 -25 -29 -30 The tendency for the ΔP to increase for lower attenuation settings has apparently disappeared. The action taken (moving the indicator) compensates for the change which apparently occurred, however, the actual cause of the change is not known but is probably due to the dislocation of an attenuator on the interior of the 403 somewhere.

Date 23 July 1978 | Page 2 of 3

Start Time

Stop Time | Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					The cal pulse was inserted at -20 dial and produced a DVIP value of 54 which is not greatly different than the 5-=55 values obtained earlier this season
					MDS comparable (-50 dial) also
1230				-20	
1308				-20	
1330			+4.1		
1330					Gap on tape ≈ 5 min in middle of data
					Expect parity error
1403					Tape 2 on Tape 1 inoperable
1410					X band on
					Min Range 07 hex
1444			+3.9		
1446				-20	
1455					Aircraft seeding W of Lake Thomas
1523					X band position read out down
1525					X band off record
1528					Repaired X band on record
1548					Rewind both tapes
1551					Small tape on 3 min #4
1554					Large tape on tape #5
1605			+4.3		
1622				-20	
1712					Tape #5 rewind
1713					Tape #4 on line till 17:17
1717					Tape #6 on line
1720			+4.2		
1734				-20	= 55 hex

Date 23 July 1978 | Page 3 of 3

Start Time

Stop Time 2055 | Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1852			+4.1		
1855				-20	
1910					Begin flyover Ackerly start
1911					Constant elevation 1.5 degree
1935					high pass Snyder flyover for tracking
1950					20,000 yds
5211					30,000 yds
					35,000 yds
2044					Normal op S band only
2055					Cal
					A2 = -6
					B2 = -51

Date 24 July 1978

Page 1 of 2

Start Time 1150

Stop Time

Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
					X band on
					Considerable bias on video this am because of tracking last pm
1205					S band on, recycle ant. prog.
			4.9		Power set 4.9 KV and AFC stable, will creep up
					Initial power +3.5 dbm
	39	26			Int = 6
					Min range = 17
					Constant = 02 for both radars
					Only a few small Cu right now
1217			+4.0		Max elev to 7.5°
1227				-20	Slowed rotation rate
1322					Attempting to reduce X band offset
					X band offset lowered to a value similar to S band
	28				
1342			+3.6	-20	
					Mag current increased
1403			+4.2		Airplanes taking off
1455					Normal scan resumed (1.5-18°, 25 sec/rev)
1520					X band off
1530			+3.8	-20	
1635			+3.9	-20	Cal pulse at -20 dial without readjustment
1812			+3.7		
1856				-20	12° max elevation
			+3.7		MDS ok

Date 24 July 1978

Start Time

Stop Time 1924

Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1912					Rotation rate reduced
					Echo activity decreasing
					(1) One echo small NW of Lamesa
					(2) Group E of Snyder 10 nm
					(3) All day shallow convection with cells ≈ 5 mi across, isolated, disorganized
1924					Begin Cal
					A2 = -6
					B2 = -51

Date 26 July 1978

Start Time 1420

Stop Time

Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1420					Start warmup
1438					Record on X and S bands
1442			+3.4	-20	MDS looks good
1521					X band elev box went south
1525					Came back on
1550			+3.7		Power increased to +3.7
1602					Rotation increased to 6.5 dial
					Elevation max to 18.5°
1607					X band elev went down
1657			+3.5	-20	
					Big cell which developed SE of Snyder now 10 nm
					E of BST (second return in north)
1704			+3.9		Power increased to +3.9
1811					Az synch tightened up, new cells forming
			+3.7	-20	between BST and Lamesa
1839					Az synch adjusted
					Motor fan placed on elev control box (multiplexer)
					for X band to see if cooling helps - so far OK
			+4.0		Power increased to +4.0
1850					Good data 10 nm NE of Snyder
					Small cells, close in
1854					X band integration to 5
					Elev change at 90°
185950					X band int = 6
1905					X band int = 4

Date 26 July 1978 | Page 2 of 3

Start Time ________

Stop Time ________ | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1910					18.5° max elev + normal scan rate
					+ X band int = 6
191115					It appeared that the processor stopped for a couple of small sectors i.e., processed video wnt to zero
1919					Wind from the south picked up?
1924					10° max
					Rotation rate reduced
					30° starting az
194208					Processor parity error
1945					Max elev - 12°
2022					End tape
2029					Begin tape #
2054					Max elev 18-5 Rotation rate increased
2103			+4.2	-20	
2114					Max elev 14° rotation slowed
2204			+4.2		
2214					Elev to 18.5
					Rotation rate increased
					Wind gusty from the north
2221					Az step at 120°
2225					Severe gusts
					Excellent dual wavelength data over Snyder
					Severe wind loading
2227					Radar shut down
					Severe winds
					Record off
2312					Both radars on
2328			+4.0		
					Ducting evident north

Date 26 July 1978 | Page 3 of 3

Start Time

Stop Time 0048 | Operator Anderson

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
2340					Bright band evident
					Be aware that the transmitted spectrum is poor when the mag is cold
0022					Extreme wind loading
0030					Stop due to wind loading
					End tape 2
0040					Cal
					A2 = -6 on end of 6001 tape
					B2 = -51 on end of 6001 tape
0048					Wind still too strong - going home

Date 27 July 1978 | Page 1 of 1

Start Time 1955

Stop Time 2010 | Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1955					4 cells
					(1) 5 mi x 10 mi cell 120° at 30 miles - top at 10.8°
					(2) 5 mi x 5 mi cell 120° at 50 miles - top ~ 5° el
					(3) small cell 160° at 60 miles top ~ 2.8°
					(4) small cell 180° at 70 miles top ~ 5° el
2000					S band off
2010					Rotated S band antenna away from wind - and 320 v supplies are blown - tried spares but still is out. Suspect problems in slip rings.
					FREQ 3295 MHz

Date 29 July 1978 — Page 1 of 1

Start Time 1838

Stop Time ____ — Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1838				-20	
1842				-10	
1843					Looks good
1909				-20	
1914			+5.0		
1915			+4.0		
1918					S band elevation consistently .5 deg high
1926			+4.0		
190818					Antenna binding
					Lost at 310° 33°
1939					S band record off
2023					S band cal
					A2 = -6

Date 30 July 1978 | Page 1 of 2

Start Time 1330

Stop Time ______ | Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1330					0.2° Antenna Calibration
					1.2°
					2.2°
					3.2°
					4.2°
					5.2°
					6.2°
					8.2°
					10.2°
					14.2°
1343					0.2°
					1.2
					2.2
					3.2
					4.2
					5.2
					6.2
					7.2
					8.2
					9.2
					10.2
					11.2
					For cross check
					12.2
					7.2
					3.2
					0.2

