AERMINUTE User's Instructions

1. Purpose

Surface meteorological data collected by the National Weather Service (NWS) and Federal Aviation Administration (FAA) are often used as the source of input meteorological data for AERMOD (EPA, 2010a). A potential concern related to the use of NWS meteorological data for dispersion modeling is the often high incidence of calms and variable wind conditions reported for the Automated Surface Observing Stations (ASOS) in use at most NWS stations since the mid-1990's. In the METAR coding used to report surface observations beginning July 1996, a calm wind is defined as a wind speed less than 3 knots and is assigned a value of 0 knots. The METAR code also introduced the variable wind observation that may include wind speeds up to 6 knots, but the wind direction is reported as missing, if the wind direction varies more than 60 degrees during the 2-minute averaging period for the observation. The AERMOD model currently cannot simulate dispersion under calm or missing wind conditions. To reduce the number of calms and missing winds in the surface data, archived 1-minute winds for the ASOS stations can be used to calculate hourly average wind speed and directions, which are used to supplement the standard archive of hourly observed winds processed in AERMET (EPA, 2010b).

2. Obtaining 1-minute ASOS wind data

Recently, the National Climatic Data Center (NCDC) began archiving the 2-minute average wind speeds for each minute of the hour for most ASOS stations for public access. These 2-minute values have not been subjected to the METAR coding for calm and variable winds, but have also been subjected to only limited quality control measures. The 1-minute ASOS wind data consists of running 2-minute average winds, reported every minute, for commissioned ASOS stations. The 1-minute ASOS wind data can be obtained without cost through the National Climatic Data Center (NCDC) website at ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin/

The 1-minute ASOS winds are in the DSI-6405 format (sub-directories with 6405 as the first four characters in the ftp directory listed above). For each station and year, files are available in monthly blocks, i.e. one file per month for a station. Files are generally named 64050XXXXYYYYMM.dat where XXXX is the four-character station call sign, and YYYY and MM are the 4-digit year and 2-digit month. An example filename for Raleigh-Durham for January 2003 is '64050KRDU200301.dat'. First-order stations' archives generally begin with data for 2000. Other stations' archives generally start in March 2005.

The file format of the 1-minute files can be found at
http://www1.ncdc.noaa.gov/pub/data/documentlibrary/tddoc/td6405.pdf

The general format of a 1-minute file and variable descriptions is shown in Figure 1.

13874KATL	ATL2003010100000500	0.059 N	0.118 N	135	10	125	10	09R60+
13874KATL	ATL2003010100010501	0.058 N	0.118 N	136	9	131	11	09R60+
13874KATL	ATL2003010100020502	0.058 N	0.118 N	141	9	143	11	09R60+
13874KATL	ATL2003010100030503	0.056 N	0.118 N	148	10	164	13	09R60+
13874KATL	ATL2003010100040504	0.054 N	0.119 N	154	11	151	13	09R60+
13874KATL	ATL2003010100050505	0.054 N	0.120 N	157	11	163	13	09R60+
13874KATL	ATL2003010100060506	0.052 N	0.117 N	160	11	166	13	09R60+
13874KATL	ATL2003010100070507	0.053 N	0.117 N	156	10	154	12	09R60+

Variable	Columns
Station WBAN Number	1-5
4-letter station call sign (with leading K in most cases)	6-9
3-letter station call sign (without leading character)	11-13
4-digit year in local standard time (LST)	14-17
2-digit month in LST	18-19
2-digit day in LST	20-21
2-digit hour (00-23) in LST	22-23
2-digit minute (00-59) in LST	24-25
2-digit hour (00-23) in Universal Time Coordinate (UTC)	26-27
2-digit minute (00-59) in UTC	28-29
Visible extinction coefficient at first sensor (N=night, D=day, M=missing)	31-41*
Visible extinction coefficient at second sensor (N=night, D=day, M=missing)	Varies
2-minute average wind direction (deg)	67-71*
2-minute average wind speed (knots)	75-78*
Maximum 5-second wind speed direction (deg)	80-83*
Maximum 5-second wind speed (knots)	85-88*
Runway visual range (hundreds of feet)	92-97*
*Column placement is not always fixed for these variables. Ranges are based on visual inspection of files during program testing.	

Figure 1. General format of an ASOS 1-minute file.

As can be seen in the variable descriptions in Figure 1, the station information (WBAN and call signs) and dates are in fixed formats while the wind data are not always in the same columns. AERMINUTE takes the wind data format variability into consideration when reading the wind data variables during file processing and looks for ranges of columns for the data variables. Also, as discussed in more detail in Section 4.2 and Appendix A, the 1-minute ASOS data files often records with "garbled" data that do not follow any clear format.

3. Processing and hourly averaging

3.1 User inputs

The user must create a file that contains information that controls the processing in AERMINUTE, including several pieces of information about the station as well as the filenames of the 1-minute data files. . The user is prompted for the name of the input file (Figure 2). The

structure and keywords of the file are shown in Figure 3. In the input file, lines that start with '**' in the first two columns are comment lines and are not processed by AERMINUTE. Each section of information is described below.
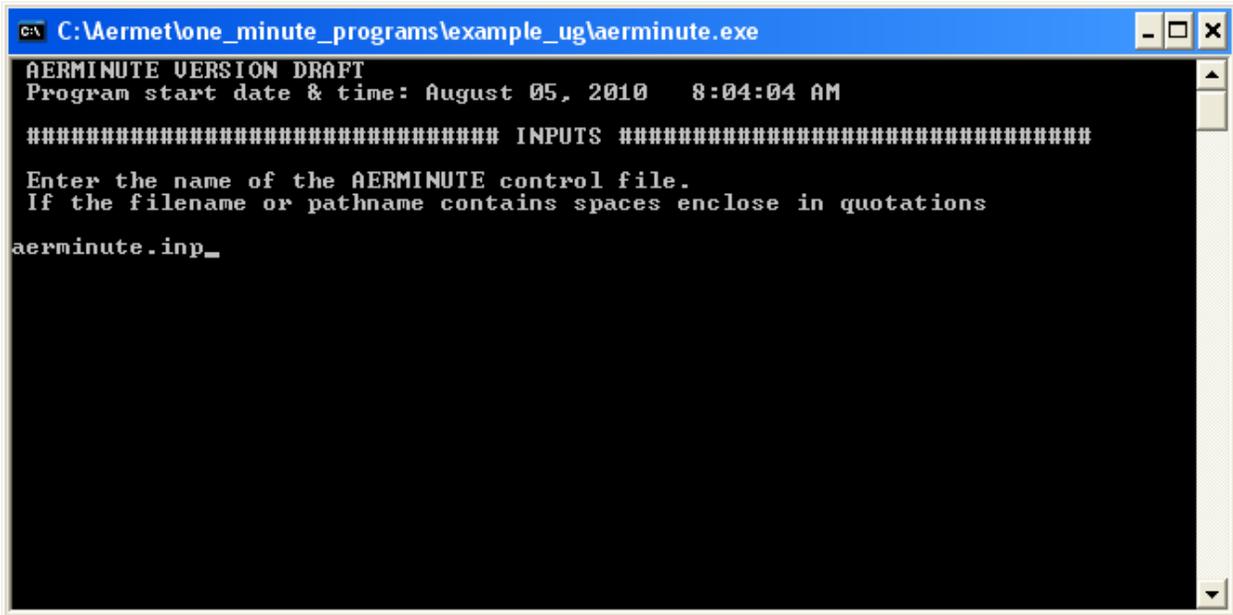

Figure 2. Initial prompt of name of AERMINUTE control file.

```
STARTEND  start_month start_year end_month end_year

IFWGROUP  Status  comm_month comm_day comm_year

DATAFILE STARTING
Datafile list
DATAFILE FINISHED

SURFDATA STARTING            (Optional)
Surface files list
SURFDATA FINISHED

OUTFILES STARTING
HOURFILE name
SUMMFILE name                (Optional)
COMPFILE name                (Optional)
OUTFILES FINISHED
```

Figure 3. AERMINUTE control input file structure.

