M E M O R A N D U M

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SUBJECT: RESOLVING SOURCES OF DIFFERENCES IN PERFUM METHYL ISOTHIOCYANATE BUFFER ZONES BETWEEN BAKERSFIELD AND VENTURA

Background

The Department of Pesticide Regulation draft methyl isothiocyanate mitigation proposal (DPR, 2007) includes buffer zone tables developed using output from three air dispersion modeling approaches. Each approach has inherent strengths and weaknesses so all three were provided to risk managers, who make the final determination of the length of mitigation buffers zones. Those modeling approaches are: (1) screening method, (2) the Probabilistic Exposure and Risk Model for Fumigants (PERFUM) version 2 modeling system (Reiss and Griffin, 2005), and (3) the Fumigant Emissions Modeling System v5.074 (FEMS) modeling system (Sullivan et al., 2006). In addition, meteorological data from two locations were used, Bakersfield and Ventura, California. Details of buffer zone development and the modeling are presented in Barry (2006) and Barry (2007). The buffer zones developed using each of the models and locations for the same application methods and rates are expected to differ to varying degrees for a variety of reasons. You asked for a discussion of the sources of differences in PERFUM buffer zones between the Bakersfield and Ventura locations.

PERFUM uses weather data from the Bakersfield Automated Surface Observing System (ASOS) for the years 1999 through 2003 and the Ventura California Irrigation Management Information System (CIMIS) for the years 1995 through 1999. Figures 1 through 4 show the buffer zones for Bakersfield and Ventura applications made to square fields at the maximum application rate (320 lb metam sodium/acre) and application sizes of 1, 5, 10, 20, and 40 acres. When the buffer zones are different the Bakersfield buffer zones tend to be shorter (Figures 1 through 4). With the exception of the 10acre intermittent sprinkler scenario, Bakersfield buffer zones were between 27% and 45% shorter than Ventura. Most Bakersfield buffer zones were approximately 40% shorter than Ventura buffer zones. The 40acre standard sprinkler and standard shank scenarios cannot be examined because the PERFUM buffer zone length limit of 1440m is reach for both of these scenarios. The true length of the required buffer zone is unknown. The 10acre intermittent sprinkler scenario demonstrates an effect of the shape of the buffer zone distributions on final buffer zone size. The Ventura 90th percentile buffer zone length for this scenario is 5m but the 95th percentile buffer zone is 45m. Thus, the large difference between Bakersfield and Ventura for this scenario is a product of the difference in shapes at and near the 95th percentile position of these two buffer zone length distributions. This factor is one of several sources of differences between buffer zones developed using meteorological data from these two locations.

The objective of this memorandum is to explore and characterize sources of differences in PERFUM buffer zones between the two locations, Bakersfield and Ventura, California.

Analysis

The Bakersfield and Ventura meteorological files used with the PERFUM model to develop the MITC buffer zones were processed to extract the meteorological data for the averaging periods that determined the MITC buffer zones for each application method. The MITC threshold concentration is 220ppb 8-hr Time Weighted Average (TWA). So, there are three 8-hr periods per day. The 8-hr period with the longest buffer zone is the averaging period that determines the buffer zone length. The application methods and buffer zone determining averaging periods are shown in Table 1.

The calm hours were removed before analysis since those hours are not used by the PERFUM model. MINITAB (2005) statistical software was used to produce histograms and statistical summaries. The meteorological variables analyzed are not expected to conform to the normal distribution. Thus, results presented are limited to nonparametric measures such as the median and the inter-quartile range. The inter-quartile range is the difference between the third (75th percentile) and first quartile (25th percentile) of the data and its expectation is that 50% of the data is captured in that range. The inter-quartile range is unaffected by outlier values and gives a distribution free gauge of dispersion.

Results

Figures 5 through 7 show a comparison of frequency of wind direction between Bakersfield and Ventura. Frequency in these figures is number of hours. Both locations show bi-modal distributions with Ventura showing a very distinct and narrow peak of frequencies in each of the figures. The frequencies of Bakersfield directions are more scattered but still do exhibit the bi-modal distribution.

Figures 8 through 10 show box-plots of the wind speeds at Bakersfield and Ventura. The median wind speed is indicated by the line inside the box and is labeled. The median wind speed is similar between locations. Bakersfield shows higher maximum wind speed than Ventura for all

three scenarios but tends to have a smaller inter-quartile range. This means that the mid-range (50%) of the wind speeds at Bakersfield fall within a narrower range than at Ventura. This feature will affect the stability class distributions at Bakersfield relative to Ventura.
Figures 11 through 13 show a comparison of frequency of stability classes between Bakersfield and Ventura. Figure 11 shows that for the standard sprinkler and shank scenario which has a buffer zone determined by night hours that Bakersfield has more hours of Stability classes 6 and 7 (highly stable). Ventura shows a more even distribution of frequency between Stability classes 4 through 6. Figure 12 shows Ventura with predominately Stability class 3, Bakersfield with Stability class 2. This scenario has a few early hours that may be night hours some times of the year but the period is predominately daytime. Figure 13 shows Ventura with Stability classes 3 and 4 as most common, Bakersfield with Stability Class 4 followed by Stability classes 5 and 6. This scenario has an averaging period that can be evenly split between night and day some times of the year but can also be mostly night hours during the winter months.