Date 30 July 1978

Page 2 of 2

Start Time 1552

Stop Time

Operator Schaff

SNYDER M-33 RADAR LOG

Time (LDT)	Threshold X-Band (dbm)	Threshold S-Band (dbm)	S-Band Power (dbm)	Calibration Pulse (dbm)	Comments
1552					Record on, both radars
1607			+3.8		Line of cells E/W across area 5 mi south of Snyder
1612				-20	
1733					Recorder off line
					+320v power supply blows fuses
					X band azimuth drive causing problem
					X band shut down
					S band only record on
1832			+4.0		
1920					Changed ending elev to 10.8
					Only target is 270° at 75 mi out of area
1925					S band shut off
					X band cal
2100					01 -85
					02 -80
					03 -75
					04 -70 twice
					05 -65
					06 -60
					07 -55
					08 -50
					09 -45
					0A -42
					EOT

APPENDIX IV

Power Output Logs

RADAR DATA: SUMMARY POWER OUTPUT LOG
M-33 S-BAND 1977

Date (1977)	Time (CDT)	HP431C Power Reading (dBm)	Transmitter Power (dBm)	Comments
5/30	1245	+ 4.0	58.5	
	1558	+ 3.4	57.9	
6/1	1218	+ 3.7	58.2	
	1438	+ 3.8	58.3	
	1820	+ 3.7	58.2	
6/8	1115	+ 3.6	58.1	
	1120	+ 3.8	58.3	
	1753	+ 3.7	58.2	
6/10	0140	+ 4.3	58.8	
6/11	1413	+ 3.8	58.3	
	1500	+ 4.0	58.5	
	1624	+ 3.6	58.1	
	1721	+ 3.7	58.2	
	1805	+ 3.9	58.4	
6/12	0045	+ 4.6	59.1	
	0253	+ 4.5	59.0	
	0402	+ 4.4	58.9	
6/13	2352	+ 4.6	59.1	
6/14	0002	+ 4.6	59.1	
	0129	+ 4.6	59.1	
6/20	2008	+ 4.4	58.9	
	2101	+ 4.6	59.1	
	2248	+ 4.5	59.0	
6/21	0019	+ 4.95	59.45	
	0036	+ 4.85	59.35	
	0110	+ 4.6	59.1	
	0220	+ 5.0	59.5	
	1225	+ 4.8	59.3	
	1230	+ 5.0	59.5	
	1554	+ 4.6	59.1	
	1723	+ 4.4	58.9	

SUMMARY POWER OUTPUT LOG (Continued)

M-33 S-BAND 1977

Date (1977)	Time (CDT)	HP431C Power Reading (dBm)	Trans-mitter Power (dBm)	Comments
6/21	1957	+ 4.6	59.1	
	2020	+ 4.6	59.1	
	2352	+ 4.7	59.2	
6/22	0117	+ 4.6	59.1	
	0211	+ 4.5	59.0	
	1102	+ 4.7	59.2	
	1342	+ 4.8	59.3	
	1444	+ 4.2	58.7	
	1452	+ 4.8	59.3	
	1807	+ 5.0	59.5	
	1833	+ 5.0	59.5	
	2015	+ 4.8	59.3	
	2129	+ 4.9	59.4	
	2236	+ 5.1	59.6	
6/23	0006	+ 5.0	59.0	
	0040	+ 4.7	59.2	
	1427	+ 4.6	59.1	
	1511	+ 5.0	59.5	
	1625	+ 4.9	59.4	
	1718	+ 4.8	59.3	
	1843	+ 5.0	59.5	
	2040	+ 5.2	59.7	
	2123	+ 5.1	59.6	
6/24	1302	+ 4.6	59.1	
	1405	+ 4.2	58.7	
	1452	+ 4.7	59.2	
	1611	+ 4.5	59.0	
	1710	+ 4.6	59.1	
	1733	+ 4.5	59.0	
	1816	+ 4.5	59.0	
	2216	+ 4.8	59.3	
	2316	+ 4.5	59.0	
	2320	+ 5.0	59.5	

SUMMARY POWER OUTPUT LOG (Continued)

M-33 S-BAND 1977

Date (1977)	Time (CDT)	HP431C Power Reading (dBm)	Trans-mitter Power (dBm)	Comments
6/25	0118	+ 5.0	59.5	
	1344	+ 4.4	58.9	
	1445	+ 4.8	59.3	
	1523	+ 4.2	58.7	
	1525	+ 4.8	59.3	
	1826	+ 5.2	59.7	
	1847	+ 5.2	59.7	
	1900	+ 5.0	59.5	
	2044	+ 5.2	59.7	
	2246	+ 5.1	59.6	
6/26	0155	+ 5.2	59.7	
	1658	+ 4.4	58.9	
	1822	+ 3.8	58.3	
	1906	+ 3.7	58.2	
	2030	+ 3.7	58.2	
6/27	1525	+ 4.6	59.1	
	1539	+ 4.6	59.1	
	1749	+ 4.5	59.0	
	1922	+ 3.8	58.3	
	2038	+ 4.0	58.5	
	2122	+ 4.9	59.4	
	2211	+ 5.0	59.5	
	2330	+ 5.0	59.5	
6/28	2257	+ 5.2	59.7	
6/30	1605	+ 4.8	59.3	
	1607	+ 4.8	59.3	
	1728	+ 4.7	59.2	
	1914	+ 4.7	59.2	
	2202	+ 4.9	59.4	
	2222	+ 5.0	59.5	
7/7	2020	+ 5.1	59.6	
	2050	+ 5.1	59.6	
	2154	+ 5.1	59.6	
	2247	+ 5.1	59.6	

SUMMARY POWER OUTPUT LOG (Continued)

M-33 S-BAND 1977

Date (1977)	Time (CDT)	HP431C Power Reading (dBm)	Trans-mitter Power (dBm)	Comments
7/8	0954	+ 5.8	60.3	
	1104	+ 5.1	59.6	
	1355	+ 5.2	59.7	
	1425	+ 5.1	59.6	
	1513	+ 5.2	59.7	
	1645	+ 5.2	59.7	
	1713	+ 5.2	59.7	
	1815	+ 5.3	59.8	
	1943	+ 5.2	59.7	
7/9	1305	+ 5.6	60.1	
	1417	+ 5.0	59.5	
	1445	+ 5.0	59.5	
	1704	+ 5.1	59.6	
	1940	+ 4.8	59.3	
	2048	+ 4.8	59.3	
7/10	1605	+ 4.7	59.2	
	1643	+ 4.6	59.1	
	1834	+ 4.4	58.9	