3.1.1 STARTEND

The keyword STARTEND lists the start month, start year, end month and end year of data processing. These are denoted by the variables *start_month*, *start_year*, *end_month*, and *end_year*. The start day and hour are assumed to be one. The end day is the last day of the end month and the end hour is assumed to be hour 24.

3.1.2 IFWGROUP

The keyword IFWGROUP denotes if the station is part of the Ice Free Winds (IFW) group during the period denoted by the dates listed with STARTEND. The IFW group is composed of NWS and FAA ASOS sites that use sonic anemometers instead of cup and vane anemometers to measure winds. AERMINUTE treats wind speeds less than 2 knots differently based on whether the station uses a sonic or cup and vane anemometer during the data period. A list of stations with their IFW installation dates, as of October 27, 2009, can be found at: http://www.weather.gov/ops2/Surface/documents/IFW_stat.pdf. The variable, *status*, denotes if the station is part of the IFW group. If a station is part of the IFW group during the data period denoted by STARTEND, *status* should be set to an upper or lowercase "Y" followed by the commission month, day, and 4-digit year. The hour of commission is assumed to be hour 1 of the commission date. If a station is not part of the IFW group during the data period denoted by STARTEND or is not part of the IFW group at all, *status* should be set to an uppercase or lowercase "N," and any text after the status variable is ignored. When AERMINUTE detects that the station is part of the IFW group, it checks the commission date against the end date listed in STARTEND. If the commission date is after the end date in STARTEND, AERMINUTE resets the status of the station to "no" and notifies the user. This would be the equivalent of setting IFWGROUP to "N" in the input file. If the IFW commission date is before or after the start date but is before the end date, the IFW status is left unchanged from the user input. For more information about the Ice Free Winds implementation see http://www.nws.noaa.gov/ops2/Surface/asosimplementation.htm

3.1.3 DATAFILE

The DATAFILE section lists the 1-minute data files to be read by AERMINUTE. The DATAFILE section begins with "DATAFILE STARTING." On lines below "DATAFILE STARTING" the user lists the 1-minute data files, one file per line. After the last file, the DATAFILE section ends with "DATAFILE FINISHED." Both "DATAFILE STARTING" and "DATAFILE FINISHED" must be present or AERMINUTE will abort and notify the user of the error.

If multiple 1-minute data files are to be read into AERMINUTE, they do not have to be in temporal sequential order and can cover dates not included in the file processing. However, AERMINUTE will read all the data files, so if the user only wants to process a year or a few months, the user may want to list only those files, or comment out files outside the data period, to speed up processing. The files should be for one station only. If more than one station is detected by AERMINUTE based on the WBAN number, a fatal error is issued and the AERMINUTE program aborts further processing. If a change in the call sign is detected, but the

WBAN number does not change, the user is warned that the station call sign has changed during processing. If the files are in the current working folder[1] or directory, just the filenames can be listed. If the files are in a different folder than the current folder, the filenames should include the full pathame of the files. If the pathname or filenames have spaces in the names, the entire text string should be enclosed in quotations. See Figure 4 for example inputs. In Figure 4a, the files are located in a folder called "example files" that is a subfolder of the current working directory. Note that the entire pathname is in quotations and that the files are not listed in sequential order; i.e. January 2003 is listed at the end. Figure 4b shows files for multiple years that are located in the current working directory.

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[1] Current working folder refers to the folder or directory where processing is taking place. If the user is executing AERMINUTE by double clicking the AERMINUTE executable icon, the current folder is the location of the icon. If the user is executing AERMINUTE from a command line, i.e. DOS, Linux, or Unix window, the current folder or directory is the location the user is in at the time of processing.

```
"example files\64050KATL200302.dat"
"example files\64050KATL200303.dat"
"example files\64050KATL200304.dat"
"example files\64050KATL200305.dat"
"example files\64050KATL200306.dat"
"example files\64050KATL200307.dat"
"example files\64050KATL200308.dat"
"example files\64050KATL200309.dat"
"example files\64050KATL200310.dat"
"example files\64050KATL200311.dat"
"example files\64050KATL200312.dat"
"example files\64050KATL200301.dat"
```
a

```
64050KEWR200301.dat
64050KEWR200302.dat
64050KEWR200303.dat
64050KEWR200304.dat
64050KEWR200305.dat
64050KEWR200306.dat
64050KEWR200307.dat
64050KEWR200308.dat
64050KEWR200309.dat
64050KEWR200310.dat
64050KEWR200311.dat
64050KEWR200312.dat
64050KEWR200401.dat
64050KEWR200402.dat
64050KEWR200403.dat
64050KEWR200404.dat
64050KEWR200405.dat
64050KEWR200406.dat
64050KEWR200407.dat
64050KEWR200408.dat
64050KEWR200409.dat
64050KEWR200410.dat
64050KEWR200411.dat
64050KEWR200412.dat
```
b

Figure 4. Examples of inputfiles.txt for a) files enclosed in quotations, with full pathname, and out of sequential order; and b) files for multiple years in the current working directory.

3.1.4. SURFDATA

The keyword SURFDATA is optional. The SURFDATA section lists data files of standard NWS observations. These are the same files that would be read by AERMET in Stage 1 when processing NWS surface data. Currently, AERMINUTE is only configured to read Integrated Surface Hourly Data (ISHD) in the DS-3505 full archival format. The purpose of reading these

data files is to compare the non-quality controlled 1-minute winds from the 1-minute data files listed in the DATAFILE section against the quality controlled standard observations. The SURFDATA section follows the same syntax as the DATAFILE section. The section starts with the keywords "SURFDATA STARTING" and ends with "SURFDATA FINISHED." The standard observation files are listed between the lines as shown in Figure 3. The listing of the standard observation files also follows the convention of the 1-minute data files, i.e. files with spaces in the names must be listed in quotation marks and full or relative pathnames must be listed when the files are not in the current directory. If processing the standard observations, both "SURFDATA STARTING" and "SURFDATA FINISHED" must be present or AERMINUTE will abort and notify the user. If the SURFDATA section is missing, AERMINUTE will not abort as long as the COMPFILE keyword is not listed in the OUTFILES section (See Section 3.1.5).