Discussion

The buffer zones developed using the Ventura meteorological data are longer than those developed using the Bakersfield meteorological data. These two data sets are from different sources, CIMIS (Ventura) versus ASOS (Bakersfield). In addition, the five year spans are different: 1999 through Ventura and 1995 through 1999 for Bakersfield. These two factors alone contribute an unknown but potentially substantial portion of the differences observed.

The wind direction histograms provide the most compelling evidence for the source of the differences. The Ventura wind direction histograms illustrate the well-known diurnal land/sea wind direction shift (Dorman and Winant, 2000; Ventura APCD, 2003). The wind directions at the Ventura CIMIS station exhibit narrow frequency peaks indicating persistent wind direction. The averaging time for MITC is 8 hours so effectively only half of the diurnal (24 hour) wind shift pattern is included in the averaging period. Thus, this wind direction pattern results in many hours of MITC mass distributed in the same direction. Conversely, the Bakersfield wind direction histograms exhibit a more spread out wind direction histogram where the direction tends to shift during the 8 hour averaging period. This Bakersfield wind direction pattern coupled with the lower wind speed and more frequent highly stable hours leads to a more narrow MITC plume that is less likely to have a downwind centerline concentration in one persistent direction over the threshold averaging period. Even a small shift in wind direction under the highly stable atmospheric conditions will spread the centerline contribution over a wider area and lead to a shorter maximum direction buffer zone. The land/sea diurnal wind direction pattern in Ventura that has the potential to generate smaller maximum direction buffer zones for fumigants with threshold concentrations averaged over 24 hours leads to longer buffer zones when only half of that diurnal pattern is included a shorter averaging period.

In conclusion, the MITC 8-hour TWA buffer zones developed using the Ventura CIMIS meteorological data tend to be longer than those developed using the Bakersfield ASOS meteorological data because of the more persistent wind directions exhibited over the 8-hour averaging period at Ventura.

References

Barry, T. 2007. Development of additional methyl isothiocyanate buffer zones for the metam sodium mitigation proposal. Memorandum dated February 8, 2007 to Charles Andrews, Chief, Worker Health and Safety Branch. Environmental Monitoring Branch, Department of Pesticide Regulation, California Environmental Protection Agency.

Barry, T. 2006. Development of methyl isothiocyanate buffer zones using the Probabilistic Exposure and Risk Model for Fumigants Version 2 (PERFUM2). Memorandum dated January 27, 2006 to Charles Andrews, Chief, Worker Health and Safety Branch. Environmental Monitoring Branch. Department of Pesticide Regulation. California Environmental Protection Agency. EM06-05

DPR. 2007. Mitigation Proposal: Control of Off-site and Bystander Short-term Exposure to Methyl Isothiocyanate (MITC) from Metam Sodium and Metam Potassium Applications. January 5, 2007. Department of Pesticide Regulation. California Environmental Protection Agency. 1001 I Street, Sacramento, California 95814. Available at: <www.cdpr.ca.gov/docs/emon/methbrom/mitc_proposal.pdf>.

Dorman, C.E. and C.D. Winant. 2000. The structure and variability of the marine atmosphere around the Santa Barbara Channel. Monthly Weather Review 128:261-282.

MINITAB. 2005. MINITAB Statistical Software. Release 14.20. MINITAB, Inc. Sate College, Pennsylvania 16801-3008.

Riess, R. and J. Griffin. 2005. User's guide for the Probabilistic Exposure and Risk model for FUMigants (PERFUM), version 2. October 17, 2005. Sciences International.

Sullivan, D., D.J. Hlinka, M.T. Holdsworth, and R.D. Sullivan. 2006. Fumigant Emission Modeling System v5.074. Sullivan Environmental Consulting.

U.S. EPA. 1995. User's guide for the Industrial Source Complx (ISC) dispersion models. Volume I-User Instructions. U.S.EPA Office of Air Quality Planning and Standards. Emssions, Monitoring, and Analysis Division. Research Triangle Park, North Carolina 27711. EPA-454/B-95-003a.

Ventura APCD. 2003. Ventura County air quality assessment guidelines. Ventura County Air Pollution Control District. Planning and Evaluation Division. 669 County Square Drive, 2nd. Floor. Ventura, California 93003. October 2003.

Table 1. Application methods and averaging periods analyzed to characterize the source of buffer zone differences developed using the PERFUM model with Bakersfield versus Ventura meteorological data. The averaging period numbering is relative to the studies used to develop the flux profiles. Period 1 begins with the commencement of the application. Each averaging period is 8 hours. The periods are numbered 1 through 3 on each day of the 4-day flux profile. The Day/Night column indicates the predominant type of hours in the averaging period.

Application Method Flux Profile	Averaging Period	Hours	Day/Night
Standard Sprinkler	3	2400 – 0700 hrs	Night
Standard Shank	3	2400 - 0700 hrs	Night
Intermittent Sprinkler, Bakersfield	1	0600 – 1300 hrs	Day
Intermittent Shank, Lost Hills	2	1600 – 2300 hrs	Mix

Figure 1. Intermittent sprinkler, period 1 (0600 hrs–1300 hrs). Comparison of buffer zone length (m).