SUMMARY POWER OUTPUT LOG
M-33 S-BAND RADAR 1978

Date (1978)	Time (CDT)	HP431C Power Reading (dBm)	Trans-mitter Power (dBm)	Comments
6/2	0945	+4.8	59.3	
	1035	+4.6	59.1	
	1100	+4.9	59.4	
	1142	+4.8	59.3	
	1227	+4.8	59.3	
	1312	+4.9	59.4	
	1454	+4.8	59.3	
	1840	+4.5	59.0	
	1854	+4.5	59.0	
	2110	+4.5	59.0	
6/5	1437	+4.1	58.6	Since AM
	1705	+5.0	59.5	
	1922	+5.4	59.9	Reset to +4.4
	1938	+5.4	59.9	
	1950	+5.2-5.4	59.7-59.9	
	2056	+5.6	60.1	
6/6	0945	+4.8	59.3	
	1024	+5.1	59.6	
	1111	+5.1	59.6	
	1244	+5.4	59.9	
	1403	+5.1	59.6	
	1454	+4.5	59.0	Set up to +5.2
6/7	1741	+4.6	59.1	
	1746	+4.8	59.3	
	1917	+5.2	59.7	
6/10	1403	+4.1	58.6	
6/12	1730	+4.6	59.1	
6/13	1430	+5.0	59.9	
	1512	+5.2	59.7	
	1616	+4.8	59.3	

SUMMARY POWER OUTPUT LOG (Continued)

M-33 S-BAND 1978

Date (1978)	Time (CDT)	HP431C Power Reading (dBm)	Transmitter Power (dBm)	Comments
6/13	1743	+4.0	58.5	Set up to 4.8
Cont'd	1818	+4.9	59.4	
	1909	+5.1	59.0	
	1930	+5.0	59.5	
6/21	2110	+5.2	59.7	
6/28	1600	+5.0	59.5	
	1617	+4.7	59.2	Power reduced to +4.7
	1632	+4.7	59.2	
	1653	+4.7	59.2	
	1737	+3.7	58.2	
	1742	+4.0	58.5	

//

Flexible wave guide replaced. The new sphere calibration should be applied to all data after 6/29/78, 1430 CDT.

Date (1978)	Time (CDT)	HP431C Power Reading (dBm)	Transmitter Power (dBm)	Comments
6/29	1507	+4.6	59.1	
	1557	+3.9	58.4	Power at +3.9 for a short time Power reset to 4.7
	1641	+4.7	59.2	
	1707	+3.2	57.7	
	1743	+4.8	59.3	
	1822	+4.6	59.1	
	1850	+5.0	59.5	
	1858	+3.4	57.9	Severe power problems
	1905	+2.0	56.5	"
	2111	+6.0	60.5	Power lowered to +5.2
	2119	+5.2	59.7	Power lowered to +3.6
6/30	1420	+3.5	58.0	
	1454	+5.0	59.5	
	1511	+4.7	59.2	
	1539	+5.2	59.7	
	1612	+5.1	59.6	
	1626	+5.2	59.7	
	1657	+5.2	59.7	

SUMMARY POWER OUTPUT LOG (Continued)

M-33 S-BAND 1978

Date (1978)	Time (CDT)	HP431C Power Reading (dBm)	Transmitter Power (dBm)	Comments
7/1	1447	+4.6	59.1	
	1552	+4.3	58.8	
	1634	+4.0	58.5	
	1744	+4.6	59.1	
	1852	+4.4	58.9	
7/2	1452	+4.0	58.5	
	1544	+4.0	58.5	
	1706	+4.2	58.7	
	1724	+3.8	58.3	
	1745	+3.7	58.2	
	1839	+4.2	58.7	
	1854	+4.2	58.7	
	1927	+4.1	58.6	
	2022	+4.4	58.9	
7/3	1327	+4.0	58.5	
	1718	+3.6	58.1	
	1927	+3.5	58.0	
	1946	+3.5	58.0	Power increased to +4.7
	2112	+4.7	59.2	
	2142	+4.9	59.4	
	2225	+5.2	59.7	Power lowered to +4.5
	2323	+4.5	59.0	
7/15	1649	+4.1	58.6	
	1712	+4.3	58.8	
	1750	+4.4	58.9	Power reduced to +4.1
	1909	+3.3	57.8	
	1911	+3.3	57.8	Power increased to +4.4
	2007	+4.7	59.2	
7/20	1526	+4.3	58.8	
	1600	+4.2	58.7	
	1705	+3.9	58.4	Power increased to +4.3
	1740	+4.2	58.7	
	1800	+4.0	58.5	

SUMMARY POWER OUTPUT LOG (Continued)

M-33 S-BAND 1978

Date (1978)	Time (CDT)	HP431C Power Reading (dBm)	Trans-mitter Power (dBm)	Comments
7/22	1349	+4.5	59.0	
	1355	+4.3	58.8	
	1410	+4.6	59.1	
	1435	+4.4	58.9	
	1530	+4.1	58.6	
	1615	+4.5	59.0	
	1657	+4.4	58.9	
	1737	+4.3	58.5	
	1800	+4.1	58.6	
	1851	+4.6	59.1	
	1927	+4.2	58.5	
7/23	0845	+4.5	59.0	
	0942	+4.1	58.6	
	1030	+4.2	58.7	
	1104	+4.2	58.7	
	1330	+4.1	58.6	
	1444	+3.9	58.4	
	1605	+4.3	58.8	
	1720	+4.2	58.7	
	1852	+4.1	58.6	
7/24	1205	+3.5	58.0	
	1217	+4.0	58.5	
	1342	+3.6	58.1	
	1403	+4.2	58.7	
	1530	+3.8	58.3	
	1635	+3.9	58.4	
	1812	+3.7	58.2	
	1856	+3.7	58.2	
7/26	1442	+3.4	57.9	
	1550	+3.7	58.2	
	1657	+3.5	58.0	
	1704	+3.9	58.4	
	1811	+3.7	58.2	
	1839	+3.7	58.2	Power increased to +4.0
	2103	+4.2	58.7	
	2204	+4.2	58.7	
	2328	+4.0	58.5	

SUMMARY POWER OUTPUT LOG (Continued)

M-33 S-BAND 1978

Date (1978)	Time (CDT)	HP431C Power Reading (dBm)	Trans-mitter Power (dBm)	Comments
7/29	1914	+5.0	59.5	
	1915	+4.0	58.5	
	1926	+4.0	58.5	
7/30	1607	+3.8	58.3	
	1832	+4.0	58.5	

