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THE NATIONAL AFOS-ERA VERIFICATION DATA PROCESSING SYSTEM

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1. INTRODUCTION

The AFOS-era Verification (AEV) data processing system is the new method for collecting, archiving, and summarizing weather observations, local forecasts, and Model Output Statistics (MOS) guidance (Glahn and Lowry, 1972). Public and aviation forecasts, and the corresponding observations, are now transmitted from Weather Service Forecast Offices (WSFO's) directly to the National Meteorological Center (NMC) via AFOS. In the previous system, public and aviation weather forecasts were coded on mark-sense cards which were sent to Weather Service Headquarters for further processing.

The AEV processing system became operational in October 1983. This system consists of three steps: the archiving of data sent from the WSFO's, quality control of these data, and production of summary reports of verification scores. Summary reports are produced at the end of each 6-mo season or as desired. Scores are provided at the national, regional, and local levels and are defined in the National Verification Plan (NVP) (National Weather Service, 1982).

2. DATA ARCHIVING

A. Data Collection Activities

The AEV data processing system begins with the collection of data at NMC. The verification data are transmitted in ASCII format from the WSFO's (Miller et al., 1984) and are stored by the IBM 4341 computer system located in Suitland, Md. Every 3 hours (0245, 0545, ..., 2345 GMT) the data are dumped to a circular disk file (NWS.NMC.PROD.RAWDTA.VERAFO) which is available to the NAS 9000 series computers. The data are in the form of EBCDIC character strings. Twice a day, at approximately 0000 and 1200 GMT, the data are read from the circular file, decoded and written as a binary message to one of the following 20 rotating disk files: OSD.PROD.ARCxxdd.STORAFO, where xx=00 or 12 and dd=01, 02, ..., 10. All new data which were received since the last run are gathered from the circular file and written in 102-word messages on the rotating files. Each verification message contains the call letters of the station, the year, month, day, and cycle that the forecast was produced, the forecast and observed data in coded form, and the time that the data were transmitted to the circular disk file. These station data are not in any particular order on the rotating files. They are simply written to the files in the same order as they are received from the WSFO's. The date and hour that the data are written to the circular file at NMC is normally 10 to 12 cycles later than the time at which the forecasts were produced.

Every 10 days the data on one rotating file are overwritten, so once a week a computer job is run to write the data to magnetic tape. This program reads only the rotating files that were written since the last run of the job, discards duplicate data, and writes data to tape in a new format.

B. Archive Format

The verification data are permanently archived on a series of magnetic tapes. These are 9-track tapes written in 6250 bpi density. Each tape contains one or more files of data. A file contains data for one 6-mo verification period of October-March or April-September. The format is shown in Fig. 1.

Currently, each of the 47 WSFO's listed in Table 1 transmits data for two stations, itself and one Weather Service Office (WSO). The archiving system is flexible in that stations may be added or dropped. Generally, if stations are changed, it is done at the end of a month, and usually only the WSO's change.

C. Weather Elements

Both local (official) and MOS guidance forecasts and the corresponding observations are archived for the public and aviation weather elements. These elements are maximum/minimum (max/min) temperature, probability of precipitation (PoP), precipitation type (PoPT), snow amount, wind direction, wind speed, cloud amount, ceiling height, and visibility. The forecast categories and valid times, summarized by general type of weather element are:

- Max/Min Temperature - The local max (min) forecast is valid for the daytime (nighttime) hours. The MOS forecast is a calendar day forecast. Two types of observations are archived. The first is a calendar day max (min) reported at 1200 (0600) GMT, while the second is a daytime max (nighttime min).

- PoP - Both the local and MOS forecasts are valid for 12-h periods ending at taus of 24, 36, and 48 hours.

- Precipitation Amount - The observed precipitation amount is for a 12-h period. For the 0000 (1200) GMT cycle, the 12-h amount is the sum of the two 6-h amounts reported at 1800 and 0000 GMT (0600 and 1200 GMT).

- Precipitation Type - The local and MOS forecasts are conditional on occurrence of precipitation. Both are categorical forecasts. Possible values are 1, 2, or 3 where:

  1 = freezing (ZL, ZR),
  2 = frozen (IC, IF, IPW, S, SG, SP, SW), and
  3 = liquid (L, R, RW).

  Two types of observations are archived. The first is the observed type(s) at the verifying hour, and the second is the observed type(s) reported in routine and special observations in a 2-h window ($\pm$ 1 hour) about the verifying hour.

  When the verification data are received from the WSFO's, each of the two types of observations is encoded as a 3-digit number, xyz, where:

  x = 0 if no freezing precipitation occurred,
  = 1 if freezing precipitation occurred,

y = 0 if no frozen precipitation occurred,
= 2 if frozen precipitation occurred,
z = 0 if no liquid precipitation occurred, and
= 3 if liquid precipitation occurred.

Since more than one precipitation type can occur simultaneously, three separate records in the central archive are needed to save the precipitation type observations. Each precipitation type observation is divided into 3 categories, and each category is archived as a separate record. Category 1 corresponds to freezing; category 2, to frozen; and category 3, to liquid. The occurrence or nonoccurrence of a particular category is indicated by a value of 1 or 0, respectively.

- Snow Amount - The local forecast and observed values are inches of snow for the 12-h period ending 24 hours after 0000 or 1200 GMT. The observed amount for the 0000 (1200) GMT cycle is the sum of the two 6-h amounts reported at 1800 and 0000 GMT (0600 and 1200 GMT). The MOS forecast is a categorical forecast for the same 12-h period. The categories are defined as follows:

  0 = $\leq$ 1 inch,
  2 = 2-3 inches,
  4 = 4-5 inches, and
  6 = $\geq$6 inches.

- Wind Direction - The local and MOS forecasts and verifying observations are sent from the WSFO's in tens of degrees and archived to the nearest 10°.

- Wind Speed - The 12-, 18-, and 24-h local and MOS forecasts and verifying observations are in knots. If the speed exceeds 100 knots, the tens and units digits are given and 50 is added to the direction. Two types of observations are archived: the first is the observed speed at the verifying time, and the second is the highest sustained wind speed in a 6-h window ($\pm$ 3 hours) about the verifying hour.

  The 42-h local forecast is a yes/no forecast of wind speed greater than 22 knots. The MOS forecast is an ordinary forecast of wind speed, and the observation is in the same form as for the other projections.

- Cloud Amount - Local forecasts, MOS guidance, and the observed cloud amounts are categorical. The categories are defined as follows:

  1 = CLR,-X,-SCT,-BKN,-OVC,
  2 = SCT,
  3 = BKN, and
  4 = OVC,X.

- Ceiling height - Both the local forecast and the observed ceiling height are in hundreds of feet. The "persistence forecast" is the 0900

(2100) GMT observation for the 0000 (1200) GMT cycle, and is also in hundreds of feet. The MOS forecast is categorical, where:

1 = 0-100 ft,
2 = 200-400 ft,
3 = 500-900 ft,
4 = 1000-2900 ft,
5 = 3000-7500 ft, and
6 = > 7500 ft.

- Visibility - The local forecast is sent from the WSFO's as a two-digit number, in which the first digit is whole miles and the second is quarters of miles. The local forecast is archived as a decimal value of miles to the nearest hundredth. The observed visibility, in hundredths of miles when transmitted from the WSFO, is archived as a decimal. The "persistence forecast" is the 0900 (2100) GMT observation for the 0000 (1200) GMT cycle and is archived in the same manner as the verifying observation. The MOS guidance is categorical, with the following values:

  1 = < 1/2 mi,
  2 = 1/2 - 7/8 mi,
  3 = 1 - 2 3/4 mi,
  4 = 3 - 4 mi,
  5 = 5 - 6 mi, and
  6 = > 6 mi.

Every week the raw AEV data which are received from the WSFO's are archived on magnetic tape. Table 2 shows the identification codes, data categories, and projections of the weather elements in the central archive. The table also indicates the difference between the units in which the data are received at NMC and the units in which they are archived. Before any verification scores are calculated, the data are checked for accuracy.

3. QUALITY CONTROL

At the local level, data are quality controlled by the forecaster before transmission to NMC. Ideally, error-free matched sets of forecasts and observations should be received at NMC. Nevertheless, automated quality control is performed on the archived data before it is verified for two reasons: the first is to provide a list of stations which are having problems running the local programs, and the second is to assure that the verification scores are produced from accurate data.

The quality control program (MOS OP NO. 166 in Glahn et al., 1975) is run at the end of each month. The current month's raw data are read from the central archive tape, passed through the basic data checks listed in Table 3, and written to a disk data set (DSN=NWS.SDO.TDL.HG.NWSVER.DATA). The raw data on the archive tapes remain as is (i.e., not quality controlled). The new data set contains data for a period of 1 to 6 months, only for the current season. Each time the program is run, data are added (DISP=MOD) to the data set. The format of the new data set is exactly the same as that of the archive tape.

Output from the quality control program consists of messages which indentify erroneous data, as well as overall summaries of the receipt of data. Fig. 2 is an example of the output containing the messages describing questionable data. Fig. 3 shows a sample of the data summary for a WSFO and its corresponding WSO.

At the end of the 6-mo season, the guidance forecasts in the quality controlled data set are compared to forecasts from the Techniques Development Laboratory (TDL) routine archive of MOS forecasts. If the forecasts are not equal, the MOS guidance in the quality controlled verification data set are set to missing (9999.). The data are then written to a disk data set (DSN=NWS.SDO.TDL.HG.NWSVER.EDIT). The format of this data set is the same as that of the previous data set. After the data have been checked for gross errors, and have been compared to forecasts from TDL's archive of MOS guidance, they are ready to be used as input for the next step in which the desired data are selected for processing.

4. VERIFICATION PROCESSING

A. Selecting the Data

Since the quality controlled verification data set contains many types of forecasts, the desired data must be extracted. This is done using the documented TDL software, M660, which is described in TDL Office Note 75-2, MOS OP NO. 90 (Glahn et al., 1975). This FORTRAN program selects data for the desired stations, dates, and variables; collates the data; and writes it to an output data set. In general, the M660 software is used to extract data for about 100 stations for a 6-mo season. All elements are verified separately with the exception of max/min temperature and PoP. The data for a given element would include the observed value, the local forecast, the MOS guidance, and possibly a persistence forecast.

Other sources of data may also be used. Data sets containing the climatic precipitation frequency or experimental guidance forecasts, as well as from various other sources, may be accessed and collated with the archived verification data. In general, the source of experimental forecasts is a tape prepared by another TDL program, M701, which is described in TDL Office Note 75-2, MOS OP NO. 47. The source of climatic precipitation frequency data is a catalogued data set (DSN=NWS.W423.GM.POPCON). This is a random access file of the same general format as the TDL constant file described in TDL Office Note 74-14, Chapter XIII (Glahn, 1974). The documented TDL subroutine RDCON, described in TDL Office Note 75-2, MOS OP NO. 93, is used to read the precipitation frequency data. This data set contains monthly climatic precipitation frequencies for each station, based on 15 years of data (Jorgensen, 1967). The frequencies correspond to 12-h periods (0000-1200 GMT and 1200-2400 GMT). The data ID information is given in Table 4.

Once the desired data are gathered from the appropriate sources, they are written to an output data set. Fig. 4 shows the format of the output data set. This format is not that needed by the verification program, so an additional step to reformat the data is necessary before computing the verification summary statistics.

B. Reformatting the Data

The reformatting step is needed in order to rearrange the data for use by the verification programs. The verification programs, which make use of the Statistical Analysis System (SAS Institute, 1982), require input in a form which is different from the M660 output format. The reformatting program reads one record of input (which contains data that are valid for one date and cycle, for all stations), rearranges the data, and writes the reformatted data to another data set. This is repeated until all data for the desired period are reformatted. The data are rearranged so that each output record contains data for only one station for each date and projection. Fig. 5 shows the format of the output data set. Each data record contains N+3 words, where N depends on the element being verified. Table 1 of Appendix I shows the number of words of variable data (N above) per record, and the order in which the output data must appear for each element. Experimental data are always included in the output data set, even if no experimental forecasts are to be verified. The experimental forecast values are automatically set equal to 9999. by the program if they are not desired. The procedure for running the reformatting program is described in detail in Appendix I. Once the desired data are reformatted, they are ready to be used as input to the SAS verification programs.

C. Score Calculation and Summary Reports

The reformatted data are used as input to the final step in which scores are calculated and reports are printed. This step makes use of SAS to calculate verification scores for the desired element and prints the results in summary reports. These summary reports are produced for each station, region, and the nation. Some examples of the reports are given for various weather elements in Figs. 6-12. The scores for each element, as defined in the NVP, are given in Appendix II. Also included in this appendix are the definitions of the categorical MOS forecasts.