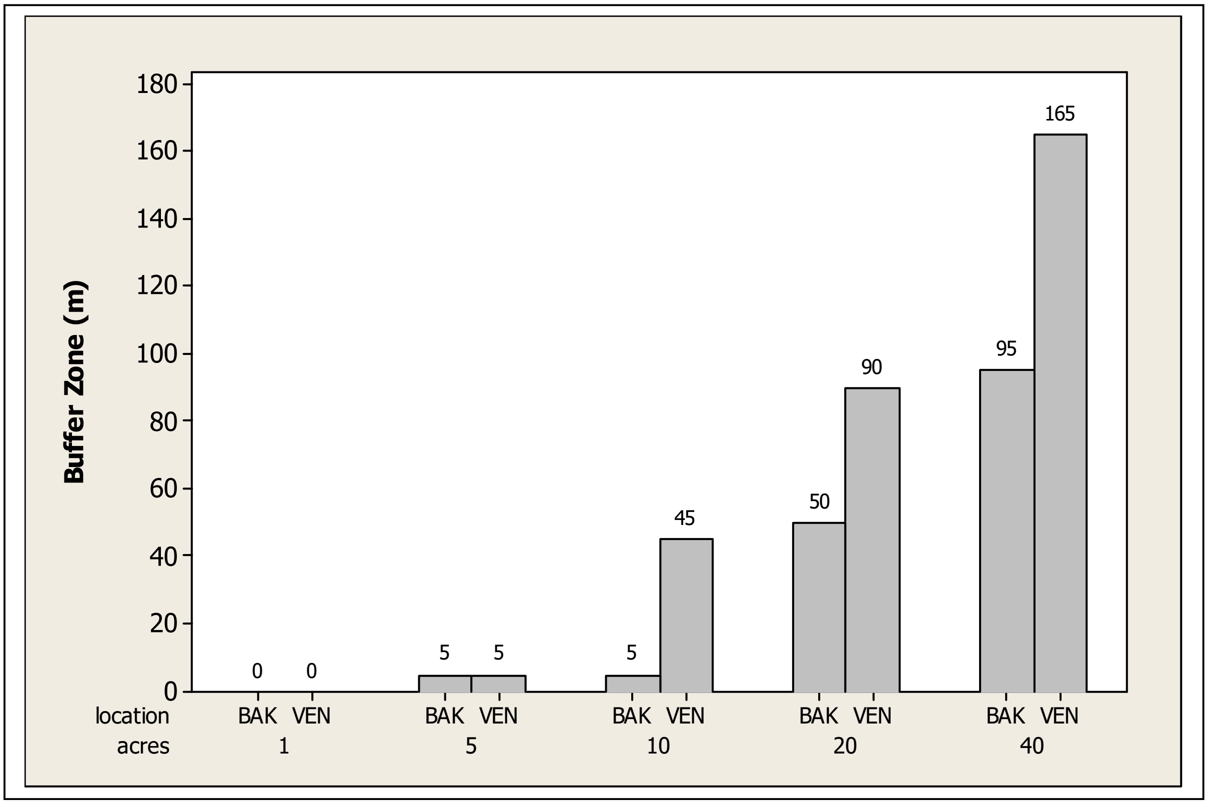

Figure 2. Intermittent shank, period 2 (1600 hrs–2300 hrs). Comparison of buffer zone length (m).