3.1.5. OUTFILES

The OUTFILES section lists three files that can be output:

- *HOURFILE*: The hourly averaged winds output from AERMINUTE and formatted for input into AERMET in Stage 2. This keyword is mandatory.
- *SUMMFILE*: A comma delimited summary file that details the number of minutes used for each hour as well as minimum, maximum, and average wind speed and direction. This keyword is optional.
- *COMPFILE*: A comma delimited file that lists the winds from the 1-minute data and standard observations for all observation times listed in the standard observations file. This keyword must be present if the SURFDATA keywords are used or AERMINUTE will abort. If COMPFILE is present and the SURFDATA keywords are not present, AERMINUTE will also abort.

The syntax of the OUTFILES section is similar to DATAFILE and SURFDATA. The section starts with "OUTFILES STARTING" and ends with "OUTFILES FINISHED." Both keyword lines must be present or AERMINUTE will abort.

An example input file for Richmond, VA for 2005 is shown in Figure 5. The data period to process is January through December 2005. The IFWGROUP status is set to yes with a commission date of March 28, 2007. Because the IFW commission date is after the end date of December 31, 2005, AERMINUTE will reset the IFWGROUP status to no and notify the user. The DATAFILES section contains the 12 monthly 1-minute data files as downloaded from the NCDC website. The optional comparison to the standard observations will be performed with the standard observations file listed. This should be the same file as read into AERMET for stage 1 processing of NWS data. Finally, the output files are listed and the optional summary file will be output. Since comparisons against the standard observations will be made, the optional COMPFILE must be listed as well.

```
STARTEND  1 2005 12 2005

IFWGROUP  y 3 28 2007

DATAFILE STARTING
64050KRIC200501.dat
64050KRIC200502.dat
64050KRIC200503.dat
64050KRIC200504.dat
64050KRIC200505.dat
64050KRIC200506.dat
64050KRIC200507.dat
64050KRIC200508.dat
64050KRIC200509.dat
64050KRIC200510.dat
64050KRIC200511.dat
64050KRIC200512.dat

DATAFILE FINISHED

SURFDATA STARTING
724010-13740-2005.dat
SURFDATA FINISHED

OUTFILES STARTING
  HOURFILE  richmod_05.dat
  SUMMFILE  minute_summary_richmond.csv
  COMPFILE  checks_richmond.csv
OUTFILES FINISHED
```

Figure 5. Example AERMINUTE control input file.

3.2. File checking

Once AERMINUTE has read the input control file, the program reads the list of 1-minute data
files and checks that each file exists and that there are no duplicate filenames. If there are non-
existent files or duplicate names, AERMINUTE notifies the users of the filenames and aborts. A
similar procedure is done for the standard observation data files in the SURFDATA section.

3.3 Record processing

Since AERMINUTE reports running 2-minute average winds every minute, non-overlapping
minutes are used in the hourly averages. That is, if winds listed at minute 2 are used, winds
listed at minute 3 are not used but winds listed at minute 4 are used as they do not overlap with
the minute 2 winds. Even minute winds are given first priority in calculating hourly average
winds. The times listed in the data files are assumed to be the ending time, i.e. the winds listed at

minute 2 are for minutes 1 and 2. Winds from minute 1 of any hour are not used at all since the 2-minute average wind spans two hours. The hourly averaged winds are assumed to be hour ending, i.e. hour 1 average winds are from hour 0, minutes 2, 4, 6, etc. Winds for hour 1, minute 0 are also part of the hour 1 averaged winds. Winds in the files are reported for hours 0 through 23. During processing, hour 0 minute 0 winds become hour 24 minute 60 winds of the previous day, since AERMET and AERMOD process hours 1 through 24.

Another issue with 1-minute ASOS wind data that influences the procedures used to process the data is that all ASOS wind speeds, including 1-minute and ASOS data and ASOS data in standard archives, are truncated, rather than rounded, to whole knots. Note that the hourly-averaged wind speeds generated by AERMINUTE are not adjusted to account for the bias introduced by truncating the ASOS wind speeds to whole knots. However, the AERMET processing, beginning with version B10300, applies the truncation adjustment for all ASOS wind speeds, including those derived from 1-minute data (EPA, 2010b).

The following steps are followed when reading a record from the 1-minute files:

- The minute in LST is read from the record. If the minute is less than zero or equal to one, the processing for that record is stopped and the next record is read.
- If the minute is valid (not less than zero or equal to one), the record format of the wind data section is checked. For details about the record format quality check see Appendix A.
- If the record passes the quality control check, the date in LST is read from the record. If the date is outside the processing range, processing stops for the record and processing for the next record begins.
- If the record's date is inside the processing date range, the 2-minute average wind speed and direction are processed as:
  o If the wind speed is less than 2 knots:
    ▪ If the station is not part of the IFW group, or the station is part of the IFW group and the date and time of the record is before the station's IFW commission date, the 2-minute wind is considered to be "calm" and the wind speed is set to half the instrument threshold, i.e., 0.51 m/s (1 knot), consistent with guidance for processing site-specific wind data. The wind speed will be used in calculating the hourly average wind speed but the direction is considered to be invalid and will not be used in calculating the hourly wind direction.
    ▪ If the station is part of the IFW group and the record's date is on or after the station's IFW commission date, the minute is flagged as non-calm and the speeds are converted from knots to m/s, since the threshold for sonic anemometers is effectively zero. The wind speed and wind direction are used in hourly averages.
  o If the wind speed is 2 knots or greater, regardless of IFW group status and date, the 2-minute wind speed is converted from knots to m/s. The wind speed and wind direction are used in hourly averages.
  o AERMINUTE uses a unit vector approach to calculate the hourly-averaged wind direction from the 2-minute average values. The 2-minute wind directions are

converted to x and y-component wind directions using Equations 1 and 2 below, which are the functions inside the summations of equations 6.2.17 and 6.2.18 of the meteorological guidance document (EPA, 2000).

$$v_x = -\sin\theta \tag{1}$$

$$v_y = -\cos\theta \tag{2}$$

where v_x and v_y are the x- and y-components of the 2-minute wind direction θ.

As noted in the bullets above, while reading the 1-minute data files, AERMINUTE determines if any records are within the data period set by the dates listed in STARTEND of the input file. If no records are within the data period, AERMINUTE notifies the user of the earliest and latest dates in the data files and aborts. Such a situation may occur because the user entered the wrong dates on STARTEND or the wrong data files in the DATAFILES section of the input file.

3.4 Flagging 2-minute values for hourly averaging

After processing the 1-minute data files, AERMINUTE determines if any odd minutes are to be used and which hours are to be averaged. AERMINUTE will use all non-overlapping valid minutes to calculate an hourly average. For each valid odd minute (calm or non-calm), if the even minutes just before and just after the odd minute are not valid, the odd minute is flagged as a minute that can be used. For example for hour 1, if minute 3 is valid but minutes 2 or 4 are also valid, minute 3 is not used. However, if both minutes 2 and 4 are not valid, minute 3 can be used in the hourly averaging.