A separate SAS program is used to verify each element. The SAS programs are located on a catalogued data set with DSN=W.NWS.W42.VD.SASPRG. This is a partitioned data set whose members are the SAS programs. The names of the members are: VERFCIG, VERFCLD, VERFPOPT, VERFPOSA, VERFTMPC, VERFVIS, VERFWDIR, and VERFWSPD. In the SAS step, a DDNAME of SYSIN is required to reference the source program.

In addition to the reformatted verification data, the SAS programs require as input a list of stations to be verified. Due to the inconvenience of using card input, the SAS programs read the data from an external source, which in this case is a disk data set. An on-line disk data set (either on TSODA or SYSDB), which is in card image form, has the advantages of being both eye-readable and editable. The most important advantage in using this form of data input is that the input "cards" are not physically inserted into the source code, which is how SAS requires card input.

The station list consists of three items of information per station: the station WBAN number, the first letter of the NWS region in which the station is located, and the station call letters. Any number of stations, up to six, may appear on a "card." Fig. 13 describes the format of the station list data set. The data set is in card image form; therefore, the data set characteristics

are: LRECL=80, BLKSIZE=6400, and RECFM=FB. The DDNAME of this data set must be INSTA. The data set must be unnumbered otherwise the line numbers will be read in as station information. Usually the user will know that this is the case when the program writes a message that the variables have been defined as one type and the data are of the wrong type.

Besides the station list, some other variable information is needed. This information consists of: the first and last dates of the desired verification period, a code which determines the types of forecasts to compare, the projections of the forecasts, a code which indicates the destination of the verification reports, and a code which indicates if the scores are to be saved. Figure 14 describes the order in which the information must appear and the definition of the coded variables. This information is provided at the time that the verification program is invoked. The SAS statement which contains the information is concatenated onto the SAS source code. This statement is similar to a FORTRAN subroutine call. It is essentially the invocation of the macro and initialization of the variables. The following is an example of some of the DD statements used to run the SAS verification program for max/min temperature and PoP:

```
//SYSIN DD DSN=W.NWS.W42.VD.SASPRG(VERFTMPC),DISP=SHR
//      DD *
//      %VERFTMPC(840401,840930,1,1,24,36,48,60,FT20F001,NA)
```

The DD cards indicate that the SAS source code for the verification of max/min temperature and PoP is found in member VERFTMPC of the data set W.NWS.W42.VD.SASPRG. The macro is invoked (called) by the statement which begins %VERFTMPC. The variable information is also initialized in this statement. In this example, the verification period is April 1, 1984-September 30, 1984; the Local and MOS forecasts are to be verified for the projections of 24, 36, 48 and 60 hours; the verification reports are written to an output data set; and the scores are not saved for further processing.

Information which is common to all of the SAS verification programs is stored in a SAS format library. A SAS format library is a partitioned data set whose members are user-defined "formats." A format is generally used to change the appearance or value of a variable. One such format used in the verification programs equates each station WBAN number with the station's name. When a station's name is to be printed in a title, for example, the WBAN number is converted to a 20-character name.

The user-defined formats required by the verification programs are stored in a partitioned data set (DSN=W.NWS.W42.VD.SASFMT). This data set currently consists of five members: NAMEFMT, $REGFMT, REGNFMT, WSFOFMT, MNTHFMT. The first format equates station WBAN numbers with 20-character station names. The second, $REGFMT, equates the first letter of the region in which the station is located with the region's printed name, while REGNFMT equates a numeric code for each region with the region's printed name. WSFOFMT equates the station WBAN number with the WSFO to which it belongs. The last format, MNTHFMT, equates the number of the month to the name of the month. Since these formats are used in each of the verification programs, each program must contain these format definitions within the source code. For efficiency, these formats have all been stored in a format library. In order to use the contents of the

format library, a DD card describing the data set must be included in the JCL of the SAS step. The DDNAME for this data set MUST be SASLIB. This is required by SAS.

The verification summary results may be printed on paper or recorded on microfiche. If the reports are to be printed on paper, the FT20F001 DD card is omitted from the JCL. If microfiche output is desired, a DD card naming a data set in which to send the output must be included in the JCL. The attributes of this data set are those of a printed page: LRECL=137, BLKSIZE=2000, RECFM=VBA. The DDNAME of the file is FT20F001 with DISP=MOD. This is a temporary disk data set (SYSDA) into which the output reports are written.

Another step, to write the output reports to magnetic tape for further processing, consists of executing the documented FR80 procedure MICFICHE (National Oceanic and Atmospheric Administration, 1978). This step must immediately follow the SAS step in which the summary reports are produced. An additional procedure in which the actual microfiche is produced may be executed as the final job step or may be executed separately at a later time. This is a documented FR80 procedure called WRTMIC.

Finally, the scores may be written to an output data set to be saved for further processing. If this option is desired, a DD card describing the output data set must be included in the JCL. The DDNAME must be SCORARCH. The data set characteristics should not be defined by the user since SAS automatically determines the characteristics. The resulting data set is in a form which only SAS can read. Although this appears to be a disadvantage, subsequent data retrieval is very easy since the data format is already internally defined by SAS. If the score archiving option is not desired, this extra DD card is omitted.

5. SUMMARY

This report summarizes the three steps which comprise the AEV data processing system: data archiving, quality control, and verification processing. These new procedures which make use of the Statistical Analysis System are an improvement over the previous method of verification data processing in terms of providing timely reports to forecasters and managers. The processing of data and preparation of summary reports now is completed roughly 4 months earlier than was the case for the old system.

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Table 1. Forty-seven WSFO's participating in AEV.

Portland, ME	PWM	Boston, MA	BOS
*New York-Laguardia, NY	LGA	Albany, NY	ALB
Buffalo, NY	BUF	Philadelphia, PA	PHL
Pittsburgh, PA	PIT	*Washington-National, DC	DCA
Charleston, WV	CRW	Raleigh, NC	RDU
Columbia, SC	CAE	Atlanta, GA	ATL
Miami, FL	MIA	Birmingham, AL	BHM
Jackson, MS	JAN	Memphis, TN	MEM
Louisville, KY	SDF	Cleveland, OH	CLE
*Detroit, MI	DTW	Milwaukee, WI	MKE
Indianapolis, IN	IND	*Chicago-Ohare, IL	ORD
Minneapolis, MN	MSP	Des Moines, IA	DSM
St. Louis, MO	STL	Little Rock, AR	LIT
New Orleans, LA	MSY	San Antonio, TX	SAT
Dallas-Fort Worth, TX	DFW	Lubbock, TX	LBB
Oklahoma City, OK	OKC	Topeka, KS	TOP
Omaha, NE	OMA	Sioux Falls, SD	FSD
Bismarck, ND	BIS	Great Falls, MT	GTF
Cheyenne, WY	CYS	Denver, CO	DEN
Albuquerque, NM	ABQ	Phoenix, AZ	PHX
Salt Lake City, UT	SLC	Boise, ID	BOI
Reno, NV	RNO	Los Angeles, CA	LAX
San Francisco, CA	SFO	Portland, OR	PDX
Seattle, WA	SEA		

* These stations are WSO's.

Table 2. Weather elements and corresponding data identification codes in the central archive. The projections archived, the units in which the data are received, and the units in which they are archived are also indicated.

Weather Element	Type of Data	Data ID	Data Category	Projections	Units (WSFO)	Units (Archive)
Max temp	MOS forecast	2000	1	24,36,48,60	°F+100	°F
	Local forecast	2050	1	24,36,48,60	°F+100	°F
	Calendar day Max Ob	2080	1	24,36,48,60	°F+100	°F
	Daytime Max Ob	2090	1	24,36,48,60	°F+100	°F
Min temp	MOS forecast	2100	1	24,36,48,60	°F+100	°F
	Local forecast	2150	1	24,36,48,60	°F+100	°F
	Calendar day Min Ob	2180	1	24,36,48,60	°F+100	°F
	Nighttime Min Ob	2190	1	24,36,48,60	°F+100	°F
PoP	MOS forecast	6100	1	24,36,48	%	%/100
	Local forecast	6150	1	24,36,48	%	%/100
Precip Amt	Ob	6190	1	24,36,48	hundredths of inches (1.50 in = 150) trace = -2	inches to nearest hundredth (1.50 in = 1.50) trace = .004
Precip Type	MOS forecast	4000	1	18,30,42	category	category
	Local forecast	4050	1	18,30,42	category	category
	Ob at verifying time	4080	1,2,3	18,30,42	3-digit code	binary
	Ob for 2-h window	4090	1,2,3	18,30,42	3-digit code	binary
Snow Amt	MOS forecast	4300	1	24	category	category
	Local forecast	4350	1	24	inches	inches
	Ob	4390	1	24	inches	inches
Wind dir	MOS forecast	5500	1	12,18,24,42	tens of degrees	degrees
	Local forecast	5550	1	12,18,24,42	tens of degrees	degrees
	Ob (verif hr)	5590	1	12,18,24,42	tens of degrees	degrees
Wind speed	MOS forecast	5000	1	12,18,30,42	kt	kt
	Local forecast	5050	1	12,18,30,42	kt	kt
	Ob at verifying hour	5080	1	12,18,30,42	kt	kt
	Ob for 6-h window	5090	1	12,18,30,42	kt	kt

Table 2. (Continued).

Weather Element	Type of Data	Data ID	Data Category	Projections	Units (WSFO)	Units (Archive)
Cloud Amt	MOS forecast	8000	1	12,18,24	category	category
	Local forecast	8050	1	12,18,24	category	category
	Ob	8090	1	12,18,24	category	category
Ceiling	MOS forecast	1000	1	12,15,18,24	category	category
	Local forecast	1050	1	12,15,18,24	hundreds of ft 96=above 9000 ft	hundreds of ft 96=above 9000 ft
	Persistence forecast	1070	1	9	97=unlimited hundreds of ft	888=unlimited hundreds of ft
	Ob	1090	1	12,15,18,24	hundreds of ft	hundreds of ft
Visibility	MOS forecast	1500	1	12,15,18,24	category	category
	Local forecast	1550	1	12,15,18,24	miles and quarters 80 = > 7 mi (2 1/2 mi = 22)	decimal value of mi to the nearest hundredth 80 = > 7 mi (2 1/2 mi = 2.50)
	Persistence forecast	1570	1	9	hundredths of mi 800 = > 7 mi	decimal value of miles to the nearest hundredth 800 = > 7 mi
	Ob	1590	1	12,15,18,24	hundredths of mi	mi to nearest hundredth

Table 3. Basic quality control checks for each element. Note, a value of 9999 indicates the datum is missing. To "9-out" something means to set that value to 9999.

CHECKS BEING MADE IN AFOS-ERA VERIFICATION DATA EDITING PROGRAM	IF PROBLEM OCCURS, PROGRAM WILL FLAG AND:
Illegal ceiling value reported	
MOS values must be between 1 and 6	9-out ceiling
Local, persistence, and verifying observations values must be greater than or equal to 0, but can not exceed 90 unless they equal 96 or 888	9-out ceiling
Illegal visibility value reported	
MOS values must be between 1 and 6	9-out visibility
The local values must be between 0. and 7.0 or they must equal 80	9-out visibility
The verifying observation and persistence values must be between 0. and 7.0 or they must equal 800	9-out visibility
Illegal cloud value reported	
MOS, local, and verifying observation values must be between 1 and 4	9-out clouds
Illegal max or min value reported	
MOS, local, and verifying observation values must be between -70 and 125	9-out max or min
The MOS and local values can not differ by more than 40	9-out max or min for both
The MOS and calendar day verifying observations can not differ by more than 30	9-out both
The local and daytime (nighttime) verifying observations can not differ by more than 30	9-out both
The daytime max verifying observation values can not exceed the corresponding calendar day observations by more than 1	9-out max for both
The nighttime min verifying observation values can not be less than the corresponding calendar day observations by more than 5	9-out min for both
Illegal PoP value reported	
MOS and local values must be 0.,.02,.05,.10,.20,...,.90, or 1.0	9-out PoP
The verifying observation values must be 0. or greater, but can not exceed 20	9-out precipitation amount

Table 3. (Continued).