APPENDIX V

Radar Data Tape Inventory

SNYDER RADAR INVENTORY

MRI IN-HOUSE PRODUCTS

FIELD TAPE	-	Raw data direct from M-33 recorded at 1600 bpi on 9 tracks. 150 m range resolution
RAW TAPE	-	Same data as is on field tape but at 800 bpi on 9 tracks. 150 m range resolution
WORK TAPE	-	Output from program redit error correction routines with a raw tape as input. Data is in a modified A-file format recorded at 800 bpi on 9 tracks. 450 m range resolution

SNYDER RADAR INVENTORY - 1976
MRI IN-HOUSE PRODUCTS

Start		Stop		Field Tape	Raw Tapes	Work Tape
Date 1976	Time (CDT)	Date	Time (CDT)			
5/21	1711				M00286	W00642
		5/22	1835		M00287	W00642
5/25	1339	6/03	1733		M00294	W00643
6/03	1734	6/4	1738		M00295	W00644
7/10	1637	7/10	1853		M00292	W00654
7/10	1853	7/10	2008		M00293	W00660

SNYDER RADAR INVENTORY - 1977
MRI IN-HOUSE PRODUCTS

Start		Stop		Field Tape	Raw Tapes	Work Tape
Date 1977	Time (CDT)	Date	Time (CDT)			
6/01	0932	6/01	1126	R00516	R00369	W00449
6/01	1126	6/01	1155	R00517	R00527	W00661
6/01	1155	6/01	1630	R00374	R00383	W00661
6/01	1630	6/01	1957	R00374	R00384	W00663
6/08	1115	6/08	1230	R00377	R00389	W00662
6/09	1340	6/09	1843	R00375	R00385	W00666
6/09	1843	6/09	2154	R00375	R00386	W00701
6/09	2154	6/10	0120	R00376	R00387	W00702
6/10	0121	6/10	0149	R00376	R00388	W00702
6/11*	1412	6/11	1757	R00378	R00391	W00703
6/11*	1757	6/11	2043	R00378	R00392	W00703
6/11	2043	6/11		R00379	R00534	W00703
6/11		6/11	2320	R00379	R00535	W00703
6/11	2325	6/12	0025	R00380	R00395	W00703
6/12	0025	6/12	0103	R00380	R00396	W00703
6/12	0103	6/12	0144	R00381	R00397	W00704
6/12	0144	6/12	0207	R00381	R00398	W00705
6/20	2041	6/20	2253	R00412	R00419	W00499
6/20	2253	6/20	2346	R00412	R00418	W00497
6/20	2346	6/21	0000	R00413	R00543	W00707
6/21	0000	6/21	0051	R00413	R00544	W00707
6/21	0051	6/21	0127	R00414	R00422	W00707
6/21	0127	6/21	0152	R00414	R00423	W00707
6/21	0152	6/21	0250	R00415	R00424	W00707
6/21	0250	6/21	0336	R00415	R00425	W00708
6/21	1225	6/21		R00413	R00545	W00708
6/21		6/21	1930	R00473	R00546	W00708
6/21	1930	6/21		R00472	R00547	W00709
6/21		6/21	2214	R00472	R00548	W00709
6/21	2214			R00471	R00549	W00708
		6/22	0100	R00471	R00550	W00710
6/22	0100	6/22	0209	R00436	R00440	W00710
6/22	1102	6/22		R00470	R00551	W00711
6/22		6/22	1248	R00470	R00551	W00711
6/22	1248	6/22		R00469	R00552	W00711

* Tape unreadable

SNYDER RADAR INVENTORY - 1977
MRI IN-HOUSE PRODUCTS

Start		Stop		Field Tape	Raw Tapes	Work Tape
Date 1977	Time (CDT)	Date	Time (CDT)			
6/22		6/22	1727	R00469	R00553	W00711
6/22	1727	6/22		R00468	R00554	W00712
6/22		6/22	1950	R00468	R00555	W00712
6/22	1950	6/22		R00467	R00556	W00712
6/22		6/22	2257	R00467	R00557	W00713
6/22	2257	6/23	0031	R00463	R00558	W00713
6/23	1400	6/23		R00466	R00559	W00713
6/23		6/23	1553	R00466	R00560	W00714
6/23	1553	6/23		R00465	R00561	W00714
6/23		6/23	1730	R00465	R00562	W00714
6/23	1730	6/23		R00464	R00563	W00715
6/23		6/23	1930	R00464	R00564	W00715
6/23	1930	6/23		R00426	R00565	W00715
6/23		6/23	2112	R00426	R00566	W00716
6/24	1250	6/24		R00462	R00567	W00716
6/24		6/24	1800	R00462	R00568	W00716
6/24	1800	6/24		R00461	R00569	W00716
6/24		6/24	2100	R00461	R00570	W00717
6/24	2100	6/24		R00460	R00571	W00717
6/24		6/24	2230	R00460	R00572	W00718
6/24	2230	6/25	0000	R00459	R00573	W00719
6/25	0000	6/25		R00458	R00575	W00800
6/25		6/25	0155	R00458	R00576	W00800
6/25	1100	6/25		R00457	R00577	W00800
6/25		6/25	1500	R00457	R00578	W00801
6/25	1500	6/25		R00456	R00579	W00801
6/25		6/25	2000	R00456	R00580	W00801
6/25	2000	6/25		R00455	R00581	W00801
6/25		6/25	2200	R00455	R00582	W00801
6/25	2200	6/25		R00454	R00583	W00801
6/25		6/25	0000	R00454	R00584	W00801
6/26	0000	6/26		R00453	R00585	W00803
6/26		6/26	0155	R00453	R00586	W00803
6/26	1645	6/26		R00477	R00587	W00803
6/26		6/26	2000	R00477	R00588	W00803