After determining all minutes that can be used for averaging, AERMINUTE determines which hours to average. If an hour has at least two usable non-calm observations in the first half of the hour (minutes 2 through 30) or at least one usable non-calm observation in the last half of the hour (minutes 31 through 60), the hour is flagged as an hour to average. If neither of the previous conditions is met, the hour is flagged as an hour not to average. Only non-calm observations are considered because the calm wind directions are not used. If an hour contained only calm minutes, no wind direction can be computed for the hour, and the hourly-average is coded as missing.

3.5 Quality control

Before hourly averaging of the 1-minute winds is performed, the user can direct AERMINUTE to read the standard hourly observations file that is read into AERMET. Currently this is limited to ISH (DS-3505) files. AERMINUTE reads the standard observations and compares the winds to the winds from the 1-minute data for times when there are observations in the both standard observations files and the 1-minute files. The comparison is done as a quality control step on the 1-minute data to validate against quality controlled data from the standard observations. The following checks are performed:

- For standard observations that are calm, the corresponding 1-minute data are checked for:
  - o The number of missing 1-minute observations
  - o The number of 1-minute observations that are less than 3 knots

- o The number of 1-minute observations that are 3 knots and greater
- For standard observations that are variable, the corresponding 1-minute data are checked for:
  - o The number of missing 1-minute observations
  - o The number of non-missing 1-minute observations
  - o The number of observations where the absolute difference in the 1-minute wind speed and the standard observation wind speed are:
    - 0 m/s
    - 0.1 or 0.2 m/s
    - 0.3 through 0.5 m/s (inclusive)
    - 0.5 through 1.0 m/s (inclusive)
    - 1.0 through 3.0 m/s (inclusive)
    - 3.0 through 5.0 m/s (inclusive)
    - > 3.0 m/s
- For standard observations that are normal or valid, the corresponding 1-minute data are checked for:
  - o The number of missing 1-minute observations
  - o The number of non-missing 1-minute observations
  - o The number of observations where the absolute difference in the 1-minute wind speed and the standard observation wind speed are:
    - 0 m/s
    - 0.1 or 0.2 m/s
    - 0.3 through 0.5 m/s (inclusive)
    - 0.5 through 1.0 m/s
    - 1.0 through 3.0 m/s
    - 3.0 through 5.0 m/s
    - > 5.0 m/s
  - o The number of observations where the absolute difference in the 1-minute wind direction (nearest 10 degrees) and standard observations are:
    - 0 degrees
    - 10 degree increments (10, 20, 30, etc.)

3.6 Averaging

Hourly averaged wind speeds are the arithmetic averages of the wind speeds for all valid minutes for the hour, including those flagged as calm, using half the threshold (Equation 3).

$$S = \frac{1}{N}\sum_{i=1}^{N} s_i \tag{3}$$

Where S is the hourly averaged wind speed, N is the number of valid observations or minutes for the hour, and s_i is the two minute wind speed for minute i.

For wind directions, the x- and y-components of non-calm observations are summed according to equations 6.2.17 and 6.2.18 of the meteorological monitoring guidance (EPA, 2000), summarized in equations 4 and 5 below with v_{xi} and v_{yi} calculated in equations 1 and 2. The

hourly wind direction is calculated based on a unit-vector approach, using equation 6.2.19 of the meteorological monitoring guidance (EPA, 2000), summarized in equation 6.

$$V_X = \frac{1}{N} \sum_{i=1}^{N} v_{xi} \tag{4}$$

$$V_Y = \frac{1}{N} \sum_{i=1}^{N} v_{yi} \tag{5}$$

$$\theta = Arc \tan\left(\frac{V_X}{V_Y}\right) + CORR \tag{6}$$

Where V_x and V_y are the hourly averaged x- and y-components of the wind respectively, θ is the hourly averaged wind direction, N is the number of observations used for the hour, and

$$
CORR =
\begin{cases}
= 180 & \text{for } V_x > 0 \text{ and } V_y > 0 \text{ or } V_x < 0 \text{ and } V_y > 0 \\
= 0 & \text{for } V_x < 0 \text{ and } V_y < 0 \\
= 360 & \text{for } V_x \geq 0 \text{ and } V_y < 0
\end{cases}
$$

4. Outputs

Up to six output files are generated by AERMINUTE, depending on the user options:

- Hourly averaged winds file (HOURFILE), formatted for input to AERMET Stage 2
- Good_records.dat
- Bad_records.dat
- Check_records.dat
- Optional summary file (SUMMFILE)
- Optional standard observations vs. 1-minute data file (COMPFILE)
- AERMINUTE.log

4.1 Hourly winds (HOURFILE)

The hourly average winds file is the file that is input to AERMET stage 2 processing. The filename is set by the user using the HOURFILE keyword in the control input file. The file format of the hourly averaged file is shown in Figure 6. The first line of the file contains information about the AERMINUTE program and the station: AERMINUTE version number, station WBAN, 4-character station call sign, IFW status, and IFW date. If the station is part of the IFW group for the data period, the IFW status is "Y." Otherwise it is "N." The IFW flag is considered for the data period only. If the station becomes part of the IFW group after the data period, the flag will be set to "N." If the station is part of the IFW group for the data period, the

IFW installation date is listed as a character string composed of 4-digit year, 2-digit month, and 2-digit day. If the station is not part of the IFW group for the data period, the IFW date is not listed. For the example shown Figure 6, Richmond International Airport (KRIC) does not become part of the IFW group until March 28, 2007, so the IFW status is no and the date is not included.

Beginning with line two, the hourly averaged winds are listed. The order of variables is listed in Figure 6. AERMINUTE writes the output in a fixed format, but AERMET reads the data in free format, i.e. the data fields are separated by spaces. AERMINUTE writes to a fixed format for visual purposes only. For hours that are missing or not considered valid due to an insufficient number of non-calm observations, the wind speed and direction are both set to 999.0.

```
AERMINUTE  Version B10300 WBAN: 13740    Call sign: KRIC      IFW: N
 5  1  1  1    2.50 201.0
 5  1  1  2    2.29 208.0
 5  1  1  3    2.35 197.0
 5  1  1  4    1.05 199.0
 5  1  1  5    0.97 188.0
 5  1  1  6    2.21 193.0
 5  1  1  7    2.28 193.0
 5  1  1  8    1.78 183.0
 5  1  1  9    0.67 173.0
```

Variables
2-digit year
2-digit month
2-digit day
2-digit hour (1-24)
Wind speed (m/s)
Wind direction (degrees)

Figure 6. Example hourly averaged winds and order of variables.

4.2 Record check files

AERMINUTE generates three files that contain the full 1-minute data records, depending on whether AERMINUTE determines that the record contains "good" data that can be used to calculate the hourly averages, the record do not meet strict quality control checks on the format but may contain useable data, or the record is unusable due to serious formatting problems. Each of these categories of data records are written to separate files in order to fully document the data that were used or rejected by AERMINUTE.