CHECKS BEING MADE IN AFOS-ERA VERIFICATION DATA EDITING PROGRAM	IF PROBLEM OCCURS, PROGRAM WILL FLAG AND:
Illegal precipitation type value reported	
MOS and local values must be 1, 2, or 3	9-out precipitation type
The verifying observation values must be 0 or 1	9-out precipitation type
Illegal snow amount value reported	
MOS values must be 0, 2, 4, or 6	9-out snow amount
The local values must be 0 or greater, but can not exceed 36	9-out snow amount
The verifying observation values must be 0 or greater, but can not exceed 36	9-out snow amount
Illegal wind values reported	
MOS, local, and verifying observation of direction values must be between 0 and 360	9-out direction and speed
MOS, local, peak wind, and verifying observation of speed values must be between 0 and 100	9-out direction and speed
A 0 wind speed must be accompanied by a 0 wind direction and vice versa	9-out direction and speed
MOS and local wind speed values must not differ by more than 30	9-out direction and speed for both
The observed peak wind value must equal or exceed the observed average wind speed, but by not more than 40	9-out direction, speed, and peak wind

Table 4. Identification information for climatic precipitation frequency.

Cycle (GMT)	Hours added to basic date to get date for this variable	Data ID (in hex)		Description
0000	24, 48	231451	0000	1200-2400 GMT Precipitation Frequency
	36	231450	0000	0000-1200 GMT Precipitation Frequency
1200	24, 48	231450	0000	0000-1200 GMT Precipitation Frequency
	36	231451	0000	1200-2400 GMT Precipitation Frequency

```
A. - One or more "pseudo files" of data each consisting of:

     1 - Header information, consisting of:

         Record 1:

             Word 1 - 4 characters = 'NWSV' used to identify NWSVER tape.
             Word 2 - Number of stations in this pseudo file = NSTA.
                      (Integer*4)
             Word 3 - Record size = NWDS = NSTA + 4.  (Integer*4)
             Words 4-10 - Zero (not used).

         Record 2 (Integer*4):

             Word 1 - Zero (not used).
             Word 2 - Record ID = 1.
             Word 3 - Zero (not used).
             Word 4 - Zero (not used).
             Words 5-NWDS - NSTA station WBAN numbers in numerical order.

         Record 3 (Integer*4 except call letters are A4):

             Word 1 - Zero (not used).
             Word 2 - Record ID = 2.
             Word 3 - Zero (not used).
             Word 4 - Zero (not used).
             Words 5-NWDS - NSTA station call letters, left justified, in
                            same order as in header record 2.

     2 - Multiple records, consisting of:

             Word 1 - Record date in format YR*1000000 + MO*10000 + DA*100 + HR,
                      where HR is the GMT forecast cycle either 00 or 12.
                      (Integer*4)

             Word 2 - Data ID (see Table 1).  (Integer*4)

             Word 3 - Data category (see Table 1).  (Integer*4)

             Word 4 - Data tau (projection).  (Integer*4)

             Words 5-NWDS - Data for stations in order specified in header
                            records 2 and 3.  (Real*4)

     3 - A dummy record, consisting of:

             Words 1-NWDS - set = 9999.  (Integer*4)

B - End of data on tape signaled by an EOF.
```

Figure 1. Format of NWS verification data archive. See Chapter XVI of TDL Office Note 74-14 (Glahn, 1974) for further details.

```
                LIST OF ERRONEOUS STATION DATA

THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H VISIBILITY   8
THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR OBS 12-H PK WIND SPD DIR= 40 SPD= 10 PK SPD=  4
THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H CEILING HGT  3
THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H VISIBILITY   8
THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR MOS 18-H CEILING HGT  9
THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR MOS 18-H VISIBILITY   8
THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR MOS 24-H CEILING HGT  9
THE 84070312 REPORT IS SUSPECT AT STATION CYS FOR MOS 24-H VISIBILITY   8
THE 84070312 REPORT IS SUSPECT AT STATION CPR FOR MOS OR LOCAL 48-H MIN TEMP     MOS= 52 LCL= 17
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H CEILING HGT  9
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H VISIBILITY   8
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H WIND SPEED  DIR= 80 SPD=  0
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR OBS 12-H PK WIND SPD DIR= 10 SPD= 10 PK SPD=  5
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H CEILING HGT  9
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H VISIBILITY   8
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR OBS 18-H PK WIND SPD DIR=300 SPD= 10 PK SPD=  6
THE 84070400 REPORT IS SUSPECT AT STATION CYS FOR MOS 24-H VISIBILITY   8
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H CEILING HGT  9
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H VISIBILITY   8
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR OBS 12-H PK WIND SPD DIR=170 SPD= 12 PK SPD= 10
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H CEILING HGT  9
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H VISIBILITY   8
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 18-H CEILING HGT  9
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 18-H VISIBILITY   8
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR OBS 18-H PK WIND SPD DIR=290 SPD= 12 PK SPD=  8
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 24-H CEILING HGT  9
THE 84070412 REPORT IS SUSPECT AT STATION CYS FOR MOS 24-H VISIBILITY   8
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H VISIBILITY   8
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H WIND SPEED  DIR= 80 SPD=  0
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H CEILING HGT  9
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 15-H VISIBILITY   8
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 18-H CEILING HGT  9
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 18-H VISIBILITY   8
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR OBS 18-H PK WIND SPD DIR=280 SPD= 10 PK SPD=  0
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 24-H CEILING HGT  9
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR MOS 24-H VISIBILITY   8
THE 84070500 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 55 12H= 27
THE 84070512 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 55 12H= 27
THE 84070600 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 55 12H= 27
THE 84070612 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 55 12H= 27
THE 84071112 REPORT IS SUSPECT AT STATION CPR FOR OBS 24 OR 12-H MAX TEMP     24H= 47 12H= 50
THE 84071200 REPORT IS SUSPECT AT STATION CPR FOR OBS 24 OR 12-H MAX TEMP     24H= 47 12H= 50
THE 84071212 REPORT IS SUSPECT AT STATION CYS FOR MOS 12-H CLOUD AMT    0
THE 84071212 REPORT IS SUSPECT AT STATION CYS FOR OBS 24-H CLOUD AMT    0
THE 84071212 REPORT IS SUSPECT AT STATION CPR FOR OBS 24 OR 12-H MAX TEMP     24H= 47 12H= 50
THE 84071300 REPORT IS SUSPECT AT STATION CPR FOR OBS 24 OR 12-H MAX TEMP     24H= 47 12H= 50
THE 84071300 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 60 12H= 58
THE 84071312 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 60 12H= 58
THE 84071400 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 60 12H= 58
THE 84071400 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 54 12H= 52
THE 84071412 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 60 12H= 58
THE 84071412 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 54 12H= 52
THE 84071500 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 54 12H= 52
THE 84071512 REPORT IS SUSPECT AT STATION CYS FOR OBS 18 OR 12-H MIN TEMP     18H= 54 12H= 52
```

Figure 2. Sample of the quality control program (M530) output listing the questionable data for a WSFO and its WSO. See MOS OP NO. 166 (Glahn et al., 1975) for further details.

PERIOD OF RECORD 84100100 85033112
NUMBER OF POSSIBLE REPORTS 00Z=182 12Z=182

	WSFO=ALB					WSO=BTV				
	MOS	LOCAL	HRLY OBS		PERS	MOS	LOCAL	HRLY OBS		PERS
12-H CEILING(00Z)	168	169	170		170	166	167	169		169
12-H CEILING(12Z)	165	165	166		166	161	161	164		165
15-H CEILING(00Z)	0	169	170			0	167	168		
15-H CEILING(12Z)	0	165	166			0	161	166		
18-H CEILING(00Z)	170	169	168			167	167	167		
18-H CEILING(12Z)	165	165	166			161	161	166		
24-H CEILING(00Z)	169	169	170			166	167	168		
24-H CEILING(12Z)	165	165	166			161	161	166		
	MOS	LOCAL	HRLY OBS		PERS	MOS	LOCAL	HRLY OBS		PERS
12-H VISIBILITY(00Z)	170	169	170		170	167	167	169		169
12-H VISIBILITY(12Z)	165	165	166		166	161	161	164		165
15-H VISIBILITY(00Z)	0	169	170			0	167	168		
15-H VISIBILITY(12Z)	0	165	166			0	161	166		
18-H VISIBILITY(00Z)	169	169	168			166	167	167		
18-H VISIBILITY(12Z)	165	165	166			161	161	166		
24-H VISIBILITY(00Z)	169	169	170			166	167	168		
24-H VISIBILITY(12Z)	165	165	166			161	161	166		
	MOS	LOCAL	24-H OBS	12-H	OBS	MOS	LOCAL	24-H OBS	12-H	OBS
24-H MAX TEMP(00Z)	169	171	171		171	166	167	167		168
24-H MIN TEMP(12Z)	165	167	167		163	159	163	164		161
36-H MIN TEMP(00Z)	169	171	170		167	165	167	168		165
36-H MAX TEMP(12Z)	165	167	167		167	159	163	164		165
48-H MAX TEMP(00Z)	169	171	170		171	165	167	166		169
48-H MIN TEMP(12Z)	165	167	167		163	160	163	165		162
60-H MIN TEMP(00Z)	169	171	171		166	164	167	168		166
60-H MAX TEMP(12Z)	165	167	165		167	159	163	160		166
	MOS	LOCAL	HRLY OBS	2-H	OBS	MOS	LOCAL	HRLY OBS	2-H	OBS
18-H PRECIP TYPE(00Z)	171	169	169169169	170	170170	167	165	166166166	167	167167
18-H PRECIP TYPE(12Z)	166	167	167167167	167	167167	160	163	165165165	165	165165
30-H PRECIP TYPE(00Z)	171	169	171171171	171	171171	167	165	169169169	169	169169
30-H PRECIP TYPE(12Z)	166	167	165165165	166	166166	160	163	163163163	164	164164
42-H PRECIP TYPE(00Z)	171	169	169169169	170	170170	167	165	167167167	168	168168
42-H PRECIP TYPE(12Z)	165	167	167167167	167	167167	160	163	166166166	166	166166
	MOS	LOCAL	12-H OBS			MOS	LOCAL	12-H OBS		
24-H SNOW AMT(00Z)	171	168	170			167	164	162		
24-H SNOW AMT(12Z)	166	167	167			160	163	163		
	MOS	LOCAL	HRLY OBS	6-H	OBS	MOS	LOCAL	HRLY OBS	6-H	OBS
12-H WIND SPEED(00Z)	170	169	170		170	167	167	169		169
12-H WIND SPEED(12Z)	164	165	166		166	160	161	164		164
18-H WIND SPEED(00Z)	170	169	167		167	166	167	167		167
18-H WIND SPEED(12Z)	164	165	166		166	160	161	166		166
24-H WIND SPEED(00Z)	170	169	170		170	167	167	168		168
24-H WIND SPEED(12Z)	164	165	166		165	160	161	166		166
42-H WIND SPEED(00Z)	164	168	167		167	160	166	168		168
42-H WIND SPEED(12Z)	159	166	166		166	153	164	167		167
	MOS	LOCAL	HRLY OBS			MOS	LOCAL	HRLY OBS		
12-H WIND DIR(00Z)	170	169	170			167	167	169		
12-H WIND DIR(12Z)	164	165	166			160	161	164		
18-H WIND DIR(00Z)	170	169	167			166	167	167		
18-H WIND DIR(12Z)	164	165	166			160	161	166		
24-H WIND DIR(00Z)	170	169	170			167	167	168		
24-H WIND DIR(12Z)	164	165	166			160	161	166		
42-H WIND DIR(00Z)	164	168	167			160	166	168		
42-H WIND DIR(12Z)	159	166	166			153	164	167		
	MOS	LOCAL	12-H OBS			MOS	LOCAL	12-H OBS		
24-H PRECIP PROB(00Z)	170	171	170			166	167	166		
24-H PRECIP PROB(12Z)	164	167	167			158	163	164		
36-H PRECIP PROB(00Z)	170	171	170			165	167	168		
36-H PRECIP PROB(12Z)	164	167	166			159	163	163		
48-H PRECIP PROB(00Z)	170	171	170			167	167	167		
48-H PRECIP PROB(12Z)	165	167	166			159	163	165		
	MOS	LOCAL	HRLY OBS			MOS	LOCAL	HRLY OBS		
12-H CLOUD AMT(00Z)	169	169	171			166	165	168		
12-H CLOUD AMT(12Z)	166	167	167			160	163	164		
18-H CLOUD AMT(00Z)	170	169	169			166	165	166		
18-H CLOUD AMT(12Z)	165	167	167			160	163	165		
24-H CLOUD AMT(00Z)	170	169	171			166	165	168		
24-H CLOUD AMT(12Z)	165	167	167			160	163	165		