SNYDER RADAR INVENTORY - 1977
MRI IN-HOUSE PRODUCTS

Start		Stop		Field Tape	Raw Tapes	Work Tape
Date 1977	Time (CDT)	Date	Time (CDT)			
6/26	2000	6/26	2100	R00478	R00589	W00720
6/27	1523	6/27	1733	R00452	R00590	W00720
6/27	1735	6/27	2345	R00452	R00591	W00721
6/28	2245	6/29	0111	R00448	R00597	W00722
6/30	1525	6/30	1751	R00437	R00442	W00723
6/30	1751	6/30	1902	R00437	R00443	W00724
6/30	1902	6/30	2019	R00438	R00444	W00724
6/30	2019	6/30	2113	R00438	R00445	W00724
6/30	2113	6/30	2238	R00439	R00446	W00445
6/30	2238	6/30	2319	R00439	R00447	W00446
7/07*	2009	7/07	2226	R00479	R00493	
7/07*	2226	7/07	2300	R00479	R00494	
7/08	0938	7/08	1126	R00480	R00495	W00677
7/08	1126	7/08	1215	R00480	R00496	W00691
7/08	1215	7/08	1303	R00481	R00498	W00691
7/08	1303	7/08	1335	R00481	R00499	W00691
7/08	1335	7/08	1433	R00482	R00500	W00691
7/08	1433	7/08	1459	R00482	R00501	W00691
7/08	1459	7/08	1528	R00483	R00502	W00691
7/08	1528	7/08	1550	R00483	R00503	W00691
7/08	1550	7/08	1623	R00484	R00504	W00691
7/08	1623	7/08	1648	R00484	R00505	W00725
7/08	1648	7/08	1726	R00485	R00506	W00725
7/08	1726	7/08	1754	R00485	R00507	W00725
7/08	1754	7/08	1826	R00486	R00508	W00725
7/08	1826	7/08	1923	R00486	R00509	W00725
7/08	1953	7/08	2033	R00487	R00510	W00726
7/09	1252	7/09	1501	R00488	R00513	W00677
7/09	1501	7/09	1601	R00488	R00514	W00677
7/09	1601	7/09	1714	R00489	R00598	W00677
7/09	1716	7/09	1806	R00489	R00599	W00677
7/09	1806	7/09	1957	R00490	R00600	W00677
7/09	1958	7/09	2055	R00490	R00601	W00677
7/10	1507	7/10	1721	R00491	R00522	Sphere
7/10	1721	7/10	1841	R00491	R00523	Sphere
7/12	1146	7/12	1210	R00492	R00524	Range

* Tape unreadable

SNYDER RADAR INVENTORY - 1978
MRI IN-HOUSE PRODUCTS

Start		Stop		Field Tape	Raw Tapes	Work Tape
Date 1978	Time (CDT)	Date	Time (CDT)			
6/02	0930	6/02		R00739	R00744	W00775
6/02		6/02	1045	R00739	R00745	W00775
6/02	1045	6/02		R00740	R00746	W00775
6/02		6/02	1210	R00740	R00747	W00775
6/02	1210	6/02	1350	R00741	R00748	W00776
6/02	1840	6/02		R00742	R00749	W00776
6/02		6/02	2110	R00742	R00750	W00777
6/02	2110	6/02	2150	R00754	R00841	W00777
6/05	1108	6/05		R00751	R00837	W00772
6/05		6/05	1822	R00751	R00838	W00773
6/05	1822	6/05		R00752	R00839	W00773
6/05		6/05	2056	R00752	R00840	W00774
6/05	2056	6/05	2150	R00753	R00840	W00774
6/06	0940	6/06		R00755	R00842	W00779
6/06		6/06	1150	R00755	R00843	W00784
6/06	1154	6/06		R00756	R00843	W00784
6/06	1430	6/06	1511	R00756	R00844	W00786
6/06	1516	6/06	1645	R00757	R00845	W00786
6/07	1705	6/07	1926	R00769	R00846	W00786
6/10		6/10		R00770		Sphere
6/13	1400	6/13		R00771	R00847	W00764
6/13		6/13	2020	R00771	R00848	W00764
6/28	1600	6/28	1800	R00773	R00849	W00766
6/29	1507	6/29	2124	R00774	R00789	W00767
6/30	1415	6/30	1420	R00775	R00850	W00748
6/30	1420	6/30		R00776	R00851	W00748
6/30		6/30	1713	R00776	R00852	W00748
6/30	1713	6/30		R00777	R00853	W00748
6/30		6/30	2108	R00777	R00854	W00748
7/01	1447	7/01		R00779	R00855	W00749
7/01		7/01	1910	R00779	R00856	W00750
7/02	1452	7/02	2050	R00780	R00857	W00768
7/03	1327	7/03		R00781	R00893	W00745
7/03		7/03	1727	R00781	R00894	W00745
7/03		7/03		R00782	R00894	W00745
7/03	1727	7/03	1810	R00783	R00858	W00745

SNYDER RADAR INVENTORY - 1978
MRI IN-HOUSE PRODUCTS

Start		Stop		Field Tape	Raw Tapes	Work Tape
Date 1978	Time (CDT)	Date	Time (CDT)			
7/03	1810	7/03		R00784	R00859	W00778
7/03		7/03	1920	R00784	R00860	W00746
7/03	1920	7/03	2047	R00785	R00861	W00746
7/03	1920	7/03		R00786	R00862	W00746
7/03		7/03	2055	R00786	R00863	W00746
7/03	2055	7/03		R00787	R00864	W00746
7/03		7/03	2255	R00787	R00865	W00747
7/03	2255	7/03	2359	R00788	R00866	W00747
7/20	1526	7/20	1830	R00819	R00874	W00763
7/22	1349	7/22	1455	R00820	R00875	W00750
7/22	1500	7/22		R00821	R00876	W00751
7/22		7/22	1654	R00821	R00877	W00751
7/22	1654	7/22	1700	R00811	R00867	W00750
7/22	1700	7/22	1834	R00822	R00877	W00751
7/22	1838	7/22		R00823	R00878	W00751
7/22		7/22	2025	R00823	R00879	W00879
7/23	0830	7/23		R00824	R00880	W00739
7/23		7/23	1400	R00824	R00881	W00739
7/23	1400	7/23	1403	R00812	R00868	W00750
7/23	1403	7/23	1550	R00825	R00882	W00739
7/23	1551	7/23	1554	R00813	R00869	W00750
7/23	1554	7/23		R00826	R00883	W00739
7/23		7/23	1713	R00826	R00884	W00740
7/23	1717	7/23		R00827	R00884	W00740
7/23		7/23	1825	R00827	R00885	W00740
7/23	1825	7/23		R00828	R00886	W00740
7/23		7/23	2040	R00828	R00887	W00740
7/23	2040	7/23	2055	R00829	R00888	W00740
7/24	1200	7/24		R00830	R00889	W00740
7/24		7/24	1800	R00830	R00890	W00765
7/24	1800	7/24	1930	R00814	R00870	W00765
7/26	1420	7/26		R00831	R00899	W00750
7/26		7/26	2020	R00831	R00900	W00752
7/26	2020	7/26		R00832	R00901	W00753
7/26		7/26	2320	R00832	R00902	W00753
7/26	2320	7/26	- - - -	R00833	R00903	W00754
7/26		7/27	0040	R00833	R00904	W00754

M-33 RADAR TAPE LOG
FROM A-7 RUN

Operational Day		Tape Number	Start Time	End Time
1976	5-21-76	0001	17:11:56	20:53:24
	5-22-76	0001	16:32:47	18:35:04
	5-25-76	"	13:39:25	15:50:56
	6-03-76	"	15:22:22	19:11:40
	6-04-76	"	14:44:09	17:39:11
	7-10-76	"	16:27:37	20:05:47
1977	6-01-77	0002	09:32:28	19:56:42
	6-08-77	"	11:16:15	12:29:48
	6-09-77	"	13:40:27	00:00:22
	6-10-77	"	00:00:22	01:49:20

Hereafter changed to run each operational day as one file per your request.