The file 'good_records.dat' contains the records from the 1-minute files that meet the strict quality control checks in AERMINUTE and the winds from these files are considered valid. A detailed description of the quality control check is in Appendix A. These records include those observations for odd minutes that may or may not be used in hourly averages. The user should be able to rename good_records.dat (to avoid overwriting the data during processing), replace the files listed in inputfiles.txt with the renamed file and rerun AERMINUTE and get the exact same

answers as using the full list of inputs. An example of good_records.dat is shown in Appendix A.

The second file is called 'check_records.dat'. This is a file containing records that did not meet the strict quality control of AERMINUTE and are not used in calculating hourly averages, but the wind observations are close to the locations, i.e. column locations, set by strict quality control. These records also contain the flags detailing the quality control failures.   See Appendix A for an example of check_records.dat. Often, manual editing by the user could allow these records to be used by AERMINUTE. When viewing the data, the user should check observations in good_records.dat from the same hour to determine if data is reasonable when compared to other observations for the hour. If there is any doubt about the record, the 'check_records.dat' data should not be used in the hourly averages.

A third file output by AERMINUTE is called 'bad_records.dat'. This file contains records from the 1-minute files that did not meet the strict quality controls in AERMINUTE, and are unlikely to contain usable data. This file also includes flags indicating what quality control checks failed. These records do not meet the criteria outlined for acceptance into good_records.dat and are not used.   See Appendix A for details about the flags. This file should be reviewed by the user since the quality and formatting of the 1-minute files varies from station to station and by year.

If the user determines that additional valid data can be obtained by appropriately editing the 'check_records.dat' data file, the user can rename the 'good_records.dat' and 'check_records.dat' files, replace the files listed in the control input file with these renamed files and rerun AERMINUTE to get new hourly averages.

4.3 Summary file (SUMMFILE)

AERMINUTE can also output a comma delimited summary file that is named via the optional SUMMFILE keyword in the AERMINUTE input file. The SUMMFILE lists each hour in the data period, including those not in the 1-minute files, with counts of minutes for the hour and can be used as a quality assurance check against the hourly averaged winds file. Also included for each hour are the minimum and maximum 2-minute wind speed and direction used in the hourly calculations, as well as the hourly averaged wind speed and direction that are listed in the HOURFILE. The minimum wind speed and direction are unpaired in time, i.e. they may not represent the same time. The same is true for the maximum wind speed and direction. An example of the file is shown in Figure 7, along with the format. If there were observations for an hour, the keep flag for the hour is "V" or "NV." Hours with a keep flag of "V" have hourly averaged winds in the hourly average winds file. Hours with a keep flag of "NV" had observations for the hour but did not meet the completeness criteria for the hour. Hours that were not in the files or had no minutes in the file that met the quality control criteria are denoted by "M" for the keep flag. After the keep flag, the IFW status of the hour is shown. A value of 0 means that the station was not part of the IFW group for that hour. A value of 1 denotes the station was part of the IFW group for the hour. For the minute counts, the number of total minutes read for the hour, total calms, even minutes, even calms, odd minutes, odd calms, odd minutes used in hourly averages, and odd calms used in hourly averages are listed. The maximum number of total minutes or total calms for an hour is 59. The maximum number of

even minutes or even calms for an hour is 30. The maximum number of odd minutes or odd calms is 29 (minute 1 is excluded). The maximum number of odd minutes used or odd calms used is 29. If the number of odd minutes used or odd calms used is 29, then the number of even minutes should be zero, since overlapping observations are not used. When reviewing the minute counts and looking at the raw 2-minute winds, the user should remember that the counts for an hour are for minutes whose actual reporting hour is the hour before; i.e. counts for 0100 are for minutes whose reported hour in the 1-minute files is hour 00.

Date,hr,flag,IFW flag,total minutes,total calms,total even,even calms,total odd,total odd calm,odd used,odd calms used,min speed,avg speed,max speed,min dir,avg dir,max dir
20050101,01,V , 0,59, 0,30, 0,29, 0, 0, 0, 1.53, 2.50, 3.57,182,201,217
20050101,02,V , 0,59, 0,30, 0,29, 0, 0, 0, 1.53, 2.29, 2.55,191,208,225
20050101,03,V , 0,59, 0,30, 0,29, 0, 0, 0, 1.53, 2.35, 3.06,184,197,223
20050101,04,V , 0,59,18,30, 9,29, 9, 0, 0, 0.51, 1.05, 2.04,180,199,244
20050101,05,V , 0,59,28,30,14,29,14, 0, 0, 0.51, 0.97, 1.53,175,188,209
20050101,06,V , 0,59, 0,30, 0,29, 0, 0, 0, 1.53, 2.21, 3.06,186,193,199

Variables	
Date	Date of observation (YYYYMMDD)
Hr	Hour of observation (01-24)
Flag	Flag denoting if hour is valid (V), non-valid (NV), or missing (M)
IFW flag	Integer code corresponding to IFW status (0=not IFW during data period, 1=part of IFW group during data period)
Total minutes	Total number of minutes read from 1-minute files for hour
Total calms	Total number of calm minutes for hour
Total even	Total even minutes read from files for hour
Even calms	Total number of even minutes with calm winds for hour
Total odd	Total odd minutes read from files for hour
Total odd calm	Total number of odd minutes with calm winds for hour
Odd used	Total odd minutes used in hourly average winds for hour
Odd calms used	Total number of odd minutes with calm winds used in hour average winds for hour
Min speed	Minimum 2-minute wind speed (m/s) for the hour
Avg speed	Hourly averaged wind speed (m/s)
Max speed	Maximum 2-minute wind speed (m/s) for the hour
Min dir	Minimum 2-minute wind direction (m/s) for the hour
Avg dir	Hourly averaged wind direction
Max dir	Maximum 2-minute wind direction (m/s) for the hour

Figure 7. Format of SUMMFILE.

4.4 Comparison file (COMPFILE)

AERMINUTE can output the optional COMPFILE that compares the standard observations against the 1-minute observations. The file is comma delimited and the format of the file is shown in Figure 8 using Richmond, VA (RIC) as an example. The file can be imported into a spreadsheet program where the user can look at specific observations to determine if the 1-minute data and the standard observations are in reasonable agreement. For minutes where either the standard observation is missing or the 1-minute data is missing, speeds and directions are listed as 999 and differences as -999.

date(yyyymmdd),hour,minute,calm flag,1-min dir,1-min dir10,1-min speed,1-min speed_1,obs. dir,obs. speed,dirdiff,speeddiff,wind flag,qc flag
20050101, 1, 0,0, 209.0, 210.0,   1.5,   1.5, 210.0,   2.1,   0.0,   0.6,N,5
20050101, 2, 0,0, 198.0, 200.0,   2.0,   2.0, 999.0, 999.9, -999.0, -999.0,9,9
20050101, 3, 0,0, 223.0, 220.0,   1.5,   1.5, 999.0, 999.9, -999.0, -999.0,9,9
20050101, 4, 0,0, 184.0, 180.0,   1.0,   1.0, 999.0, 999.9, -999.0, -999.0,9,9
20050101, 5, 0,0, 185.0, 190.0,   1.5,   1.5, 999.0, 999.9, -999.0, -999.0,9,9
20050101, 6, 0,0, 193.0, 190.0,   2.5,   2.6, 999.0, 999.9, -999.0, -999.0,9,9