Figure 3. Sample of the quality control program (M530) output showing the receipt of data summary for a WSFO and its WSO.

```
Record 1 - 20 words:

  Word 1 - NCAS   = Number of cases(dates) for which data are
                    to be written
       2 - NV     = Number of variables to be output
       3 - NSTA   = Number of stations to be output
       4 - LSTCAL = 0 if call letters are not written
                  ≠ 0 if call letters are written
       5 - LSTNAM = 0 if station names are not written
                  ≠ 0 if station names are written
       6-20 Not used

Record 2 - NSTA words:

  These are the station WBAN numbers.

Record 3 - NSTA words:

  This record is written only if LSTCAL ≠ 0.  It contains the station call
  letters.

Records 4 - 8 - NSTA words each:

  These records are written only if LSTNAM ≠ 0.  Each record contains
  four characters of the station name.

Next NV Records - 27 four-byte words each:

  One record is written for each variable.

Next NCAS Records - NSTA*NV+1 words each:

  These are data records.

All records are written with an unformatted FORTRAN write statement.
```

Figure 4. Format of the M660 output data set. Additional explanation is contained in the M660 documentation in TDL Office Note 75-2 (Glahn et al., 1975).

```
Record 1 - 7 words:

  Words 1-2 - 2 word(8 character) tape ID
     Character 1 - W (warm season) or C (cool season)
     Character 2 - 0 (00 GMT cycle) or 2 (12 GMT cycle)
     Character 3 - M (if MOS guidance forecast is on this data set) or
                   blank (if MOS guidance is missing)
     Character 4 - E (if experimental forecast is on this data set) or
                   blank (if experimental forecast is missing)
     Characters 5-8 - Code indicating which type of data is on this
                   data set:
                   TMPC - Max/Min Temperature and PoP
                   POPT - Precipitation Type
                   WIND - Wind speed and direction
                   POSA - Snow amount
                   CLD  - Cloud amount
                   CIG  - Ceiling height
                   VIS  - Visibility
  Word 3 - NSTA = Number of stations
  Word 4 - N    = Number of data types (columns of data) See Table 1 of
                  Appendix I.
  Word 5 - NPRJ = Number of projections
  Word 6 - NCAS = Number of dates
  Word 7 - IREC = Number of records containing WBAN numbers

Records 2-IREC+1:

  Each record contains up to 15 WBAN numbers.

All subsequent records:

  NSTA*NPRJ records contain data for one date.  Each record is N+3 words,
  containing the following data:

  Word 1 - WBAN number
  Word 2 - Projection
  Word 3 - Date in the form YR*1000000+MO*10000+DAY*100+CYC
  Words 4 - N+3 - The next N words contain data for this station and date.
            The exact format differs for each element (see Table 1 of
            Appendix I).  The format depends on the columns in which the
            user places the data.

  The next NSTA*NPRJ records contain data for all stations and projections
  for the second date.  This sequence is repeated until NCAS dates are
  written to the data set.

All records are written with an unformatted FORTRAN write statement.
```

Figure 5. Format of the reformatted output data set produced by the REFORM program (see Appendix I).

PUBLIC COMPARATIVE FORECAST VERIFICATION FOR PORTLAND OR OCT 1, 1984 - MAR 31, 1985 0 Z CYCLE SCORES

TEMPERATURE	1ST PERIOD MAX LCL	1ST PERIOD MAX MOS	2ND PERIOD MIN LCL	2ND PERIOD MIN MOS	3RD PERIOD MAX LCL	3RD PERIOD MAX MOS	4TH PERIOD MIN LCL	4TH PERIOD MIN MOS
NO. OF CASES	159	159	158	158	159	159	158	158
MEAN ABS ERROR (MAE)	3.0	2.9	3.6	3.9	3.7	3.8	4.3	4.7
MEAN ALG ERROR	-0.1	-0.1	-0.9	-2.0	-0.2	-0.8	-0.6	-1.6
ROOT MEAN SQ ERROR	3.8	3.8	4.4	4.9	4.6	4.8	5.3	5.8
MAE WHEN ABS ERROR GE 6	6.4	6.5	6.0	6.7	6.4	6.4	6.8	7.5
24 HR VARIABILITY	3.9		4.7		4.0		4.6	
MAE 24-H VRLTY GE 10	5.3	6.2	3.6	4.1	5.1	4.6	4.7	5.2
IMP OVR GUID(24H VRLTY GE 10)	13.5		12.2		-10.9		10.1	
PRBLTY OF DETECTN (32 DEG F)			0.67	1.00			0.33	0.33
FLSE ALRM RATIO (32 DEG F)			0.50	0.50			0.75	0.86
PERCENT IN ERROR DEGREE CLASS								
0 - 5	85.5	85.5	79.7	74.1	74.8	76.1	68.4	63.9
6 - 10	13.2	13.8	19.6	24.1	24.5	21.4	28.5	32.3
11 - 15	1.3	0.6	0.6	1.3	0.6	2.5	3.2	2.5
GT 15	0.0	0.0	0.0	0.6	0.0	0.0	0.0	1.3

PRECIPITATION	1ST PERIOD LCL	1ST PERIOD MOS	2ND PERIOD LCL	2ND PERIOD MOS	3RD PERIOD LCL	3RD PERIOD MOS
NO. OF FORECAST PERIODS	160	160	159	159	160	160
NO. PRECIP CASES	69		59		72	
OBSVD PRECIP FREQUENCY	0.431		0.371		0.450	
MEAN POP FORECAST	0.37	0.34	0.36	0.32	0.35	0.34
MEAN POP (PRECIP)	0.64	0.58	0.63	0.55	0.53	0.50
MEAN POP (NO PRECIP)	0.16	0.15	0.21	0.19	0.19	0.21
BRIER SCORE	0.1202	0.1327	0.1314	0.1393	0.1717	0.1791
IMP OVER GUIDANCE	9.4		5.7		4.1	
CLIMATOLOGICAL BRIER	0.2573		0.2552		0.2589	
IMP OVER CLIMATOLOGY	53.3	48.4	48.5	45.4	33.7	30.8
TOTAL PERCENT CORRECT	85.0	83.1	79.9	81.1	76.9	75.6
NO. CHGS TO GUID(PERCENT)	89(56)		111(70)		115(72)	
MEAN CHANGE	0.14		0.15		0.15	
NO. CHGS IN RT DIR(PERCENT)	55(62)		60(54)		62(54)	
MEAN IN RIGHT DIREC	0.14		0.16		0.17	

PROB CLASS	NO.OF FCSTS L	NO.OF FCSTS M	PRECP CASES L	PRECP CASES M	RELIABILITY FREQUENCY L	RELIABILITY FREQUENCY M	RELIABILITY ERROR L	RELIABILITY ERROR M	NO.OF FCSTS L	NO.OF FCSTS M	PRECP CASES L	PRECP CASES M	RELIABILITY FREQUENCY L	RELIABILITY FREQUENCY M	RELIABILITY ERROR L	RELIABILITY ERROR M	NO.OF FCSTS L	NO.OF FCSTS M	PRECP CASES L	PRECP CASES M	RELIABILITY FREQUENCY L	RELIABILITY FREQUENCY M	RELIABILITY ERROR L	RELIABILITY ERROR M
0	30	26	1	1	3.3	3.8	-3.3	-3.8	18	15	1	1	5.6	6.7	-5.6	-6.7	12	16	0	0	0.0	0.0	0.0	0.0
2		5		1		20.0		-18.0		8		0		0.0		2.0		7		0		0.0		2.0
5	12	16	0	0	0.0	0.0	5.0	5.0	14	14	0	0	0.0	0.0	5.0	5.0	10	11	1	1	10.0	9.1	-5.0	-4.1
10	19	19	2	2	10.5	10.5	-0.5	-0.5	27	18	2	0	7.4	0.0	2.6	10.0	42	16	9	5	21.4	31.3	-11.4	-21.3
20	14	7	5	5	35.7	71.4	-15.7	-51.4	15	21	2	6	13.3	28.6	6.7	-8.6	16	16	5	5	31.3	31.3	-11.3	-11.3
30	12	15	5	4	41.3	26.7	-1.3	3.3	14	17	4	5	28.6	29.4	1.4	0.6	12	18	4	6	33.3	33.3	-3.3	-3.3
40	8	16	3	7	37.5	43.8	2.5	-3.8	10	17	6	8	60.0	47.1	-20.0	-7.1	9	17	6	9	66.7	52.9	-26.7	-12.9
50	9	14	5	10	55.6	71.4	-5.6	-21.4	12	14	4	9	33.3	64.3	16.7	-14.3	9	16	7	11	77.8	68.8	-27.8	-18.8
60	8	7	8	5	100.0	71.4	-40.0	-11.4	12	9	10	7	83.3	77.8	-23.3	-17.8	15	20	11	16	73.3	80.0	-13.3	-20.0
70	12	15	10	14	83.3	93.3	-13.3	-23.3	11	14	6	12	54.5	85.7	15.5	-15.7	18	19	12	15	66.7	78.9	3.3	-8.9
80	14	12	15	10	93.8	100.0	-13.8	-20.0	13	5	12	5	92.3	100.0	-12.3	-20.0	11	1	11	1	100.0	100.0	-20.0	-20.0
90	8	8	7	8	87.5	100.0	2.5	-10.0	10	4	10	4	100.0	100.0	-10.0	-10.0	5	3	5	3	100.0	100.0	-10.0	-10.0
100	8	2	8	2	100.0	100.0	0.0	0.0	3	3	2	2	66.7	66.7	33.3	33.3	1		1		100.0		0.0	

Figure 6. Sample verification summary report for max/min temperature and PoP.

PRECIPITATION TYPE VERIFICATION FOR PORTLAND ME OCTOBER 1, 1983 - MARCH 31, 1984 122 CYCLE SCORES

18 - H PROJECTION

	LOCAL FORECAST Z	S	R	T		GUIDANCE FORECAST Z	S	R	T
O Z	0	0	0	0	O Z	0	0	0	0
B S	0	8	0	8	B S	1	7	0	8
S R	0	1	8	9	S R	1	1	7	9
T	0	9	8	17	T	2	8	7	17

BIAS	9999	1.13	0.89		BIAS	8888	1.00	0.78
POD1	.	POD2	1.00		POD1	.	POD2	0.88
FAR1	.	FAR2	0.11		FAR1	1.00	FAR2	0.13
SKILL	0.883	PFC	94.12		SKILL	0.685	PFC	82.35
IMP OVR GUID(SKILL)			28.835					

30 - H PROJECTION

	LOCAL FORECAST Z	S	R	T		GUIDANCE FORECAST Z	S	R	T
O Z	0	1	0	1	O Z	1	0	0	1
B S	1	7	0	8	B S	3	5	0	8
S R	0	0	8	8	S R	0	0	8	8
T	1	8	8	17	T	4	5	8	17

BIAS	1.00	1.00	1.00		BIAS	4.00	0.63	1.00
POD1	0.00	POD2	0.88		POD1	1.00	POD2	0.63
FAR1	1.00	FAR2	0.13		FAR1	0.75	FAR2	0.00
SKILL	0.788	PFC	88.24		SKILL	0.718	PFC	82.35
IMP OVR GUID(SKILL)			9.644					

42 - H PROJECTION

	LOCAL FORECAST Z	S	R	T		GUIDANCE FORECAST Z	S	R	T
O Z	0	0	0	0	O Z	0	0	0	0
B S	1	5	0	6	B S	1	5	0	6
S R	1	1	11	13	S R	3	1	9	13
T	2	6	11	19	T	4	6	9	19

BIAS	8888	1.00	0.85		BIAS	8888	1.00	0.69
POD1	.	POD2	0.83		POD1	.	POD2	0.83
FAR1	1.00	FAR2	0.17		FAR1	1.00	FAR2	0.17
SKILL	0.687	PFC	84.21		SKILL	0.543	PFC	73.68
IMP OVR GUID(SKILL)			26.422					

Figure 7. Sample verification summary report for precipitation type.