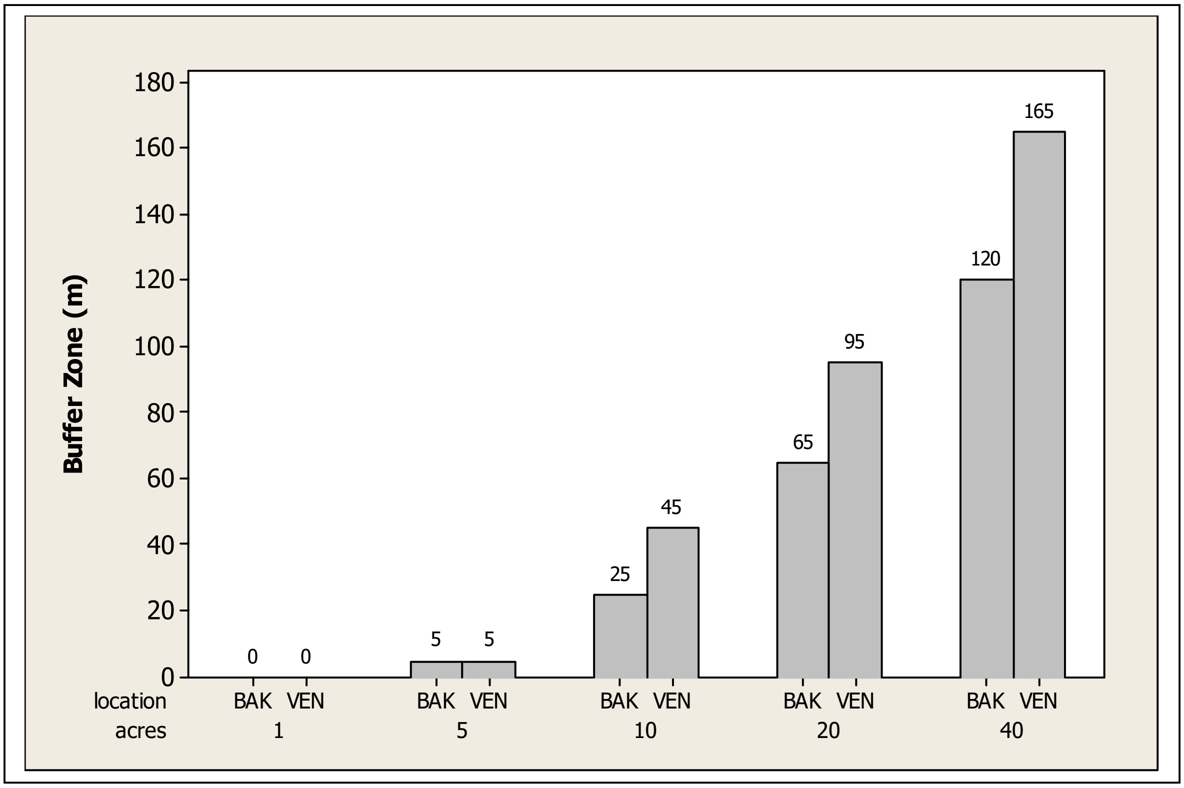

Figure 3. Standard sprinkler, period 3 (2400 hrs–0700hrs). Comparison of buffer zone length (m).

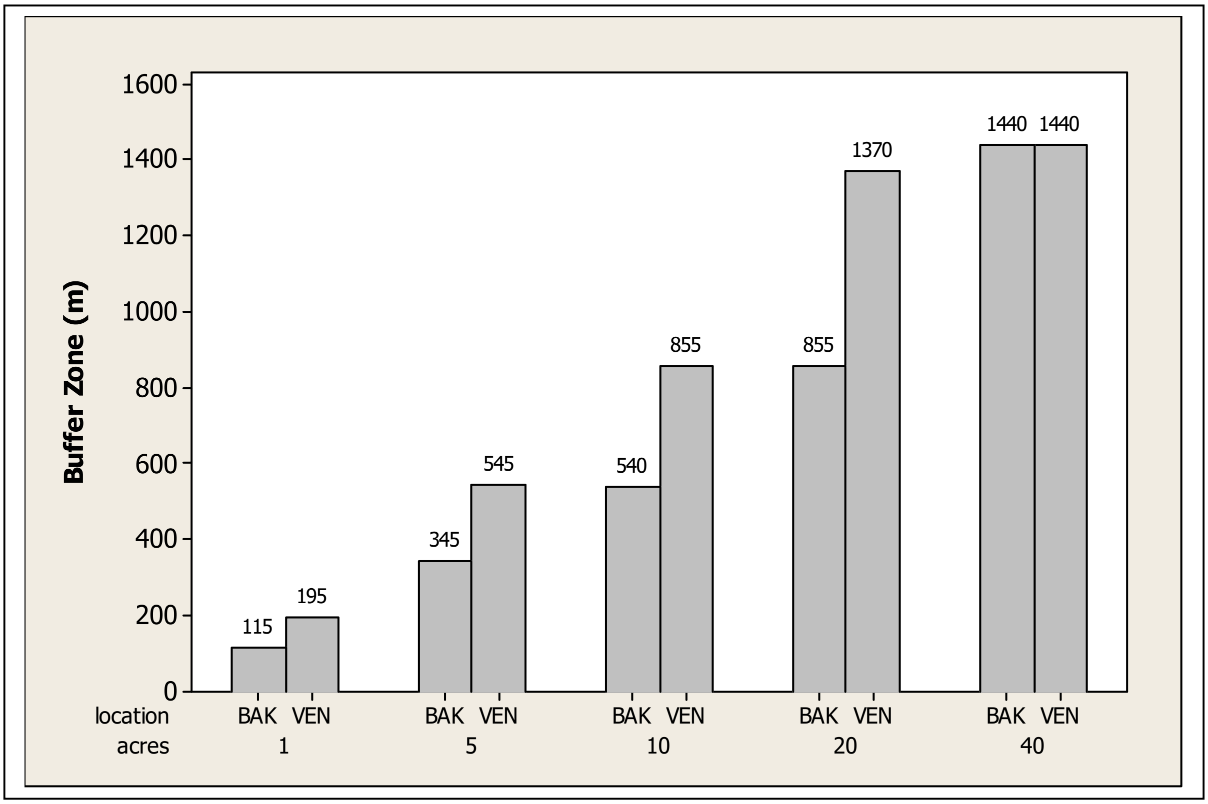

Figure 4. Standard shank, period 3 (2400 hrs–0700hrs). Comparison of buffer zone length (m).