Variables	
Date(yyyymmdd)	Date of observation with 4-digit year, month, and day
Hour	Hour of observation (1-24)
Minute	Minute of observation
Calm flag	Integer flag denoting if 1-minute observation is considered calm (0=non-calm,1=calm)
1-min dir	1-minute direction from 1-minute data files
1-min dir10	1-minute direction from 1-minute data files rounded to nearest ten degrees
1-min speed	1-minute wind speed (m/s)
1-min speed_1	1-minute wind speed rounded to nearest tenth of a m/s
Obs. dir	Wind direction from standard observations
Obs. speed	Wind speed (m/s) from standard observation
dirdiff	Difference between 1-minute wind direction and standard observation direction, i.e. 1-min dir10 – obs. dir
speeddiff	Difference between 1-minute wind speed and standard observation speed, i.e. 1-min speed_1– obs. speed
Wind flag	Wind observation type code from standard observation C=calm N=normal R=60 minute average speed Q=squall V=variable 9=missing
QC flag	Wind observation speed quality code from standard observation 0 = Passed gross limits check 1 = Passed all quality control checks 2 = Suspect 3 = Erroneous 4 = Passed gross limits check , from DSI-3280 or NCDC ASOS/AWOS 5 = Passed all quality control checks, from DSI-3280 or NCDC ASOS/AWOS 6 = Suspect, from DSI-3280 or NCDC ASOS/AWOS 7 = Erroneous, from DSI-3280 or NCDC ASOS/AWOS 9 = Passed gross limits check if element is present

Figure 8. Format of COMPFILE.

4.5 Log file

During processing AERMINUTE writes information to the screen and a log file called,
aerminute.log. In Figure 9, a summary of the user inputs is listed. First, the AERMINUTE
version number and program start date and time are listed. Listed below those lines are a
summary of the processing dates and IFW status. In this example, the data period is from
January 1 through December 31 2005. The user entered that the station is part of the IFW group
with a start date of March 28, 2007. AERMINUTE notifies the user that this date is outside the
range of processing dates. Therefore, the IFW status of the station will be set to no.

```
 AERMINUTE VERSION B10300
 Program start date & time: August 09, 2010   8:44:54 AM


 ############################### INPUTS ###############################

 Control input file: richmond.inp
 Summary of dates
 Start date:  1  1 2005
 End Date: 12 31 2005

 Station is part of IFW group
 With start date of  3 28 2007
 But is outside of the range of processed dates


 ####################################################################
```

Figure 9. Input summary section of aerminute.log.

After the user input summary, AERMINUTE checks for existence of the files listed in the
DATAFILES section and if there are any duplicate filenames. Also, if any files are listed in the
SURFDATA section, the existences of the listed files are checked as well to see if there are any
duplicate filenames. In Figure 10, AERMINUTE finds 12 1-minute data files without any
duplicate names. AERMINUTE finds one standard observation file to read and reads the file.

```
######################### 1-MINUTE DATA FILES CHECK #####################
 Checking for duplicate filenames

 No duplicate filenames found

 All files found...
 Number of files to process:  12

 ########################################################################

 ######################### SURFACE FILES CHECK ##########################

 Obtaining surface data filenames

 Checking for duplicate surface filenames

 No duplicate filenames found

 Reading surface files
 Reading surface file 724010-13740-2005.dat

 ########################################################################
```

Figure 10. Data file check section of AERMINUTE.LOG

After reading the standard observation files, AERMINUTE reads the 1-minute data files and lists
the files as they are processed. After processing the files, AERMINUTE lists the number of
processed and non-processed records. Under the processed record counts, the number of records
outside the data period set by the start and end dates are listed and the number of records within
the data period are listed. Under the non-processed records count, subtotals are provided for
records that are minute 1, bad, need checking, or had a bad record for the time. The last subtotal
should be zero, unless there was a severe formatting problem with a file. After the subtotal of
records, AERMINUTE lists the number observations that failed the various quality assurance
checks. These counts are not mutually exclusive; some records may fail multiple checks. Figure
11 lists the record totals and quality assurance checks totals. Note that for the non-processed
record counts and the number of observations that failed various quality control checks, the
counts include observations outside and within the data period set by the start and end dates

20

```
###################### FILE PROCESSING ##########################

 Reading 64050KRIC200501.dat

 Reading 64050KRIC200502.dat

 Reading 64050KRIC200503.dat

 Reading 64050KRIC200504.dat

 Reading 64050KRIC200505.dat

 Reading 64050KRIC200506.dat

 Reading 64050KRIC200507.dat

 Reading 64050KRIC200508.dat

 Reading 64050KRIC200509.dat

 Reading 64050KRIC200510.dat

 Reading 64050KRIC200511.dat

 Reading 64050KRIC200512.dat

 All files read...

 RECORD FORMAT QA

 Total number of records read from files:        458902
   Number of processed records:                  450666
     Number of records outside data period:           1
     Number of records inside data period:       450665
   Number of non-processed records:                8236
     Number of records for minute 1:               7646
     Number of bad records:                         437
     Number of check records:                       153
     Number of bad minute records:                    0
 NOTE: Number of non-processed records includes records outside data period

 QA FLAG SUMMARY COUNT
 FLAG                    DESCRIPTION                                 RECORDS
  1     Non-numeric characters in columns 67 through 90                 251
  2     Text string with leading zero in columns 66 through 90           93
  3     4-character numeric string found in columns 30 through 113      309
  4     Letters D,M, or N not found in column 39, 40, or 41            314
  5     Number in column 67                                             45
  6     No number in columns 70 and 71 for 2-minute wind direction     274
  7     No number in columns 76 and 77 for 2-minute wind speed         390
  8     No number in columns 82 and 83 for 5-second gust wind direction 259
  9     No number in columns 87 and 88 for 5-second gust wind speed    411
 10     Wind speeds and directions outside allowable ranges              2
 11     Other flags switched on, but winds may be okay                 153
 11     Other flags switched on, but record is bad                     437

 ##############################################################
```
Figure 11. File processing section of aerminute.log.

After reading the 1-minute data files, AERMINUTE compares the 1-minute data against the standard observations as outlined in Section 3.5, if the optional COMPFILE keyword is specified. AERMINUTE lists the summaries for standard calm winds, standard missing winds, standard variable winds, and standard valid winds in AERMINUTE.LOG (Figure 12).