SNOW AMOUNT VERIFICATION FOR WESTERN REGION OCTOBER 1, 1984 - MARCH 31, 1985 12Z CYCLE SCORES

24 - 4 PROJECTION

LOCAL FORECAST

		LT2	2-3	4-5	GE6	T
	LT2	1365	32	2	1	1400
O	2-3	14	8	0	0	22
B	4-5	1	2	1	0	4
S	GE6	2	1	0	0	3
	T	1382	43	3	1	1429
BIAS		0.99	1.95	0.75	0.33	

SNOW AMOUNT GE 2 IN:
POD 0.41 FAR 0.74 TS 0.188

SNOW AMOUNT GE 4 IN:
POD 0.14 FAR 0.75 TS 0.100

SNOW AMOUNT GE 6 IN:
POD 0.00 FAR 1.00 TS 0.000

PFC 96.15 SKILL 0.260

LCL IMP OVR GUID(SKILL) 31.64

GUIDANCE FORECAST

		LT2	2-3	4-5	GE6	T
	LT2	1381	14	5	0	1400
O	2-3	16	3	3	0	22
B	4-5	2	2	0	0	4
S	GE6	2	1	0	0	3
	T	1401	20	8	0	1429
BIAS		1.00	0.91	2.00	0.00	

SNOW AMOUNT GE 2 IN:
POD 0.31 FAR 0.68 TS 0.188

SNOW AMOUNT GE 4 IN:
POD 0.00 FAR 1.00 TS 0.000

SNOW AMOUNT GE 6 IN:
POD 0.00 FAR 0.00 TS 0.000

PFC 96.55 SKILL 0.198

Figure 8. Sample verification summary report for snow amount.

WIND DIRECTION VERIFICATION FOR MOBILE AL OCTOBER 1, 1983 - MARCH 31, 1984 12Z CYCLE SCORES

12 - H PROJECTION

LOCAL FORECAST

		1	2	3	4	5	6	7	8
	1	5	0	0	0	0	2	0	0
O	2	1	0	1	0	0	0	0	0
	3	0	0	0	3	0	0	0	0
B	4	0	1	0	4	5	0	0	0
	5	0	0	0	0	3	2	0	0
S	6	0	0	0	0	2	1	0	1
	7	0	0	0	0	0	0	2	0
	8	0	0	0	0	0	0	1	4
CTOT		6	1	1	7	10	5	3	5
RTOT		7	2	3	10	5	4	2	5
BIAS		0.86	0.50	0.33	0.70	2.00	1.25	1.50	1.00

SKILL 0.411 IMP OVR GUID 4.126 MAE 31.05

GUIDANCE FORECAST

		1	2	3	4	5	6	7	8
	1	4	1	0	0	1	0	0	1
O	2	1	0	1	0	0	0	0	0
	3	0	0	1	2	0	0	0	0
B	4	0	0	0	7	3	0	0	0
	5	0	0	0	2	2	0	1	0
S	6	0	0	0	2	1	0	1	0
	7	0	0	0	0	0	0	1	1
	8	1	0	0	0	0	0	0	4
CTOT		6	1	2	13	7	0	3	6
RTOT		7	2	3	10	5	4	2	5
BIAS		0.86	0.50	0.67	1.30	1.40	0.00	1.50	1.20

SKILL 0.355 TOTAL NO. CASES 38 MAE 28.16

18 - H PROJECTION

LOCAL FORECAST

		1	2	3	4	5	6	7	8
	1	7	1	0	0	0	0	0	1
O	2	1	0	0	0	0	0	0	0
	3	0	0	1	3	1	0	0	0
B	4	0	0	0	0	4	0	0	0
	5	0	0	0	0	3	0	0	0
S	6	0	0	0	1	2	0	1	1
	7	0	0	0	0	1	0	0	1
	8	1	0	0	0	1	0	2	1
CTOT		9	1	1	4	12	0	3	4
RTOT		9	1	5	4	3	5	2	5
BIAS		1.00	1.00	0.20	1.00	4.00	0.00	1.50	0.80

SKILL 0.245 IMP OVR GUID -43.755 MAE 35.00

GUIDANCE FORECAST

		1	2	3	4	5	6	7	8
	1	9	0	0	0	0	0	0	0
O	2	1	0	0	0	0	0	0	0
	3	0	0	0	5	0	0	0	0
B	4	0	0	0	4	0	0	0	0
	5	0	0	0	1	2	0	0	0
S	6	1	0	0	1	2	0	0	1
	7	0	0	0	0	0	1	0	1
	8	0	0	0	1	0	0	1	3
CTOT		11	0	0	12	4	1	1	5
RTOT		9	1	5	4	3	5	2	5
BIAS		1.22	0.00	0.00	3.00	1.33	0.20	0.50	1.00

SKILL 0.436 TOTAL NO. CASES 34 MAE 30.59

30 - H PROJECTION

LOCAL FORECAST

		1	2	3	4	5	6	7	8
	1	6	1	0	0	2	1	1	3
O	2	1	0	0	0	0	0	0	0
	3	1	1	1	1	0	0	0	0
B	4	0	0	1	4	5	0	0	0
	5	0	0	0	2	3	0	0	0
S	6	0	0	0	0	3	0	0	0
	7	0	0	0	0	2	1	5	2
	8	1	0	0	0	1	1	1	2
CTOT		9	2	2	7	16	3	7	7
RTOT		14	1	4	10	5	3	10	6
BIAS		0.64	2.00	0.50	0.70	3.20	1.00	0.70	1.17

SKILL 0.294 IMP OVR GUID -17.015 MAE 37.52

GUIDANCE FORECAST

		1	2	3	4	5	6	7	8
	1	9	0	0	0	2	1	1	1
O	2	0	0	0	1	0	0	0	0
	3	0	1	1	2	0	0	0	0
B	4	0	0	1	5	4	0	0	0
	5	0	0	0	2	3	0	0	0
S	6	0	0	0	1	2	0	0	0
	7	0	0	0	0	0	2	2	6
	8	1	0	0	0	0	0	1	4
CTOT		10	1	2	11	11	3	4	11
RTOT		14	1	4	10	5	3	10	6
BIAS		0.71	1.00	0.50	1.10	2.20	1.00	0.40	1.83

SKILL 0.354 TOTAL NO. CASES 53 MAE 32.08

Figure 9. Sample verification summary report for wind direction.

```
WIND SPEED VERIFICATION FOR HOUSTON          TX    OCTOBER    1, 1983 - MARCH     31, 1984    12Z CYCLE SCORES
                                                  12  - H PROJECTION
                          LOCAL FORECAST                                    GUIDANCE FORECAST
                 1    2    3    4    5    6    T                          1    2    3    4    5    6    T

        1       76   15    1    0    0    0   92                  1       86    6    0    0    0    0   92
      O 2        3    8    1    0    0    0   12                O 2        6    5    1    0    0    0   12
        3        0    0    1    0    0    0    1                  3        0    1    0    0    0    0    1
      B 4        0    0    0    0    0    0    0                B 4        0    0    0    0    0    0    0
        5        0    0    0    0    0    0    0                  5        0    0    0    0    0    0    0
      S 6        0    0    0    0    0    0    0                S 6        0    0    0    0    0    0    0
        T       79   23    3    0    0    0  105                  T       92   12    1    0    0    0  105

BIAS 0.86 1.92 3.00 8888 8888 8888                          BIAS 1.00 1.00 1.00 8888 8888 8888
SKILL  0.396 IMP OVR GUID   1.187                           SKILL  0.392
PFC   80.95  TS1   0.00  TS2  0.00                          PFC   86.67  TS1   0.00  TS2  0.00
MEAN ALG ERR  2.21 MEAN ABS ERR  2.93                       MEAN ALG ERR  1.32 MEAN ABS ERR  2.82

                                                  18  - H PROJECTION
                          LOCAL FORECAST                                    GUIDANCE FORECAST
                 1    2    3    4    5    6    T                          1    2    3    4    5    6    T

        1       83   12    1    0    0    0   96                  1       93    3    0    0    0    0   96
      O 2        3    2    1    0    0    0    6                O 2        4    2    0    0    0    0    6
        3        0    1    0    0    0    0    1                  3        0    1    0    0    0    0    1
      B 4        0    0    0    0    0    0    0                B 4        0    0    0    0    0    0    0
        5        0    0    0    0    0    0    0                  5        0    0    0    0    0    0    0
      S 6        0    0    0    0    0    0    0                S 6        0    0    0    0    0    0    0
        T       86   15    2    0    0    0  103                  T       97    6    0    0    0    0  103

BIAS 0.90 2.50 2.00 8888 8888 8888                          BIAS 1.01 1.00 0.00 8888 8888 8888
SKILL  0.180 IMP OVR GUID -48.057                           SKILL  0.347
PFC   82.52  TS1   0.00  TS2  0.00                          PFC   92.23  TS1   0.00  TS2  0.00
MEAN ALG ERR  2.78 MEAN ABS ERR  3.67                       MEAN ALG ERR  1.44 MEAN ABS ERR  2.89

                                                  30  - H PROJECTION
                          LOCAL FORECAST                                    GUIDANCE FORECAST
                 1    2    3    4    5    6    T                          1    2    3    4    5    6    T

        1       72    6    3    0    0    0   81                  1       72    7    2    0    0    0   81
      O 2       11    3    1    0    0    0   15                O 2        8    6    1    0    0    0   15
        3        1    3    1    0    0    0    5                  3        0    3    1    1    0    0    5
      B 4        0    0    0    0    0    0    0                B 4        0    0    0    0    0    0    0
        5        0    0    0    0    0    0    0                  5        0    0    0    0    0    0    0
      S 6        0    0    0    0    0    0    0                S 6        0    0    0    0    0    0    0
        T       84   12    5    0    0    0  101                  T       80   16    4    1    0    0  101

BIAS 1.04 0.80 1.00 8888 8888 8888                          BIAS 0.99 1.07 0.80 9999 8888 8888
SKILL  0.209 IMP OVR GUID -41.630                           SKILL  0.358
PFC   75.25  TS1   0.00  TS2  0.00                          PFC   78.22  TS1   0.00  TS2  0.00
MEAN ALG ERR  1.50 MEAN ABS ERR  4.19                       MEAN ALG ERR  1.31 MEAN ABS ERR  3.23

                                                  42  - H PROJECTION
          LOCAL FORECAST                                          GUIDANCE FORECAST
           LE 22 GT 22   TOT                                        LE 22 GT 22   TOT

      O LE 22  102     0   102                                O LE 22  102     0   102
      B GT 22    0     0     0                                B GT 22    0     0     0
      S TOT    102     0   102                                S TOT    102     0   102

BIAS      1.00   8888                                      BIAS      1.00   8888
SKILL  0.000                                               SKILL  0.000
IMP OVR GUID    0.000                                      PFC100.00 TS1   0.00
PFC100.00 TS1   0.00
```

Figure 10. Sample verification summary report for wind speed.

CLOUD VERIFICATION FOR CONCORD NH OCTOBER 1, 1984 - MARCH 31, 1985 0Z CYCLE SCORES

12 - H PROJECTION

LOCAL FORECAST

		1	2	3	4	T
	1	27	13	8	2	50
O	2	8	5	6	0	19
B	3	2	7	9	8	26
S	4	0	5	5	50	60
	T	37	30	28	60	155

BIAS 0.74 1.58 1.08 1.00

PFC 58.71 SKILL 0.426

LCL IMP OVR GUID(SKILL) 11.264

GUIDANCE FORECAST

		1	2	3	4	T
	1	24	15	11	0	50
O	2	8	5	3	3	19
B	3	2	8	11	5	26
S	4	1	4	10	45	60
	T	35	32	35	53	155

BIAS 0.70 1.68 1.35 0.88

PFC 54.84 SKILL 0.383

18 - H PROJECTION

LOCAL FORECAST

		1	2	3	4	T
	1	27	9	12	3	51
O	2	4	9	5	7	25
B	3	1	9	12	5	27
S	4	0	7	12	35	54
	T	32	34	41	50	157

BIAS 0.63 1.36 1.52 0.93

PFC 52.87 SKILL 0.367

LCL IMP OVR GUID(SKILL) -0.191

GUIDANCE FORECAST

		1	2	3	4	T
	1	31	7	9	4	51
O	2	4	12	7	2	25
B	3	3	5	8	11	27
S	4	3	4	14	33	54
	T	41	28	38	50	157

BIAS 0.80 1.12 1.41 0.93

PFC 53.50 SKILL 0.368

24 - H PROJECTION

LOCAL FORECAST

		1	2	3	4	T
	1	42	16	4	5	67
O	2	6	10	2	4	22
B	3	2	5	2	7	16
S	4	5	6	6	35	52
	T	55	37	14	51	157

BIAS 0.82 1.68 0.88 0.98

PFC 56.69 SKILL 0.382

LCL IMP OVR GUID(SKILL) 10.560

GUIDANCE FORECAST

		1	2	3	4	T
	1	50	7	3	7	67
O	2	10	2	6	4	22
B	3	3	6	2	5	16
S	4	9	4	5	34	52
	T	72	19	16	50	157

BIAS 1.07 0.86 1.00 0.96

PFC 56.05 SKILL 0.345

Figure 11. Sample verification summary report for cloud amount.