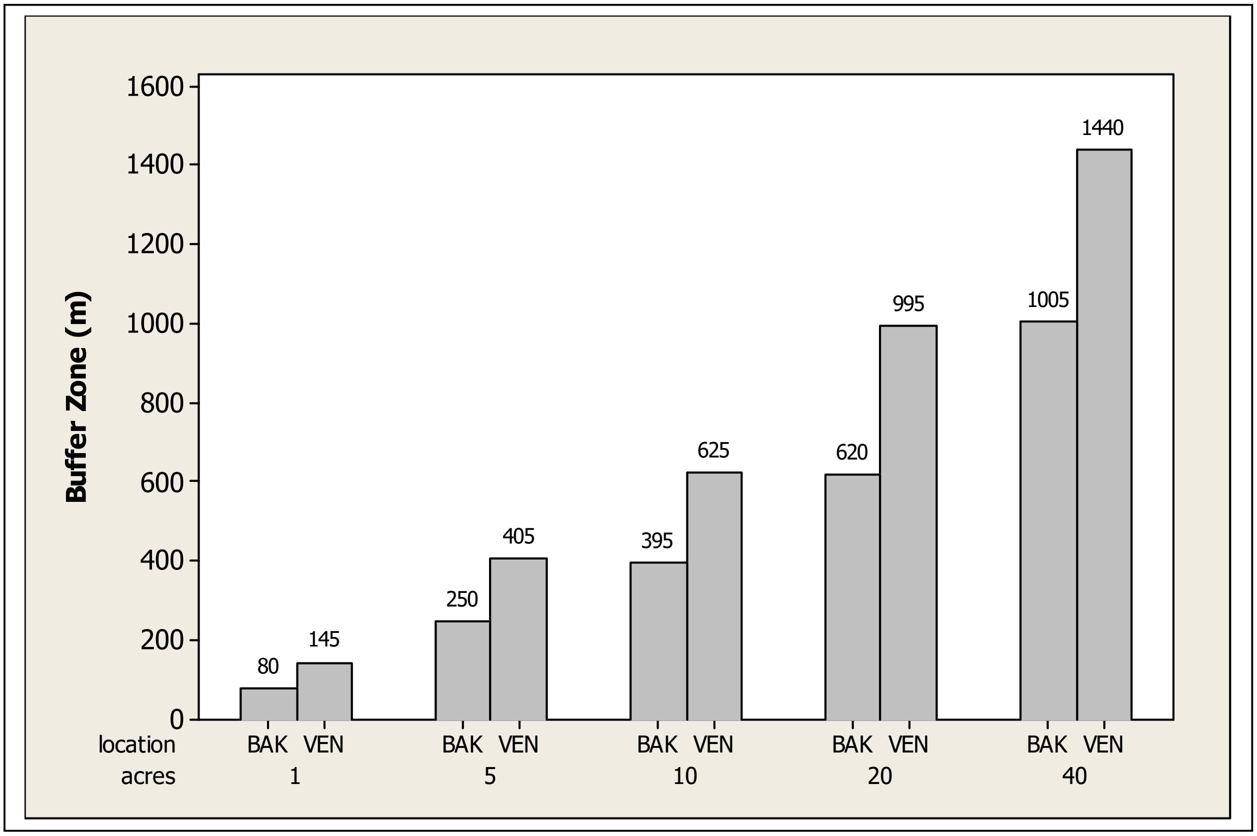

Figure 5. Standard sprinkler and standard shank, period 3 (2400 hrs–0700hrs) wind direction frequency distribution. Frequency is number of hours.

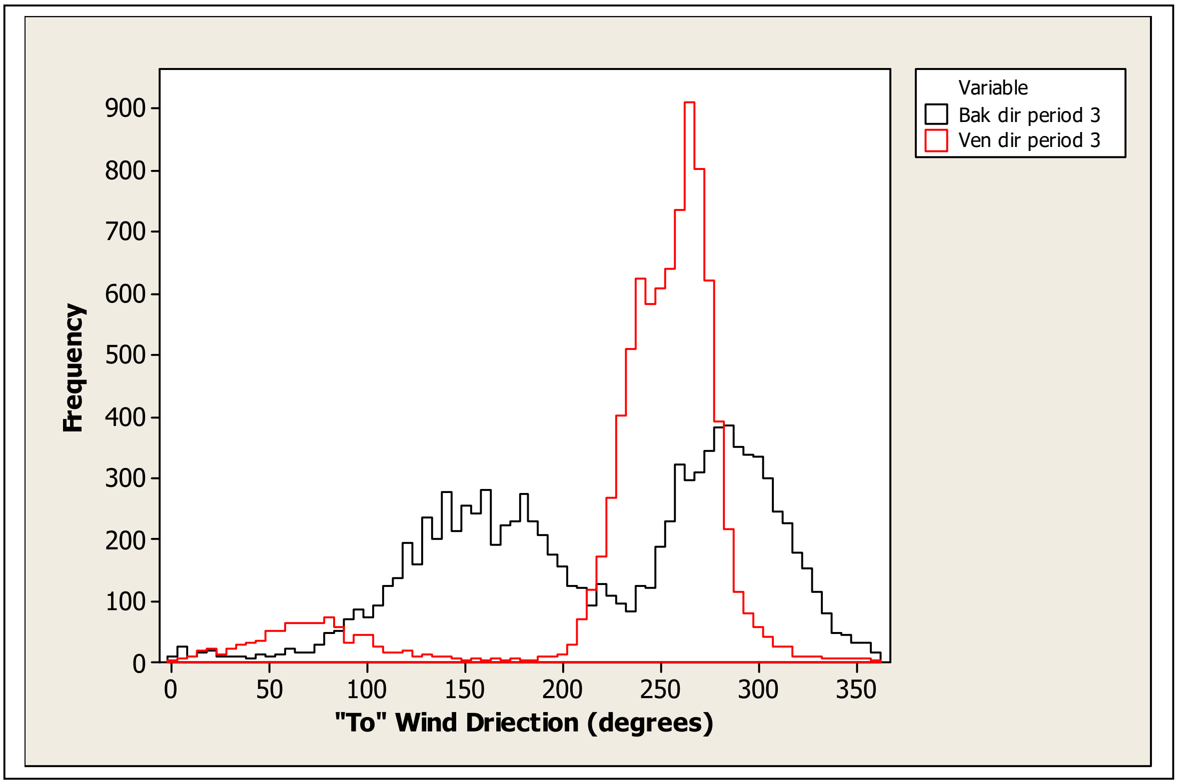

Figure 6. Intermittent sprinkler, period 1 (0600 hrs–1300 hrs) wind direction frequency distribution. Frequency is number of hours.