DRAFT

```
########################## DATA QC SUMMARY ##########################

STANDARD CALMS
   Number of standard observation calms:    1038
   Number of missing 1-minute winds:         170
   Number of 1-minute winds < 3 knots:       842
   Number of 1-minute winds >= 3 knots:       26

 STANDARD MISSING WINDS
   Number of standard observation missing winds:  3697
   Number of missing 1-minute winds:               340
   Number of non-missing 1-minute winds:          3357

 STANDARD VARIABLE WINDS
   Number of standard observation variable winds:  132
   Number of missing 1-minute winds:                17
   Number of non-missing 1-minute winds:           115

 VARIABLE WINDS:  SPEED DIFFERENCES (M/S)
 Speed difference      Number of minutes
        0                    65
    <= 0.2                   29
 0.3 - 0.5                    7
 0.5 - 1.0                    2
 1.0 - 3.0                   12
 3.0 - 5.0                    0
    > 5.0                     0

 STANDARD VALID WINDS    Number of standard observation valid winds:   4488
   Number of missing 1-minute winds:              694
   Number of non-missing 1-minute winds:         3794

 VALID WINDS:  SPEED DIFFERENCES (M/S)
 Speed difference      Number of minutes
        0                  2218
    <= 0.2                 1095
 0.3 - 0.5                  193
 0.5 - 1.0                  131
 1.0 - 3.0                  131
 3.0 - 5.0                   22
    > 5.0                     4

 VALID WINDS:  DIRECTION DIFFERENCES (DEG)
  Direction difference    Number of minutes
     0                    3354
 <=  10                    286
 <=  20                     84
 <=  30                     37
 <=  40                     14
 <=  50                      6
 <=  60                      4
 <=  70                      2
 <=  80                      1
 <=  90                      2
 <= 100                      0
 <= 110                      1
 <= 120                      1
 <= 130                      0
 <= 140                      1
 <= 150                      1
 <= 160                      0
 <= 170                      0
 <= 180                      0
  > 180                      0


 ####################################################################
```

Figure 12.   Quality control summaries listed in AERMINUTE.LOG.

After file processing and hourly averaging, AERMINUTE writes a summary of the winds to the screen and log (Figure 13). AERMINUTE lists the minimum and maximum 2-minute wind speeds processed along with their directions and date/times. The dates and times listed are the actual reported time for the observations. AERMINUTE also lists the minimum and maximum hourly averaged winds with their directions and date/times. After the summaries, AERMINUTE lists the number of hours in the data period. This is the number of calendar hours, not just hours processed by AERMINUTE. In this example, since an entire year is processed, there are 8,760 hours in the data period. AERMINUTE then lists the number of processed hours, valid hours, and invalid hours along with percentages of the data period. Valid hours are those hours that met the number of observations for hourly averaging criteria in Section 3.3 while invalid hours did not meet the criteria. AERMINUTE also lists the number of valid, invalid, missing, and total hours by month, where total hours it the number of hours in the month, including hours not processed. Finally, AERMINUTE lists the stop time of the program and if the program terminated normally.

```
############################# SUMMARY #############################


 Minimum 2-minute wind speed (knots), direction and original date
(YYYYMMDDHHmm)
   0.00 253 200501010312
 Maximum 2-minute wind speed (knots), direction and original date
(YYYYMMDDHHmm)
  32.00 357 200503080956

 Minimum hourly wind speed (m/s), direction and date (YYYYMMDDHH)
   0.53  89.0 2005022620
 Maximum hourly wind speed (m/s), direction and date (YYYYMMDDHH)
  12.04 353.0 2005030810



 Number of total hours in data period:   8760
 Number of processed hours:   7743 ( 88.39%)
 Number of valid hours:   7354 ( 83.95%)
 Number of processed non-valid hours:    389 (   4.44%)


                    TOTAL   VALID   INVALID   MISSING
 YEAR      MONTH    HOURS   HOURS   HOURS     HOURS
 -------------------------------------------------------
 2005    January     744     700       4        40
 2005    February    672     640      29         3
 2005    March       744     651      19        74
 2005    April       720     540      21       159
 2005    May         744     659      19        66
 2005    June        720     642      29        49
 2005    July        744     646      37        61
 2005    August      744     465      74       205
 2005    September   720     380     127       213
 2005    October     744     671       7        66
 2005    November    720     687       7        26
 2005    December    744     673      16        55


 #####################################################################

 Normal termination

 Program end date & time: August 09, 2010   8:45:11 AM


 #####################################################################
```

Figure 13. Summary section of aerminute.log

5. References

EPA, 2000: Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA-454/R-99-005. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

EPA, 2010a: Addendum - User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

EPA, 2010b: Addendum - User's Guide for the AERMOD Meteorological Preprocessor (AERMET). EPA-454/B-03-002. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Appendix A: Record Quality Control Check Methodology

This appendix details the quality control checks made on 1-minute data records. Below are the quality control flag descriptions as well as example good_record.dat, bad_record.dat, and check_record.dat files. The following quality control checks are made on each record of the 1-minute files. The checks are made in the order shown in Table A-1. Flag values of 0 are pass, values of 1 are fail.

Table A-1. Quality control checks on 1-minute winds read by AERMINUTE.

Flag	Check	Flag value	
		0	**1**
1	Check columns 67 through 90 for any non-numeric characters (alphabetic or punctuation characters). Columns 67 through 90 should only contain numbers or spaces.	No non-numeric characters in the column range	At least one non-numeric character in the column range.
2	Check columns 66 through 90 for character strings that have a leading space followed by a zero and then a non-zero number (" 01", " 02", etc.) In the 1-minute files, the wind data is right-justified without leading zeros. So a wind direction of 2 degrees would not be reported as 02 but as 2.	No text strings of leading zero in column range.	Text string with leading zero present in column range.
3	Check columns 30 through 113 for a 4-character string, consisting of numbers representing a possible time, i.e. 11:11 AM would be ' 1111' or 10:59 PM would be ' 2259'. These strings should not be in the record after column 29.	No strings found	A time string found in columns 38 through 90
4	Check for first visual extinction coefficient. Check columns 39, 40, or 41 for the existence of one of the following characters: D, N, or M.	D, N, or M is in columns 39, 40, or 41.	D, N, or M is not in columns 39, 40, and 41.
5	Check column 67 for a number. There should not be a number in column 67.	No number in column 67	Number present in column 67
6	Check columns 70 and 71 for the 2-minute average wind direction. Experience has shown that the columns for wind direction can range from column 68 to 73. Checking these two columns covers the entire range. Check column 71 first and if it is blank, check column 70.	Columns 70 or 71 contain a numeric character	Columns 70 and 71 are blank
7	Check columns 76 and 77 for the 2-minute average wind speed. The range of the wind speed has covered a range, similar to the 2-minute wind direction. Checking columns 76 and 77 covers the entire range. Check column 77 first and if it is blank check column 76.	Columns 76 or 77 contain a numeric character	Columns 76 and 77 are blank
8	Check columns 82 and 83 for the five second gust wind direction. The range of the wind speed has covered a range, similar to the 2-minute wind direction. Checking columns 82 and 83 covers the entire range. Check column 83 first and if it is blank check column 82.	Columns 82 or 83 contain a numeric character	Columns 82 and 83 are blank
9	Check columns 87 and 88 for the 2-minute average wind speed. The range of the wind speed has covered a range, similar to the 2-minute wind direction. Checking columns 87 and 88 covers the entire range. Check column 88 first and if it is blank check column 87.	Columns 87 or 88 contain a numeric character	Columns 87 and 88 are blank
10	If flags one through eight are all zero, read the 2-minute average wind direction, 2-minute average wind speed, five second gust direction, and five second gust speed from columns 68 through 90. If one of the directions is negative or less than 360 degrees or one of the speeds is negative or more than 50 knots set the ninth flag equal to one. Also set the eleventh flag equal to 9, regardless of direction and speed check just noted.	If flags 1 through 8 are zero and wind data meets range criteria **OR** One of the flags 1 through 8 is non-zero. Check for flag 9 is not performed so flag is left at zero.	Wind data does not meet range criteria.