VISIBILITY VERIFICATION FOR NEW ORLEANS LA OCTOBER 1, 1984 - MARCH 31, 1985 122 CYCLE SCORES

9 - H PROJECTION
PERSISTENCE

	1	2	3	4	T
1	0	0	0	0	0
O 2	0	2	3	1	6
B 3	0	4	16	14	34
S 4	0	1	15	110	126
T	0	7	34	125	166

BIAS 9999 1.17 1.00 0.99
LOG SCORE 1.644 PFC 77.108
SKILL 0.405

12 - H PROJECTION
LOCAL FORECAST

	1	2	3	4	T
1	0	0	0	0	0
O 2	0	0	4	2	6
B 3	0	1	19	14	34
S 4	0	0	20	106	126
T	0	1	43	122	166

BIAS 9999 0.17 1.26 0.97
LOG SCORE 1.726 PFC 75.301
SKILL 0.365
IMPRV OVER PERSIS(SKILL) -9.99

12 - H PROJECTION
GUIDANCE FORECAST

	1	2	3	4	T
1	0	0	0	0	0
O 2	0	1	2	3	6
B 3	0	2	6	26	34
S 4	0	3	13	110	126
T	0	6	21	139	166

BIAS 9999 1.00 0.62 1.10
LOG SCORE 2.224 PFC 70.482
SKILL 0.125
IMPRV OVER PERSIS(SKILL) -69.26

9 - H PROJECTION
PERSISTENCE

	1	2	3	4	T
1	0	0	0	0	0
O 2	0	1	2	1	4
B 3	[illegible]	3	13	17	33
S 4	0	3	18	111	132
T	0	7	33	129	169

BIAS 9999 1.75 1.00 0.98
LOG SCORE 1.910 PFC 73.964
SKILL 0.286

15 - H PROJECTION
LOCAL FORECAST

	1	2	3	4	T
1	0	0	0	0	0
O 2	0	1	3	0	4
B 3	0	4	16	13	33
S 4	0	0	23	109	132
T	0	5	42	122	169

BIAS 9999 1.25 1.27 0.92
LOG SCORE 1.695 PFC 74.556
SKILL 0.342
IMPRV OVER PERSIS(SKILL) 19.68

15 - H PROJECTION
GUIDANCE FORECAST

	1	2	3	4	T
1	0	0	0	0	0
O 2	0	0	0	0	0
B 3	0	0	0	0	0
S 4	0	0	0	0	0
T	0	0	0	0	0

BIAS 9999 9999 9999 9999
LOG SCORE 0.000 PFC 0.000
SKILL .
IMPRV OVER PERSIS(SKILL)

9 - H PROJECTION
PERSISTENCE

	1	2	3	4	T
1	0	1	1	3	5
O 2	0	1	4	2	7
B 3	0	3	9	23	35
S 4	0	2	19	96	117
T	0	7	33	124	164

BIAS 0.00 1.00 0.94 1.06
LOG SCORE 3.131 PFC 64.634
SKILL 0.149

18 - H PROJECTION
LOCAL FORECAST

	1	2	3	4	T
1	0	2	1	2	5
O 2	0	2	5	0	7
B 3	2	2	16	15	35
S 4	1	1	22	93	117
T	3	7	44	110	164

BIAS 0.60 1.00 1.26 0.94
LOG SCORE 3.048 PFC 67.683
SKILL 0.300
IMPRV OVER PERSIS(SKILL) 100.85

18 - H PROJECTION
GUIDANCE FORECAST

	1	2	3	4	T
1	2	0	1	2	5
O 2	2	1	2	2	7
B 3	4	2	12	17	35
S 4	5	2	27	83	117
T	13	5	42	104	164

BIAS 2.60 0.71 1.20 0.89
LOG SCORE 4.454 PFC 59.756
SKILL 0.177
IMPRV OVER PERSIS(SKILL) 18.65

9 - H PROJECTION
PERSISTENCE

	1	2	3	4	T
1	0	2	2	6	10
O 2	0	1	4	9	14
B 3	0	3	17	40	60
S 4	0	1	10	70	81
T	0	7	33	125	165

BIAS 0.00 0.50 0.55 1.54
LOG SCORE 4.745 PFC 53.333
SKILL 0.154

24 - H PROJECTION
LOCAL FORECAST

	1	2	3	4	T
1	1	3	5	1	10
O 2	0	4	6	4	14
B 3	1	4	41	14	60
S 4	1	2	21	57	81
T	3	13	73	76	165

BIAS 0.30 0.93 1.22 0.94
LOG SCORE 3.912 PFC 62.424
SKILL 0.379
IMPRV OVER PERSIS(SKILL) 145.81

24 - H PROJECTION
GUIDANCE FORECAST

	1	2	3	4	T
1	6	1	2	1	10
O 2	7	2	1	4	14
B 3	10	13	25	12	60
S 4	4	4	20	53	81
T	27	20	48	70	165

BIAS 2.70 1.43 0.80 0.86
LOG SCORE 6.065 PFC 52.121
SKILL 0.281
IMPRV OVER PERSIS(SKILL) 82.07

Figure 12. Sample verification summary report for visibility.

The data input is referred to in SAS as LIST input. This is "format-free" input, i.e., the data values do not have to appear in particular columns. They must, however, appear in the correct order and must be separated by at least one blank. This data set must not be line-numbered (must be a NONUM data set).

Three pieces of information per station are read, up to six stations per record.

```
     Words 1-3:
        Word 1 - 5-digit station WBAN number
        Word 2 - First letter of region in which the station is located
        Word 3 - Station call letters
                 (The call letters are not absolutely necessary.
                 They are not actually used in the programs at this time.)
     Words 4-6 - Repeat of words 1-3 for the next station.
     Words 7-9 - Repeat for next station
This sequence is repeated up to 6 times per record.
```

If any piece of information, such as the station call letters, is left out for any reason, a single period must appear in the position in which the information would normally appear. As above, the period must be separated from its neighboring data values by at least one blank. If a station is omitted from the list completely, all information pertaining to that station must be deleted (not replaced by periods). The station's information may be replaced by any number of blanks, since blanks are ignored in LIST input.

Figure 13. Format of the station list input data set.

Word 1 - First date of the desired period in the form YY * 10000 + MO * 100 + DAY.

Word 2 - Last date of the desired period in the same form as above.

Word 3 - Code number describing the types of forecasts to be verified:

1 = LCL vs. MOS
2 = LCL vs. MOS vs. EXP
3 = LCL vs. EXP

In the case of Temperature/PoP verification, two codes are required: the first is for the temperature, and the second is for the PoP. The codes must be separated by a comma.

Words 4-NPRJ+3 - The projections of the data for the element being verified. All projections for the element, except 9 (for persistence), are needed. The projections are separated by commas. For example, to verify temperature/PoP data, 4 values are needed (24, 36, 48, 60). Ceiling or visibility would also require 4 values (12, 15, 18, 24), while snow amount needs only one (24).

Word 4+NPRJ - Code which determines the destination of the output report:

At least 1 blank space = printed output,
FT20F001 = output to be written to an output data set (for microfiche).

If FT20F001 is used, a DD card describing the data set must be included in the JCL.

Word 5+NPRJ - Code which determines if the final scores are to be saved:

up to 8 characters = the name of the data set in which the scores will be saved,
NA = no scores will be saved.

If the scores are to be saved, a DD card describing the data set must be included in the JCL. The DDNAME must be SCORARCH.

Figure 14. Variable information provided when a SAS verification macro is invoked.

APPENDIX I

REFORM

PURPOSE: Reform reads a collated verification data set created by M660, reformats the data, and writes the data in a format suitable for use in the SAS verification modules.

```
C       PROGRAM REFORM
C          AUGUST 1983    DAGOSTARO    TDL    IBM 360/195
C          PURPOSE
C              TO READ COLLATED TAPE CREATED BY M660 AND REFORMAT THE DATA
C              SO THAT SAS VERIFICATION PROGRAM CAN USE IT AS INPUT
C          DATA SET USE
C              FT03 - M660 COLLATED DATA TAPE(INPUT)
C              FT20 - REFORMATTED DATA TAPE(OUTPUT)
C          VARIABLES
C                     ND1 = DIMENSION OF IDATE, GREATER THAN OR EQUAL TO
C                           NUMBER OF DESIRED DATES
C                     ND2 = GREATER THAN OR EQUAL TO NUMBER OF DATA
C                           VARIABLES (TYPES OF DATA)
C                     ND3 = ND2 * 2
C                     ND4 = DIMENSION OF NWBAN, GREATER THAN OR EQUAL
C                           TO NUMBER OF STATIONS
C                     ND5 = FIRST DIMENSION OF DATMTX, IS EQUAL TO NO.
C                           OF STAIONS*NO. OF PROJECTIONS
C                     ND6 = SECOND DIMENSION OF DATMTX, GREATER THAN OR
C                           EQUAL TO NUMBER OF OUTPUT DATA COLUMNS
C                           (PERSIS(?),LOCAL,MOS,EXP,OBS FOR EACH ELEMENT)
C                     ND7 = ND5 * ND6
C                     ND8 = ND5 * 3
C          DIMENSION THE ARRAYS AS FOLLOWS
C          ITPID(2),IDATE(ND1)
C          NUNIT(ND2),INCDAT(ND2),IDENT1(ND2),IDENT2(ND2),
C          NCODE(ND2),NCAT(ND2),NCOL(ND2),NTAU(ND2)
C          IDIR(ND2,2),DATHLD(ND4,ND2)
C          NWBAN(ND4),KALL(ND4)
C          NDTMTX(ND5,3),DATMTX(ND5,ND6)
      DIMENSION ITPID(2),IDATE(185)
      DIMENSION NWBAN(100),KALL(100),NUNIT(26),INCDAT(26),IDENT1(26)
      DIMENSION IDENT2(26),NCODE(26),NCAT(26),NCOL(26),NTAU(26)
      DIMENSION IDIR(26,2)
      DIMENSION NDTMTX(400,3),DATMTX(400,9),DATHLD(100,26)
      DATA ITPID/2*'    '/,IDATE/185*9999/,KALL/100*'    '/
      DATA NWBAN/100*99999/,DATMTX/3600*9999./,NDTMTX/1200*9999/
      DATA NUNIT/26*0/,INCDAT/26*0/,IDENT1/26*0/,IDENT2/26*0/
      DATA NCODE/26*0/,NCAT/26*0/,NCOL/26*0/,NTAU/26*0/,IDIR/52*0/
      DATA ND1/185/,ND2/26/,ND3/52/,ND4/100/,ND5/400/,
     1ND6/9/,ND7/3600/,ND8/1200/
      CALL REFORM (ITPID,IDATE,NWBAN,KALL,NUNIT,INCDAT,
     1IDENT1,IDENT2,NCODE,NCAT,NCOL,NTAU,IDIR,NDTMTX,DATMTX,DATHLD,
     2ND1,ND2,ND3,ND4,ND5,ND6,ND7,ND8)
      STOP
      END
```

Eight variables are given values in data statements.

ND1 - greater than or equal to the number of dates to verify

ND2 - greater than or equal to the number of data variables to be used

ND3 - ND2 * 2

ND4 - greater than or equal to the number of stations

ND5 - equal to the number of stations (ND4) * the number of projections on the output tape

ND6 - greater than or equal to the number of output data columns (For example, a MAX/MIN TEMP/PoP run would have a value of 9 - obs temp, lcl temp, MOS temp, experimental temp, obs precip, climatic frequency of precip, lcl PoP, MOS PoP, and experimental PoP. See Table 1, for the number of data columns for each element.)

ND7 - ND5 * ND6

ND8 - ND5 * 3

Arrays should be dimensioned as follows:

```
ITPID(2)
IDATE(ND1)
NUNIT(ND2),INCDAT(ND2),IDENTI(ND2),IDENT2(ND2)
NCODE(ND2),NCAT(ND2),NCOL(ND2),NTAU(ND2)
IDIR(ND2,2)
DATHLD(ND4,ND2)
NWBAN(ND4),KALL(ND4)
NDTMTX(ND5,3),DATMTX(ND5,ND6)
```

All variables are four-byte words.

Card input is as follows:

Card Type 1 - Format(2A4,2I4,2I8,3I4)

ITPID - Eight characters used to identify the output tape
1-8

- Character 1 - W (warm season) or C (cool season)
- Character 2 - 0 (00Z cycle) or 2 (12Z cycle)
- Character 3 - M (MOS values are on this tape) or blank (all MOS values have been set to missing)
- Character 4 - E (Experimental values are on this tape) or blank (all experimental values have been set to missing)
- Character 5-8 - four characters used to identify what type of data are on tape (for example, WIND = wind data, POSA = snow data, etc.)