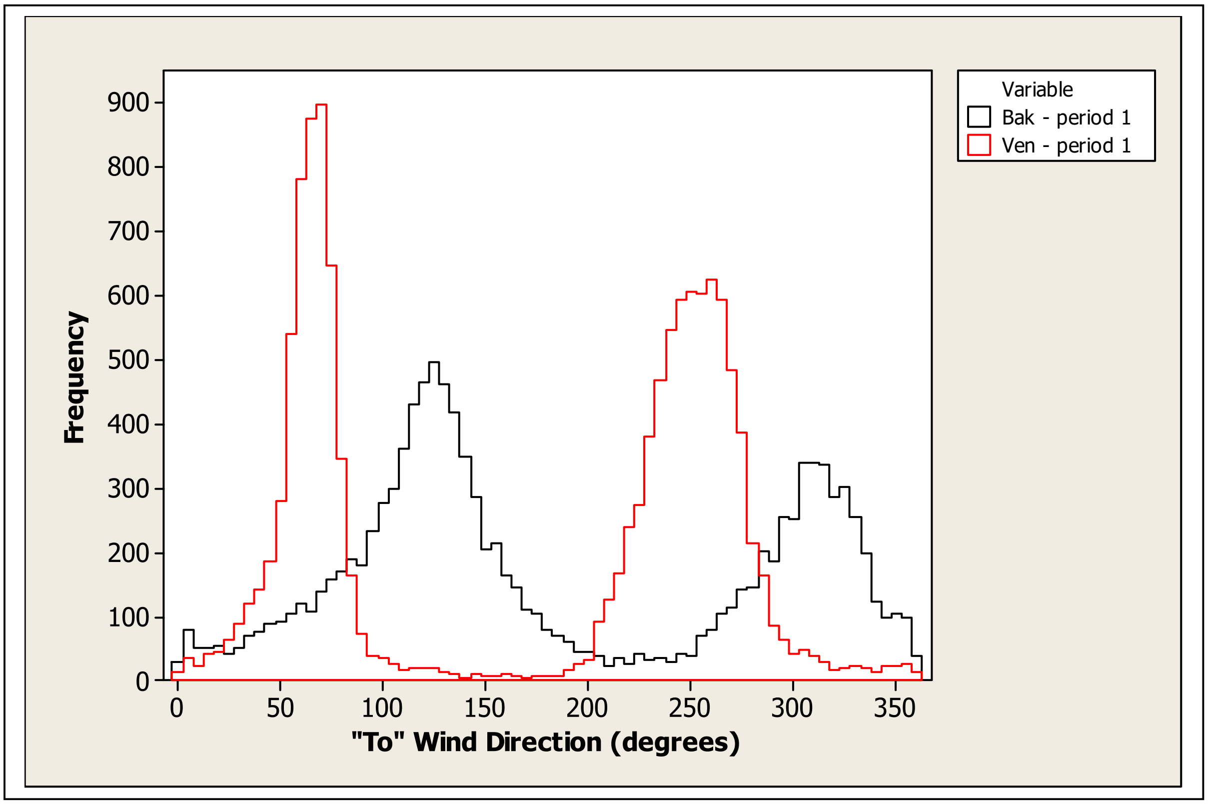

Figure 7. Intermittent shank, period 2 (1600 hrs–2300 hrs) wind direction frequency distribution. Frequency is number of hours.