If flags 1 through 9 are zero and flag 10 is zero, flag 11 is set to 9. If at least one of the flags is equal to one and flags 2 and 3 flags are zero, the record may be usable but does not fit the strict quality control criteria. AERMINUTE reads columns 67 through 90 and checks for four or five numeric fields. If four or five numeric fields are found, AERMINUTE performs the same checks as done for flag 10; positive wind directions less than or equal to 360 degrees and positive wind speeds less than 50 knots. If none of those conditions are not met, set flag 11 equal to eight. Otherwise if at least one of the conditions is met, set flag 11 equal to the number of numeric fields read from the line. If four or five fields are not found, set the eleventh flag equal to the number of fields read from the line.

Once all eleven flags have been set, get the maximum value among flags 1 through 10. If the maximum value is zero, the record is considered good and will be further processed. Also write the record to good_records.dat.   If the maximum value for the first ten flags is not zero and the eleventh flag is equal to four or five, write the line to check_records.dat. If the maximum value among the first ten flags is not zero and the eleventh flag is not equal to four or five, write the record to bad_records.dat. Do not use the record if it is written to bad_records.dat or check_records.dat

In Figure A-1, are example records from good_records.dat which contains records that meet the strict quality control checks above. Records in this file have zeros for the first ten flags and a value of nine for the eleventh flag. The flags are not displayed for these records. The text string "123456 1234 123 1234" is used as reference to denote where the wind variables should generally be:

123456   2-minute average wind direction
1234   2-minute average wind speed (whole knots)
123   5-second maximum wind gust's direction
1234   5-second maximum wind gust's speed (whole knots)

In Figure A-1, the actual column numbers in the data file for each of the above text strings are listed above each string, i.e., "123456" corresponds to columns 68 through 73. Also shown in Figure A-1, is the location of column 39. The above checks are met (in order as listed above):

- No non-numeric characters in columns 67 through90
- No leading zero numbers in columns 66 through 90
- No possible time strings outside of the station/date information block
- Columns 39,40, or 41 contain the letters N, D, or M
- No number in column 67
- A number is present in columns 70 or 71
- A number is present in columns 76 or 77
- A number is present in columns 82 or 83
- A number is present in columns 87 or 88
- All above conditions are met, read the wind data and winds meet direction and speed criteria

	39				**68-73**	**75-78**	**81-83**	**86-89**	
					123456	1234	123	1234	
13874KATL ATL2003010100000500	0.059 N		0.118 N		135	10	125	10	09R60+
13874KATL ATL2003010100020502	0.058 N		0.118 N		141	9	143	11	09R60+
13874KATL ATL2003010100030503	0.056 N		0.118 N		148	10	164	13	09R60+
13874KATL ATL2003010100040504	0.054 N		0.119 N		154	11	151	13	09R60+
13874KATL ATL2003010100050505	0.054 N		0.120 N		157	11	163	13	09R60+
13874KATL ATL2003010100060506	0.052 N		0.117 N		160	11	166	13	09R60+
13874KATL ATL2003010100070507	0.053 N		0.117 N		156	10	154	12	09R60+

Figure A-1. Example good_records.dat file.

In Figure A-2, are example records from check_records.dat. In check_records.dat, the values for the eleven flags are listed at the end of the record. The text strings are as described for Figure A-1. For a record to be written to check_records.dat, flags 1, 2 and 3 must be zero, no non-numeric characters in columns 67 through 90 (flag 1), no leading zero numbers (flag 2), and no 4-digit time strings (flag 3). Also, four numeric fields should be present in columns 67 through 90 and at least one of the wind data fields meet the wind direction and speed range criteria. Table A-2 describes the situations found for each data record and possible solutions.

```
                                       39                        68-73   75-78  81-83 86-89
                                                            123456 1234   123   1234
13874KATL ATL2003010522530353   0.064 N            0.124N   305      7    303     8   09R60+              00001100004
13874KATL ATL2003030305511051   0.155 N            0.249 N  291      5    291     5   09R60+              00011100004
13874KATL ATL2003091301240624   0.                 0.172 N   74      6     76     6   09R60+              00010000004
13874KATL ATL2003111806131113   0.119 N            0.179 N  120      6    136     8   09R60+              00001100004
```

Figure A-2. Example check_records.dat file.

Table A-2. Description of records in check_records.dat file.

Record number*	Non-zero flags	Situation	Possible solution
1	5 and 6	Number in column 67 and columns 70 and 71 are blank	All other flags are zero, shift wind data to one column to right.
2	4, 5, and 6	N, D, or M not in columns 39, 40, or 41; Number in column 67 and columns 70 and 71 are blank	Shift text in record one column to right, beginning with column 38.
3	4	N, D, or M not in columns 39, 40, or 41	Place N, D, or M in column 39
4	5 and 6	Number in column 67 and columns 70 and 71 are blank	All other flags are zero, shift wind data to one column to right.

*actual line number in file is record number plus one.

Once any records have been changed, the user can rename good_records.dat and check_records.dat, enter the new filenames in inputfiles.txt in place of the original data, and AERMINUTE can be rerun with the original good records and updated records from check_records.dat.

Example records from bad_records.dat are shown in Figure A-3. As with the previous examples, certain column numbers are denoted. In the first record, the record fails the quality control check because there is a suspected time string in columns 30 through 90 and non-numeric characters in columns 67 through 90, the string "09R60+" is in columns 80 through 85. Also, the same text string triggers the leading zero flag (flag 2). Other records shown in Figure A-3 fail the quality control checks because flag 1 is triggered, non-numeric characters in columns 67-90. These are missing wind fields as denoted by the letter "M."

	39		68-73	75-78	81-83	86-89	
			123456	1234	123	1234	
13874KATL ATL2003020301130613	0.102 N	0.169 N	2209	6	09R60+		11100000100
13874KATL ATL2003020507501250	M M	0.084 D	M	M	333	12 09R60+	10000110000
13874KATL ATL2003020507511251	-1.000 N	0.099 D	M	M	M	M 09R60+	10000111100
13874KATL ATL2003020507521252	0.050 D	0.103 D	M	M	320	10 09R60+	10000110000

Figure A-3. Example bad_records.dat file