	6-11-77	RAD003	20:43:37	00:02:29
	6-12-77	RAD003-RAD004	00:02:29	03:09:32
	6-13-77	RAD004	23:47:51	00:00:31
	6-14-77	RAD004	00:00:31	01:25:51
	6-20-77	RAD004	23:46:26	00:02:15
	6-21-77	RAD004-RAD007	00:02:15	00:02:05
	6-22-77	RAD007-RAD008	00:02:05	22:57:22
	6-23-77	RAD008-RAD009	13:59:05	20:01:16
	6-24-77	RAD009-RAD010	12:43:43	00:04:16
	6-25-77	RAD011-RAD013	00:04:16	00:00:50
	6-26-77	RAD013	00:00:50	20:33:35
	6-27-77	RAD013-RAD014	15:23:55	23:47:45
	6-30-77	RAD014-RAD015	15:28:10	21:13:53
	7-08-77	RAD015-RAD017	09:42:18	20:33:14
	7-09-77	RAD017	12:53:10	20:50:54
1978	6-02-78	RAD018-RAD019	09:28:55	21:36:32
	6-05-78	RAD019-RAD020	11:04:45	21:49:46
	6-06-78	RAD021-RAD022	09:39:37	16:41:58
	6-07-78	RAD022-	17:02:23	19:21:13
	6-13-78	RAD022-RAD023	14:20:23	20:00:41
	6-28-78	RAD023-RAD024	16:01:47	18:05:49

M-33 RADAR TAPE LOG
FROM A-7 RUN
(Continued)

Operational Day		Tape Number	Start Time	End Time
1978	6-29-78	RAD023	15:05:51	21:22:06
	6-30-78	RAD023-RAD024	14:15:59	21:05:37
	7-01-78	RAD024	14:45:47	18:56:50
	7-02-78	RAD025	14:52:37	20:53:43
	7-03-78	RAD026	13:27:18	00:03:32
	7-15-78	RAD028	16:47:36	19:09:25
	7-22-78	RAD029	13:14:40	20:25:28
	7-23-78	RAD030	08:48:17	19:97:39
	7-24-78	RAD031	12:10:30	19:21:28
	7-26-78	RAD032	11:29:32	00:02:23
	7-27-78	RAD033	00:02:23	00:29:44

NOTE: There may be various time gaps between the actual start time and end time for each operational day.

APPENDIX VI

Antenna Sweep Report

DESCRIPTION OF THE ANTENNA SWEEP REPORT

The Antenna Sweep Report produced by A8 gives a concise idea of the magnitude of fixes performed on the data and how much data is really written. Every volume detected on input produces an entry in the Antenna Sweep Report, even though some volumes may be rejected.

File Number

At the top of every page the file number and file ID are listed. The file number is incremented every time a gap of 3∅ minutes or more is detected on output, and an "end of file" record is written. (The "end of file" record is a logical record with all fields set to zero and NEWVOL set to 1.) The file ID, in parentheses just after the file number, shows the start date and time of the file according to the UND conventions. When a new file is started, a new page is written on the Antenna Sweep Report so that the volumes listed are always for the file indicated at the top of the report. File ∅ (zero) indicates that no data has been written yet.

Rejected Volumes

Rejected volumes are indicated by the number of radials read, followed by the message "Volume Rejected." The cause of the reject can be determined from the error log.

Accepted Volumes

Volumes that are deemed good produce a longer listing in the Antenna Sweep Report. Sweep statistics are printed, followed by the volume summary.

Sweep Statistics

Every sweep detected produces one line of output. The tilt angel, base tilt, and elevation mode are computed from the input radials. The other entries in the sweep statistics are determined from the radials actually written to the output tape, and most of them are suppressed if no radials are written for the particular sweep.

Tilt

The tilt angle is determined by the mode average of the tilt angles of the input radials of a given sweep. All radials written have their tilt angles forced to the reported angle. The indicated tilt angle is listed in tenths of a degree. Thus, a tilt of 14 represents 1.4 degrees.

Start Date and Time

The start date and time is for the first radial written for the sweep. If no radials are written, this field is left blank. The format is a two digit year, the Julian day, hour, minutes, seconds Greenwich Mean Time.

End Date and Time

The end date and time is for the last radial written for the sweep. It is of the same format as the start date and time.

Start Azimuth

The start azimuth is the azimuth recorded on the first radial written for the current sweep. It is printed in tenths of a degree.

End Azimuth

The end azimuth is the azimuth of the last radial written for the current sweep. It, also, is printed in tenths of a degree.

Radials Written

The number of radials, or logical records, written for the current sweep is recorded in this field. The number of radials with data in the current sweep is equal to the number of radials actually written, except that the first radial of the first sweep is always written, even if it contains no data.

Bins With Data

The number of bins containing data is counted for each sweep and is printed so that the amount of data in a given sweep can be estimated.

Base Tilt

The base-angle tilt written on the radials is printed in tenths of a degree. The base-angle tilt is not the true base angle. Rather, the base-angle tilt recorded and printed represents the first tilt angle of the volume for a given elevation mode.

Elevation Mode

The elevation mode is displayed as recorded in the radial. (Thus, an elevation mode of 6 represents a tilt step of 1.5 degrees between sweeps, and an elevation mode of 2 represents a tilt step of 2.Ø degrees between sweeps.) For the first sweep of each volume, the elevation mode represents the tilt step between the first sweep and the second. For the following sweeps, the elevation mode is computed from the tilt step between the current sweep and the preceding sweep.

Volume Statistics

Since many of the corrections performed on the data occurs before A8 has located the sweeps, these corrections are summarized for the entire volume. Since some fixes occur "between" volumes, the statistics may reflect the transition between the current volume and either the preceding volume or following volume. Exactly where every correction is applied can be determined only by the error log.

Records Read

This is a count of total radials read since the last reported count of radials read. The count includes forward scanning to the next volume, and sometimes even includes the first several records of the next volume. However, records are counted only once, so this number is usually very close to the number of input records for the current volume.