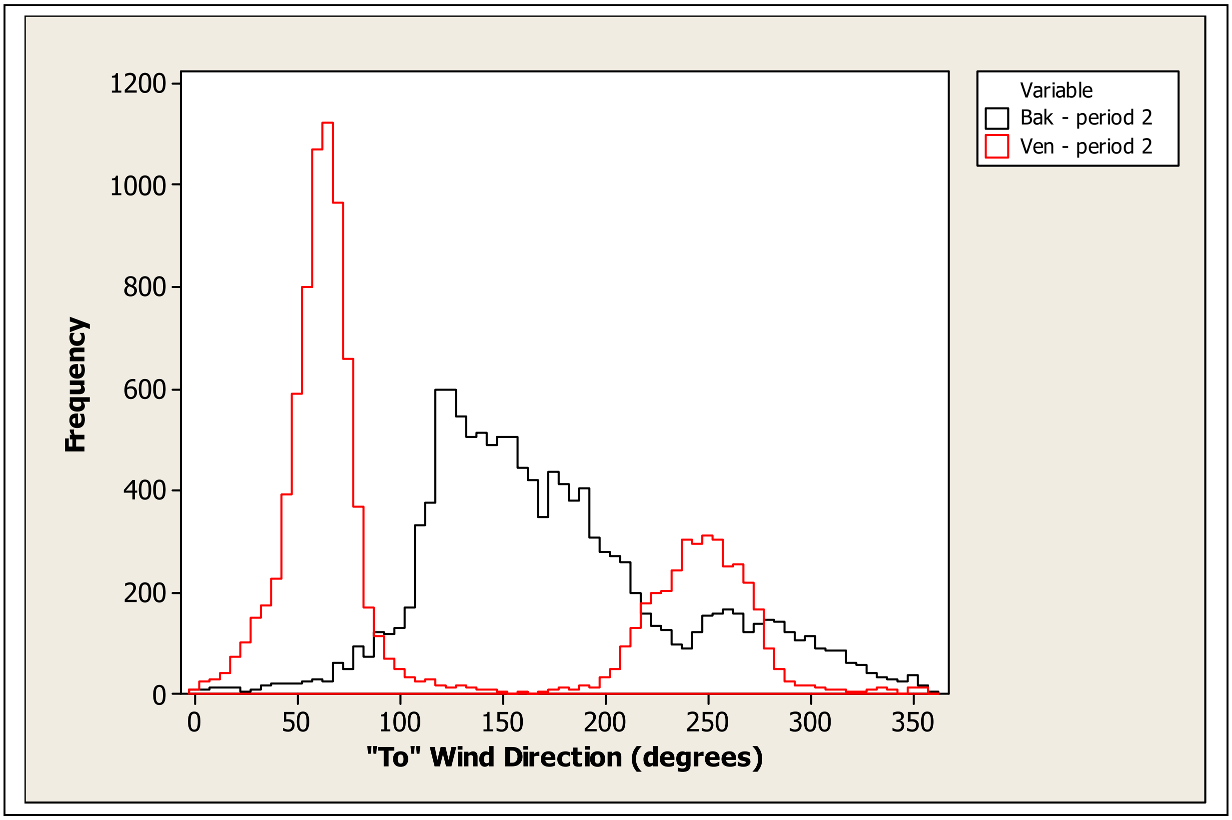

Figure 8. Standard sprinkler and standard shank, period 3 (2400 hrs–0700hrs) wind speed box plots.

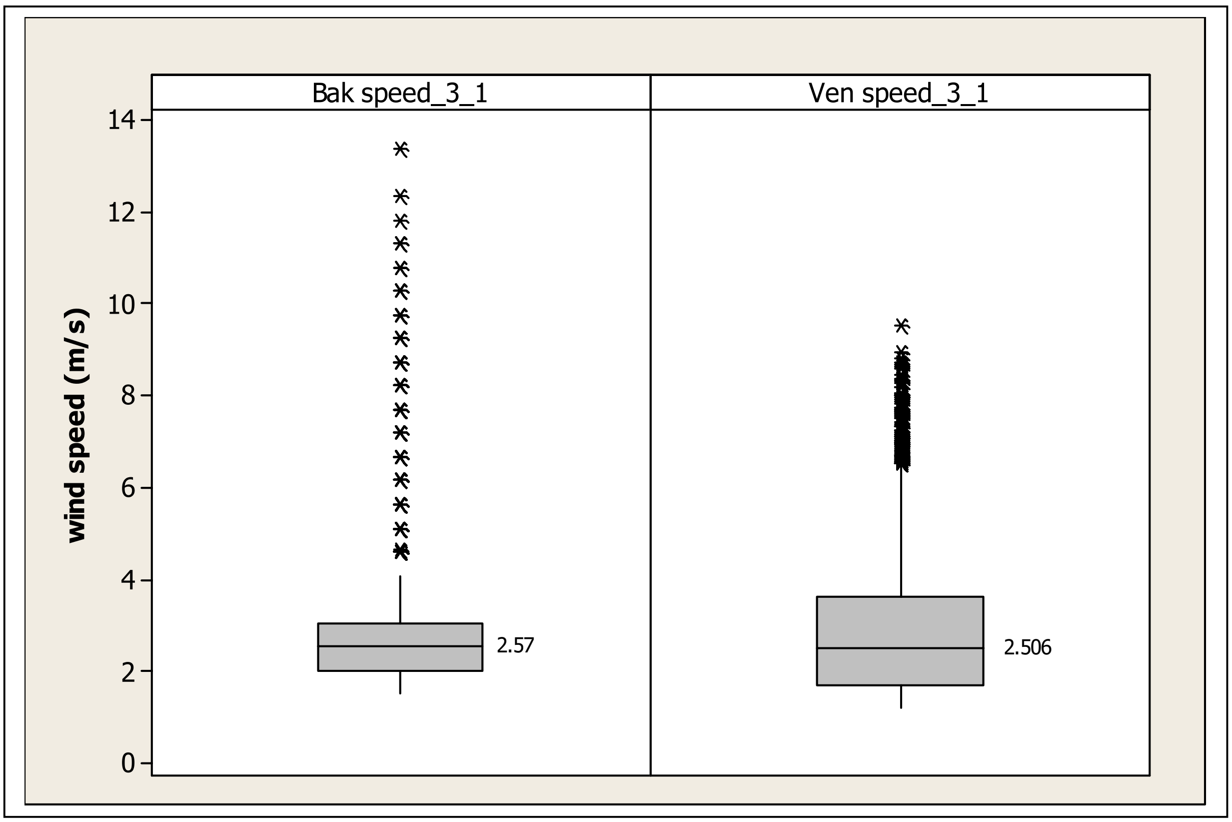

Figure 9. Intermittent sprinkler, period 1 (0600 hrs–1300hrs) wind speed box plots.