NVAR 9-12 - The exact number of columns of data to be written on output tape (for example, a TEMP/PoP run would write the 9 data columns listed next to ND6 above).

NPRJ 13-16 - Number of projections to write on output tape.

IBEG 17-24 - First date to process, date is in the form YR*10000+MO*100+DAY.

IEND 25-32 - Last date to process.

ICYC 33-36 - Cycle (00 or 12).

INUNIT 37-40 - Input unit number.

IOUTNT 41-44 - Output unit number

Card Type 2 - Format(I2,I3,IXZ6,Z4,T6,I7,I4,T13,2I4,T40,2I4)

These cards are very similar to the input cards in M660. The variables IUNIT-JTAU are exactly the same as in the M660 input cards, so the M660 input cards can be duplicated up to column 40.

IROW 40-44 - The "row" in the data array in which you want to place this data variable. The row refers to the projection. For example, there are four projections for the TEMP/PoP verification (24, 36, 48 and 60). Data for the 24-h projection would be placed in row 1, 36-h data in row 2, etc. For POSA verification, all data would be placed in row 1, since there is only 1 projection.

ICOL 45-48 - The column in the data array in which you want to place this variable. (See Table 1.)

The terminator for this Card Type is a blank card.

DATA SET OUTPUT - The output data set is written with an unformatted FORTRAN WRITE statement. The DCB of the data set is: LRECL=80, BLKSIZE=6404, RECFM=VBS.

The format of the output data set is:

Record 1:

ITPID = 2 word tape ID, this was input from cards

NSTA = Number of stations on this tape

NVAR = Number of data types (columns of data) on this tape

NPRJ = Number of projections on this tape

NCAS = Number of dates on this tape

IREC = Number of records containing station WBAN numbers

Records 2-IREC+1:

Each record contains up to 15 WBAN numbers.

All subsequent records:

NSTA*NPRJ records contain data for one date. Each record is NVAR + 3 words, containing the following data:

WORD 1 = WBAN number
WORD 2 = Projection
WORD 3 = Date in the form YR*1000000+MO*10000+DAY*100+CYC.
WORDS 4 - NVAR+3 = The next NVAR words contain data for this station and date. The exact format differs for each element. The format depends on the columns in which the user places the data (read in from input cards).

The next NSTA*NPRJ records contain data for all stations and projections for the second date. This sequence repeats until NCAS dates are written to tape.

NONSYSTEM ROUTINES CALLED: None

STORAGE REQUIREMENTS: Depends on Driver DRVREFM. Usually 1000 K is sufficient.

LANGUAGE: FORTRAN H Extended Plus.

LOCATION: W.NWS.W42.VD.LOAD(REFORM).

Example JCL and data cards:

```
//WEVDTMPC JOB (WE20008M1D3150V,TDL-11), DAGOSTARO ,
//    REGION=2000K,TIME=3
//*FORMAT PR,DDNAME=,DEST=GRAMX,CARRIAGE=8=IN
//STP1 EXEC BFORXCLG,COND=(8,LT)
//FORT.SYSIN DD DSN=W.NWS.W42.VD.SOURCE(DRM660),DISP=SHR
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=NWS.NMC.MVSW3LIB.LOAD,DISP=SHR
//            DD DSN=NWS.NMC.W3LIB.LOAD,DISP=SHR
//LKED.W4LIB DD DSN=NWS.SDO.TDL.W4LIB.LOAD,DISP=SHR
//LKED.SYSIN DD *
 INCLUDE W4LIB(DRM660)
 INCLUDE W4LIB(DRRDNVER,DRRDDATA,DRANAL,DRLSTSTA,DRIHX)
 INCLUDE W4LIB(DROUTLST,DRCHNGDT,DRSORT1,DRRDCON)
  ENTRY MAIN
//GO.FT50F001 DD DSN=NWS.SDO.TDL.HG.NWSVER.EDIT,DISP=SHR
//GO.MOSCONST DD DSN=NWS.W423.GM.POPCON,DISP=SHR
//GO.FT03F001 DD DSN=**TMPCDATA,DISP=(NEW,PASS),UNIT=SYSDA,
//     DCB=(RECFM=VBS,LRECL=8404,BLKSIZE=8412),SPACE=(TRK,(50,25),RLSE)
//GO.SYSIN DD *
  00            0   1
  841001  841002  841003  841004  841005
     .
     .
     .

  999999
50  0   2080   1  24        1  05                  10 3 OBSMAX24
50  0   2050   1  24        1  05                  10 3 LCLMAX24
50  0   2000   1  24        1  05                  10 3 MOSMAX24
50  0   2180   1  36        1  05                  10 3 OBSMIN36
50  0   2150   1  36        1  05                  10 3 LCLMIN36
50  0   2100   1  36        1  05                  10 3 MOSMIN36
50  0   2080   1  48        2  05                  10 3 OBSMAX48
50  0   2050   1  48        2  05                  10 3 LCLMAX48
50  0   2000   1  48        2  05                  10 3 MOSMAX48
50  0   2180   1  60        2  05                  10 3 OBSMIN60
50  0   2150   1  60        2  05                  10 3 LCLMIN60
50  0   2100   1  60        2  05                  10 3 MOSMIN60
50  0   6150   1  24        3  05                  10 3 LCLPOP24
50  0   6100   1  24        3  05                  10 3 MOSPOP24
50  0   6150   1  36        3  05                  10 3 LCLPOP36
50  0   6100   1  36        3  05                  10 3 MOSPOP36
50  0   6150   1  48        3  05                  10 3 LCLPOP48
50  0   6100   1  48        3  05                  10 3 MOSPOP48
50  0   6190   1  24        4  05                  10 3 OBSPCP24
50  0   6190   1  36        4  05                  10 3 OBSPCP36
50  0   6190   1  48        4  05                  10 3 OBSPCP48
30 24 231451               4  05                  10 3 00CLIM24
30 36 231450               4  05                  10 3 00CLIM36
30 48 231451               4  05                  10 3 00CLIM48

 03872 13722 13737 13739 13743
     .
     .
     .

999999
//GO.ANY DD DSN=**GOSET,DISP=(OLD,DELETE)
/*
//STP2 EXEC BFORXCLG,COND=(8,LT)
//FORT.SYSIN DD DSN=W.NWS.W42.VD.SOURCE(DRVPEFM),DISP=SHR
//LKED.SYSLIB DD
//            DD
//            DD
//            DD DSN=W.NWS.W42.VD.LOAD,DISP=SHR
//GO.FT03F001 DD DSN=**TMPCDATA,DISP=(OLD,DELETE)
//GO.FT20F001 DD DSN=$WE21VD.CLDRTP00,DISP=(NEW,CATLG),UNIT=TSODA,
//     DCB=(RECFM=VBS,LRECL=80,BLKSIZE=6404),SPACE=(TRK,(50,50),RLSE)
//GO.SYSIN DD *
W0M TMPC    9   4  841001  850331  00  03  20
50  0   2080   1  24        1  05          01  01        OBSMAX24
50  0   2050   1  24        1  05          01  02        LCLMAX24
50  0   2000   1  24        1  05          01  03        MOSMAX24
50  0   2180   1  36        1  05          02  01        OBSMIN36
50  0   2150   1  36        1  05          02  02        LCLMIN36
50  0   2100   1  36        1  05          02  03        MOSMIN36
50  0   2080   1  48        2  05          03  01        OBSMAX48
50  0   2050   1  48        2  05          03  02        LCLMAX48
50  0   2000   1  48        2  05          03  03        MOSMAX48
50  0   2180   1  60        2  05          04  01        OBSMIN60
50  0   2150   1  60        2  05          04  02        LCLMIN60
50  0   2100   1  60        2  05          04  03        MOSMIN60
50  0   6150   1  24        3  05          01  07        LCLPOP24
50  0   6100   1  24        3  05          01  08        MOSPOP24
50  0   6150   1  36        3  05          02  07        LCLPOP36
50  0   6100   1  36        3  05          02  08        MOSPOP36
50  0   6150   1  48        3  05          03  07        LCLPOP48
50  0   6100   1  48        3  05          03  08        MOSPOP48
50  0   6190   1  24        4  05          01  05        OBSPCP24
50  0   6190   1  36        4  05          02  05        OBSPCP36
50  0   6190   1  48        4  05          03  05        OBSPCP48
30 24 231451               4  05          01  06        00CLIM24
30 36 231450               4  05          02  06        00CLIM36
30 48 231451               4  05          03  06        00CLIM48
```

Table 1. Order of variables in the output data records of the reformatting program for each element.

Element	Number of Data Variables Per Record	Order of Variables Column 1 - Column N
Max/Min Temperature/PoP	9	OBSTEMP LCLTEMP MOSTEMP EXPTEMP OBSPCP CLIM LCLPOP MOSPOP EXPPOP
Precipitation Type	7	OBSPPT1 OBSPPT2 OBSPPT3 LCLPPT LCLPOP MOSPPT EXPPPT
Snow Amount	4	OBSSNOW LCLSNOW MOSSNOW EXPSNOW
Wind Speed/Direction	8	OBSSPD LCLSPD MOSSPD EXPSPD OBSDIR LCLDIR MOSDIR EXPDIR
Cloud Amount	4	OBSCLD LCLCLD MOSCLD EXPCLD
Ceiling Height	5	OBSCIG PERCIG LCLCIG MOSCIG EXPCIG
Visibility	5	OBSVIS PERVIS LCLVIS MOSVIS EXPVIS

APPENDIX II

Verification Scores

A. Temperature Verification

Number of cases (NO. OF CASES) - the number of cases which were verified; the total number of cases for which local and guidance forecasts and the corresponding observation were available.

Mean absolute error (MEAN ABS ERROR (MAE)) - an error measure taken without regard to sign.

$$MAE = \frac{1}{N}\sum\left|f_i - o_i\right|$$

where: N = sample size (number of cases),
f_i = the ith forecast,
o_i = the ith (matching) observation, and
$\sum = \sum_{i=1}^{N}$ = summation over all N cases, except where indicated otherwise.

Mean algebraic error (MEAN ALG ERROR) - indicates whether the forecasts were, overall, too high or too low.

$$\text{Mean alg. error} = \frac{1}{N}\sum(f_i - o_i)$$

Root mean square error (ROOT MEAN SQ ERROR) - An error measure that weights large errors more heavily than does the MAE.

$$RMSE = [\frac{1}{N}\sum(f_i - o_i)^2]^{1/2}$$

MAE when absolute error > 6°F (MAE WHEN ABS ERROR GE 6) - MAE of both guidance and forecasts when error of either $\geq$ 6°F.

Mean absolute 24-h temperature variability (24 HR VARIABILITY) - the absolute value of the difference in temperature over a 24-h period.

$$TV = \frac{1}{M}\sum_{i=1}^{M}\left|T_0 - T_{0+1}\right|$$

where: T_0 = temperature
T_{0+1} = temperature 24 hours later
M = number of 24-hour periods

Mean absolute forecast error when TV > 10°F (MAE 24-H VBLTY GE 10) - sum of of mean absolute temperature errors when 24-h observed temperature changes $\geq$ 10°F, divided by the number of such errors.

Improvement over guidance when 24-h variability > 10°F (IMP OVR GUID (24-H VBLTY GE 10)) - Local improvement over guidance of the MAE when 24-h variability $\geq$ 10°F.

$$\text{IMP OVER GUID} = \frac{M-L}{M} * 100$$

where: M = MOS MAE 24-h VBLTY GE 10
L = LCL MAE 24-h VBLTY GE 10

Probability of detection (32°F) (PRBLTY OF DETECTN (32 DEG F)) - fraction of time T_{min} was correctly forecast to be $\leq$ 32°F when previous T_{min} $\geq$ 40°F.

False alarm ratio (32°F) (FLSE ALRM RATIO (32 DEG F)) - fraction of time T_{min} was incorrectly forecast to be $\leq$ 32°F when previous T_{min} $\geq$ 40°F.

PERCENT IN ERROR DEGREE CLASSES -

0-5 =	less than 6° = 100 x (number of 0° to 5°F temperature errors)/(total number of temperature forecasts)
6-10 =	6° to 10° = 100 x (number of 6° to 10°F temperature errors)/(total number of temperature forecasts)
11-15 =	11° to 15° = 100 x (number of 11° to 15°F temperature errors)/(total number of temperature forecasts)
> 15 =	greater than 15° = 100 x (number of temperature errors > 15°F)/(total number of temperature forecasts)

B. Precipitation Verification

NO. OF FORECAST PERIODS - the number of cases which were verified; the total number of cases for which local and guidance forecasts and the corresponding observation are available.