Find Start of Volume

The percentage of records deleted from the end of the preceding volume to the recognized start of the current volume is printed. This number represents the percentage of input records that are transition radials between volumes.

Tilt Noise

The percentage of radials modified or deleted because of tilt noise is reported. The first number is the percentage of input radials deleted because of detected tilt noise. These radials could not be corrected because there were no good preceding radials in the file, or there were no good radials following the bad radials in the file, or the good radials following the bad radials could not be used because of time gaps, or limited data space. The second number represents the percentage of input radials that had their tilt angles corrected.

Azimuth Noise

The first number represents the percentage of input radials that were deleted because of detected azimuth noise. These were radials for which azimuth corrections could not be determined. The second number represents the percentage of input radials that had azimuth noise and were corrected.

Azimuth Shift

The bottom number listed under "Azimuth Shift" is the percentage of input radials for which an azimuth shift problem was detected. The azimuths on these radials were corrected by reshifting the azimuths. Sometimes after the azimuths were shifted, an overlap of azimuths is still present. The top number represents the percentage of the input radials where this condition was found and the overlapping radials were deleted.

Azimuth Groups Shifted

Since whole sectors of the sky are usually shifted, the number (not percentage) of sectors (or groups) of the sky shifted (bottom number) or deleted (top number) are reported.

Sweep Definitions

In defining the tilt of each sweep, two separate corrections are done. The first step is to truncate each sweep to one revolution by eliminating data from the start of the sweep. The first number is the percentage of input radials deleted so that each sweep contains no more than one revolution of data. The second correction is to force all tilt angles in the sweep to be the mode average of the tilt angles of the radials remaining in the sweep after the first correction. The second number is the percentage of input radials for which new tilt angles have been assigned to meet the sweep definitions. Typically, this number represents radials with tilt bounce and transitions between sweeps that were forced to be in a sweep.

Radials Written

The total number of radials written is recorded. This may be one more than the number of redials with data written since the first radial of the first sweep of every output volume is written, even if there is no data in the radial.

Percentage of Candidate Output Radials Suppressed

In the output section of the program, all null radials (i.e., radials with no data), except for the first radial of each volume, are suppressed from output. The number quoted is the percentage of radials that were presented to the output section that were not written because they had no data.

TILT	<----START-----> YY/DDD	HH:MM:SD	<-----END------> YY/DDD	HH:MM:SS	START AZ	END AZ	RADIALS WRITTEN	BINS WITH DATA	BASE TILT	ELMODE
14	76/142	22:38:50	76/142	22:39:15	650	3530	108	2780	14	6
29	76/142	22:39:29	76/142	22:39:50	1370	260	90	2530	14	6
43	76/142	22:40: 3	76/142	22:40:29	1470	180	60	1771	14	6
59	76/142	22:40:37	76/142	22:40:46	10	640	43	954	14	6
73	76/142	22:41:10	76/142	22:41:30	1490	100	30	352	14	6
88	76/142	22:41:43	76/142	22:41:49	1520	1590	8	49	14	6

* * VOLUME SUMMARY * * RECORDS READ= 448

	FIND START OF VOL	TILT NOISE	AZ NOISE	AZ SHIFT	(AZ GROUPS SHIFTED)	SWEEP DEF	DESCRIPTION OF SWEEP DEF MOD.
% INPUT DELETED	1.3	.0	.2	.0	0	.0	(MULT ROTATION/SWP)
% INPUT MODIFIED		1.6	.0	12.3	1	6.2	(NEW TILT ANGLES)

RADIALS WRITTEN= 339 % CANDIDATE OUTPUT RADIALS SUPPRESSED (NULL)= 1.2

****

TILT	<----START-----> YY/DDD	HH:MM:SD	<-----END------> YY/DDD	HH:MM:SS	START AZ	END AZ	RADIALS WRITTEN	BINS WITH DATA	BASE TILT	ELMODE
14	76/142	22:45:38	76/142	22:45:59	1300	40	117	3281	14	6
29	76/142	22:46:12	76/142	22:46:39	1380	360	91	2839	14	6
44	76/142	22:46:43	76/142	22:47: 3	1190	3250	68	2123	14	6
58	76/142	22:47:19	76/142	22:47:27	3580	630	51	777	14	6
73	76/142	22:47:56	76/142	22:48:30	1530	1520	24	233	14	6

* * VOLUME SUMMARY * * RECORDS READ= 479

	FIND START OF VOL	TILT NOISE	AZ NOISE	AZ SHIFT	(AZ GROUPS SHIFTED)	SWEEP DEF	DESCRIPTION OF SWEEP DEF MOD.
% INPUT DELETED	1.5	.0	.0	.0	0	1.5	(MULT ROTATION/SWP)
% INPUT MODIFIED		4.0	.0	13.4	1	9.9	(NEW TILT ANGLES)

RADIALS WRITTEN= 351 % CANDIDATE OUTPUT RADIALS SUPPRESSED (NULL)= 1.4

****

APPENDIX VII

Logical Units Used by A-8

LOGICAL UNITS USED BY A8

Logical Unit*	Internal Variable	Input or Output	Description
0 and 5	LUO**	O	EXPAND and COMPRS messages.
1	LUI**	1	EXPAND input file. This must be a tape drive since A8 keeps on reading data until two consecutive EOF's are encountered. (A8 does not recognize a ZEROES*** record as an EOF.) A8 expects to read tapes produced by A7 at MRI on this unit.
2	LUP**	O	COMPRS output file. This file contains the corrected data that should be acceptable to the UND statistical programs. A ZEROES record is written at the end of every "logical" file, and the EOF request to COMPRS is issued only at the end of program execution.
5	LUD	O	Console (terminal) list unit to track program progress and file cre-tions. Approximately six lines of output are produced for every good volume, and four lines for every rejected volume.
6	LUO	O	Error log. This is a list of run parameters, followed by a detail

Logical Unit*	Internal Variable	Input or Output	Description
			list of errors and corrections actually made. The file is formatted for line printer output. Test runs indicate that approximately 130 pages of output can be expected for a full 2400-foot tape of data.
7	LUP	O	Antenna Sweep Report. This is a summary report of data read, corrected, and written for every volume. This file is also formatted for line printer output. Test runs indicate that approximately 90 pages of output can be expected for a full 2400-foot tape of data.
8	LUQ	I and O	Scratch File. This file is temporary storage area of data. The records are fixed length, 282 words (or 1128 bytes, the size of RADCOM), and may contain a maximum of 6000 records. This file is used as a temporary area for saving "look-ahead" data between volumes and when the start of a volume is detected. Test runs indicate that a maximum of 50 records are ever written to this file, but possible pathological cases may

Logical Unit*	Internal Variable	Input or Output	Description
			dramatically increase this number. (Allocating room for 6000 records is recommended.)
9	LUS	I and O	Main Scratch File. Data for an entire volume is temprarily stored in this file. The records are all fixed length at 282 words (or 1128 butes, the size of RADCOM), for a maximum of 6000 records.

*At MRI, the logical units are assigned in the run command. At UND, the logical units are coded in SUBROUTINE LUIOP.

**The UND versions of EXPAND and COMPRS have the logical units coded in the subroutines themselves, making the assignment of variables LUI and LUP unnecessary. At MRI, the EXPAND and COMPRS routines use variables LUI, LUO, and LUP for the purposes indicated.

***A ZEROES Record is a logical record with all fields zero, except for the new volume flag, which is set at 1.

APPENDIX VIII

Daily Calibration Summary

SNYDER M-33

1976 S-BAND RADAR CALIBRATION SUMMARY

The calibration is in the form of a linear equation of the form

$$F\ (DVIP) = A + B_1 * DVIP + B_2 * DVIP^2 + B_3 * DVIP^3$$

$$B_2 = B_3 = 0$$

The coefficients are given below

Date (1976)	A	B_1	B_2 ($\times 10^{-2}$)	B_3 ($\times 10^{-5}$)
All of 1976	-104.68	+0.392		

M-33 S-BAND RADAR

1977 Daily Calibration Equations

$$F(DVIP) = A + B_1 *DVIP + B_2 *DVIP + B_3 *DVIP^3$$

$$B_2 = B_3 = 0$$

Date	Time (CDT)	A	B_1
6/8	1222	-108.9	0.4249
6/10	0140	-110.0	0.4294
6/22	0203	-107.9	0.4365
6/23*	1416	-109.0	0.4233
6/23	2115	-109.3	0.4247
6/24	1258	-109.4	0.4297
6/25	0118	-109.4	0.4235
6/25	1334	-108.3	0.4138
6/26	0146	-110.7	0.4261
6/26	1658	-109.2	0.4306
6/26	2043	-109.8	0.4288
6/28	2251	-107.7	0.4285
6/30	2247	-106.1	0.4200
7/7*	2042	-106.6	0.4131
7/8	0957	-105.9	0.4061
7/8	2026	-111.9	0.4377
7/9	2044	-107.7	0.4200

*Combined calculations

M-33 S-BAND RADAR

1978 Daily Calibration Equations

$$F(DVIP) = A + B_1 *DVIP + B_2 *DVIP^2 + B_3 *DVIP^3$$

$$B_2 = B_3 = 0$$

Date	Time (CDT)	A	B_1
6/2	1038	-112.8	0.4114
6/2	2128	-114.6	0.4196
6/5	2126	-118.1	0.4170
6/6	1224	-109.5	0.4306
6/7	1917	-110.5	0.3948
6/10	1200	-111.5	0.4210
6/10	1424	-109.2	0.4167
6/30	2059	-110.7	0.4272
7/1	1859	-109.7	0.4222
7/2	2046	-109.6	0.4208
7/3	2355	-110.3	0.4196
7/20	1828	-109.6	0.4399
7/23	2050	-110.4	0.4207
7/24	1924	-110.9	0.4308
7/29	2043	-111.2	0.4313

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1977 S-BAND RADAR CALIBRATION SUMMARY

All calibrations are in the form of a cubic equation of the form

$$F\ (DVIP) = A + B_1 * DVIP + B_2 * DVIP^2 + B_3 * DVIP^3$$

The coefficients are given below

Date (1977)	Time (CDT)	A	B_1	B_2 ($\times 10^{-2}$)	B_3 ($\times 10^{-5}$)
6/08	12:22	-151.1	+2.021	-1.941	+ 7.633
6/10	01:40	-138.9	+1.489	-1.238	+ 4.646
6/22	02:03	-157.6	+2.485	-2.663	+11.05
6/23	14:15	-138.4	+1.604	-1.498	+ 6.078
6/23	14:17	-143.0	+1.785	-1.722	+ 6.943*
6/23	21:15	-142.2	+1.733	-1.645	+ 6.611
6/24	12:58	-147.3	+1.970	-1.973	+ 8.059
6/25	01:19	-133.1	+1.321	-1.087	+ 4.247*
6/25	13:35	-145.3	+1.870	-1.828	+ 7.376*
6/26	01:47	-150.9	+1.959	-1.850	+ 7.139
6/26	16:58	-148.3	+2.010	-2.029	+ 8.342
6/26	20.43	-150.5	+2.044	-2.023	+ 8.069
6/28	22:51	-141.2	+1.779	-1.695	+ 6.715
6/30	22:47	-148.1	+2.188	-2.361	+10.09
7/07	20:42	-147.3	+2.102	-2.200	+ 9.142
7/07	22:42	-132.8	+1.418	-1.248	+ 4.998
7/08	09:57	-152.3	+2.244	-2.325	+ 9.440
7/08	20:26	-156.0	+2.059	-1.882	+ 6.943
7/09	20:45	-146.2	2.016	-2.077	+ 8.589*

* Sent 7/02/79

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1978 S-BAND RADAR CALIBRATION SUMMARY

All calibrations are in the form of a cubic equation of the form

$$F\ (DVIP) = A + B_1 * DVIP + B_2 * DVIP^2 + B_3 * DVIP^3$$

The coefficients are given below

Date (1978)	Time (CDT)	A	B_1	B_2 ($\times 10^{-2}$)	B_3 ($\times 10^{-4}$)	Comments
6/02	10:38	-205.4	3.428	-3.169	1.079	
6/02	21:28	-203.7	3.301	-2.998	1.009	
6/02	--	-202.8	3.298	-3.004	1.013	Combined
6/05	21:26	-208.9	3.216	-2.777	0.8915	
6/06	12:24	-173.3	3.033	-3.369	1.394	
6/07	19:17	-168.2	2.439	-2.302	0.8312	
6/10	12:00	-140.3	1.478	-1.240	0.4677	
6/10	14:24	-150.3	1.965	-1.865	0.7229	Not used
6/30	20:59	-185.5	3.218	-3.324	1.272	
7/01	18:59	-190.8	3.631	-4.025	1.615	
7/02	20:46	-177.5	3.064	-3.274	1.299	
7/03	23:55	-172.9	2.761	-2.792	1.068	
7/20	18:28	-176.6	3.098	-3.317	1.318	
7/23	20:50	-166.4	2.534	-2.538	0.9768	
7/24	19:24	-170.5	2.755	-2.871	1.134	
7/29	20:43	-171.7	2.765	-2.857	1.119	