NO. OF PRECIP CASES - the number of times precipitation occurred.

Observed precipitation frequency (OBSVD PRECIP FREQUENCY) - the fraction of the time precipitation occurred.

$$\text{Precipitation frequency} = \frac{\text{Precipitation cases}}{\text{Total number of forecasts}}$$

MEAN POP FORECAST - the mean PoP forecast over the entire sample.

$$MP = \frac{1}{N} \sum_{i=1}^{N} F_i$$

where: F_i = probability forecast
N = number of cases

Mean probability of precipitation when precipitation was observed (MEAN POP (PRECIP))

$$MP = \frac{1}{P} \sum_{i=1}^{P} F_i^p$$

where: P = number of precipitation cases

F_i^p = probability forecast when precipitation was observed.

Mean probability of no precipitation (MEAN POP (NO PRECIP))

$$MN = \frac{1}{N-P} \sum_{i=1}^{N-P} F_i^n$$

where: F_i^n = the probability forecast when precipitation was not observed.

BRIER SCORE - measures the mean square error.

$$BS = \frac{1}{N} \sum_{i=1}^{N} (f_i - O_i)^2$$

where: f_i = probability forecast

O_i = 0 if precipitation was not observed, or 1 if precipitation was observed
N = number of forecasts

Climatological Brier score (CLIMATOLOGICAL BRIER) - same as the BS with the forecasts, f_i, in the calculation comprised of "climatological" values, usually relative frequencies of the event computed by location and month.

Improvement over climatology (IMP OVR CLIMATOLOGY) - a "skill score" expressed in percent.

$$\text{IMP OVR CLIMATOLOGY} = \frac{BSC - BS}{BSC} \times 100$$

where: BSC = climatological Brier score

BS = Brier score

TOTAL PERCENT CORRECT - the fraction of the time a correct forecast was made.

$$PC = \frac{\text{Number of correct forecasts}}{\text{Total number of forecasts}}$$

Forecasts greater than or equal to .50 are considered a forecast of precipitation.

Number of changes to guidance (NO. CHANGES TO GUID) - the number of times the local forecast differed from the MOS forecast.

MEAN ABSOLUTE CHANGE - the mean absolute change made to MOS forecasts.

$$MC = \frac{1}{k} \sum_{i=1}^{k} \left| F_{LCL} - F_{MOS} \right|$$

where: F_{LCL} = Local PoP

F_{MOS} = MOS PoP

and k is the number of cases where $F_{LCL} \neq F_{MOS}$

Number of changes in right direction (NO. CHANGES IN RIGHT DIREC) - the number of times local forecasts differed from MOS and were closer to what actually occurred.

MEAN IN RIGHT DIRECTION -

$$MC = \frac{1}{m} \sum_{i=1}^{m} \left| F_{LCL} - F_{MOS} \right|$$

where: m = the number of changes in right direction

Probability Class (PROB CLAS) - the forecast value.

Number of forecasts (NO. OF FCSTS) - the number of times a particular probability was forecast.

Precipitation cases (PRECP CASES) - the number of times precipitation occurred when the probability forecast was a particular value.

RELIABILITY FREQUENCY

$$RF = \frac{\text{Number of precipitation occurrences}}{\text{Number of forecasts}}$$

RELIABILITY ERROR - the reliability frequency minus the probability class.

C. Precipitation Type Verification

Local and MOS forecasts and the corresponding observations are placed in the following categories:

Category	Type of Precipitation
1	freezing
2	frozen
3	liquid

NOTE: Cases for which the local PoP forecast is less than 30% are not verified.

Bias by category (BIAS) - measures the tendency to overforecast (BIAS > 1) or underforecast (BIAS < 1) a particular category. A bias of 1 indicates no overforecasting or underforecasting. Bias by category refers to the number of forecasts of a particular category (event) divided by the number of observations of that category. A value of 8888. indicates there were no observations of that category, while 9999. indicates there were no forecasts and no observations of that category.

Contingency table--not a score as such, but contains all verification information for the discrete variables. The element X_{ij} in the table is the number of times the forecast was in the jth category and the observation was in the ith category. The row and column totals are also shown here with the subscript p. Various scores can be computed from these elements.

Observed Category	Forecast Category 1	2	...	m	Total
1	X_{11}	X_{12}	...	X_{1m}	X_{1p}
2	X_{21}	X_{22}	...	X_{2m}	X_{2p}
.	.	.		.	.
.	.	.		.	.
.	.	.		.	.
m	X_{m1}	X_{m2}	...	X_{mm}	X_{mp}
Total	X_{p1}	X_{p2}	...	X_{pm}	X_{pp}

Probability of detection (POD1) - The probability of correctly forecasting the threat event. In this case, the threat event is the occurrence of freezing precipitation. The POD is also called the prefigurance.

$$POD1 = \frac{X_{11}}{X_{1p}}$$

where: X_{11} = the number of times category 1 was correctly forecast

and X_{1p} = the number of times category 1 was observed.

Probability of detection (POD2) - The same as POD1, except the threat event is now the occurrence of frozen precipitation.

False alarm ratio (FAR1) - The fraction of the forecasts of the threat event that did not verify. Here, the threat event is the occurrence of freezing precipitation. The FAR is equivalent to subtracting the post agreement from unity.

$$FAR1 = 1 - \frac{X_{11}}{X_{p1}}$$

where: X_{11} = the number of times category 1 was correctly forecast,

and X_{p1} = the number of times category 1 was forecast.

False alarm ratio (FAR2) - The same as FAR1, except the threat event is now the occurrence of frozen precipitation.

Skill score (SKILL) - the fraction of possible improvement afforded by the forecasts over some standard or test set of forecasts. When the term

skill score appears in this document, it means the Heidke skill score in which the test forecasts are values expected by chance computed on the marginal totals of the contingency table.

$$\text{SKILL} = \frac{NC - E}{T - E}$$

where: number correct (NC) = $\sum_{i=1}^{m} X_{ii}$

$$T = X_{pp}$$

$$E = \sum_{i=1}^{m} X_{ip} X_{pi}/T$$

Percent correct (PFC) - the fraction of the time a correct forecast was made, regardless of the category, expressed in percent.

Improvement over guidance (IMP OVR GUID) -

$$\text{IMP OVR GUID SKILL SCORE} = \frac{\text{LCL SKILL} - \text{MOS SKILL}}{\text{MOS SKILL}} * 100$$

D. Snow Amount Verification

Local forecasts and corresponding observations are placed in the following categories:

Category	Snow Amount (inches)
1	<2
2	2-3
3	4-5
4	≥6

MOS forecasts are already broken up into these four categories.

Bias by category (BIAS) - see definition under Precipitation Type Verification.

Percent correct (PFC) - see definition under Precipitation Type Verification.

The following three scores are calculated for categories of ≥2, ≥4, and ≥6 inches:

Probability of detection (POD) - see definition under Precipitation Type Verification.

False alarm ratio (FAR) - see definition under Precipitation Type Verification.

Threat score (TS) - the fraction of the time the threat event was correctly forecast when there was indeed a threat. A threat, for this purpose, is a situation when either the threat event occurred, or was forecast, or both. The threat score is also called the critical success index (CSI).

$$TS1 = \frac{X_{11}}{X_{11} + X_{12} + X_{21}}$$

where X_{11} = number of cases in which event was both forecast and observed,

X_{12} = number of cases in which event was not forecast but was observed,

and X_{21} = number of cases in which event was forecast but was not observed.

Skill score (SKILL) - see definition under Precipitation Type Verification.

Local improvement over guidance (LCL IMPR OVR GUID) - see definition under Precipitation Type Verification.

E. Wind Direction Verification

Local and MOS forecasts and the corresponding observations are divided into categories as follows:

Category	Direction (degrees)
1	338 - 22
2	23 - 67
3	68 - 112
4	113 - 157
5	158 - 202
6	203 - 247
7	248 - 292
8	293 - 337

Cases in which wind speeds (forecasts and/or observation) are less than 10 knots are not included in the sample.

Column totals (CTOT) - the number of times each category was forecast.

Row totals (RTOT) - the number of times each category was observed.

Bias by category (BIAS) - see definition under Precipitation Type Verification.

Skill score (SKILL) - see definition under Precipitation Type Verification.

Improvement over guidance (IMP OVR GUID) - see definition under Precipitation Type Verification.

Mean absolute error (MAE) - see definition under Temperature Verification. (The values used in this score are the original forecasts and observations, not the categorical values.)

F. Wind Speed Verification

MOS and local forecasts and corresponding observations are broken up into the following categories (for projections of 12, 18, and 30 hours):

Category	Wind Speed (kts)
1	< 12
2	13 - 17
3	18 - 22
4	23 - 27
5	28 - 32
6	≥ 33

(for projection of 42 hours):

Category	Wind Speed (kts)
1	≤ 22
2	> 22

Bias by category (BIAS) - see definition under Precipitation Type Verification.

Skill score (SKILL) - see definition under Precipitation Type Verification.

Improvement over guidance (IMP OVR GUID) - see definition under Precipitation Type Verification.

Percent correct (PFC) - see definition under Precipitation Type Verification.

Threat score for upper category (TS1) - see definition under Snow Amount Verification. (The threat event is the forecast or occurrence (or both) of category 6.)

Threat score for upper two categories (TS2) - Same as TS1 except for upper two categories combined. (The threat event is the forecast or occurrence (or both) of categories 5 or 6.)

Mean algebraic error (MEAN ALG ERR) - See definition under Temperature Verification. (Cases in which either LCL or MOS forecasts are less than 10 knots are not included in this score.)

Mean absolute error (MEAN ABS ERR) - See definition under Temperature Verification. (Same restriction as for MEAN ALG ERR).

G. Cloud Verification

Observations are placed into the following categories:

Category	Sky Cover
1	clear (CLR, -SCT, -BKN, -OVC, -X)
2	partly cloudy (SCT)
3	mostly cloudy (BKN)
4	cloudy (OVC, X)

MOS and local forecasts are already broken up into four categories.

Bias by category (BIAS) - see definition under Precipitation Type Verification.

Percent correct (PFC) - see definition under Precipitation Type Verification.

Skill score (SKILL) - see definition under Precipitation Type Verification.

Local improvements over guidance (LCL IMP OVR GUID) - see definition under Precipitation Type Verification.

H. Ceiling Height Verification

Local forecasts and corresponding observations are divided into 4 categories:

Category	Hundreds of Feet
1	0-4
2	5-9
3	10-29
4	$\geq$ 30 (including 888 and 96)

MOS forecasts, which are already categorical, are placed in the following categories:

Category	MOS category
1	1-2 ($\leq$ 400 ft)
2	3 (500-900 ft)
3	4 (1000-2900)
4	5-6 ($\geq$ 3000)

NOTE: MOS ceiling height forecasts are not produced for the 15-h projection.

Bias by category (BIAS) - see definition for Precipitation Type Verification.

Log score - A score that assumes the hazard of a missed forecast is proportional to the absolute value of $\log_{10} f_i - \log_{10} O_i$ where f_i and O_i are the forecast and observed categories, respectively. The log score is the average of these individual values, scaled by multiplying by 50.

$$LS = \frac{50}{N}\sum\left|\log_{10} f_i - \log_{10} O_i\right| = \frac{50}{N}\sum\left|\log_{10}\frac{f_i}{O_i}\right|$$

Percent Correct (PFC) - see definition under Precipitation Type Verification.

Skill score (SKILL) - see definition under Precipitation Type Verification.

Improvement over persistence (IMPRV OVER PERSIS) -

$$\text{IMPRV OVER PERSIS} = \frac{SKILL_f - SKILL_p}{SKILL_p}$$

where: $SKILL_f$ = the forecast (either LCL or MOS) skill score.
$SKILL_p$ = the persistence skill score

I. Visibility Verification

Local forecasts and corresponding observations are divided into 4 categories:

Category	Visibility (miles)
1	< 1
2	1 - 2 3/4
3	3 - 6
4	> 6

MOS forecasts, which are already categorical, are placed in the following categories:

Category	MOS category (vis. in miles)	
1	1-2	(< 1/2 - 7/8)
2	3	(1 - 2 3/4)
3	4-5	(3 - 6)
4	6	(> 6)

Verification scores for visibility are identical to scores for ceiling height verification.