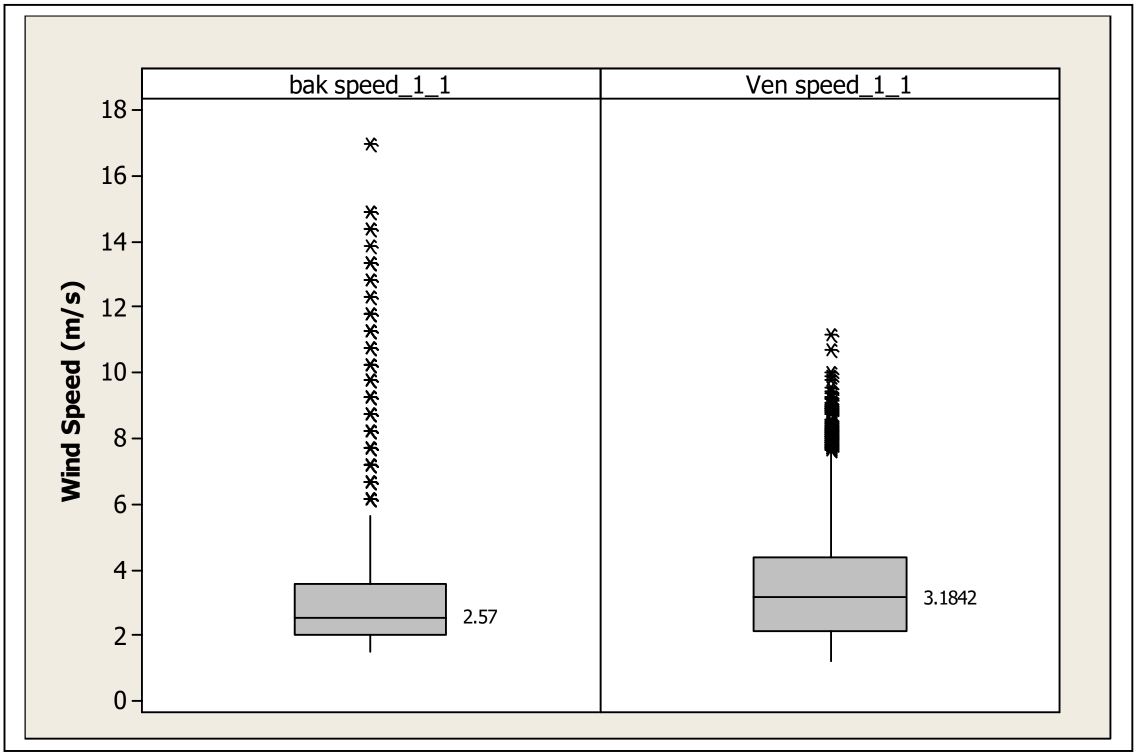

Figure 10. Intermittent Shank, period 2 (1600 hrs–2300 hrs) wind speed box plots.

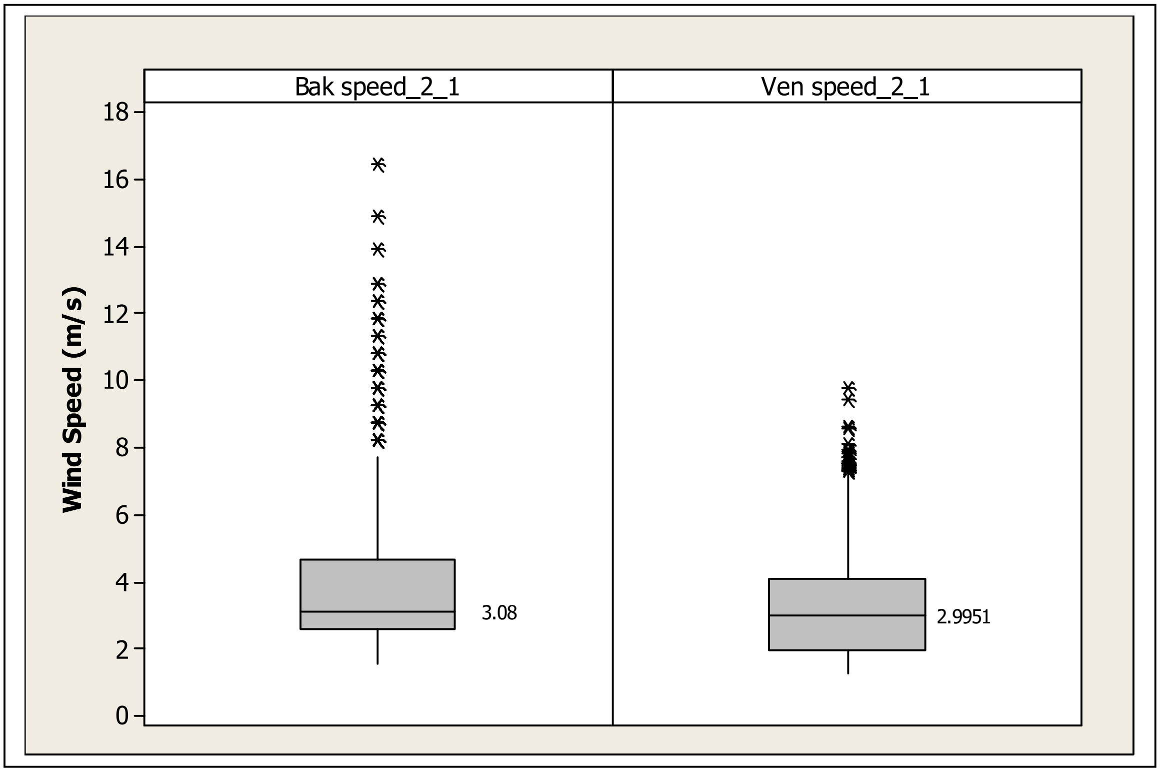

Figure 11. Standard sprinkler and standard shank, period 3 (2400 hrs–0700hrs) stability class frequency distribution. Frequency is number of hours.

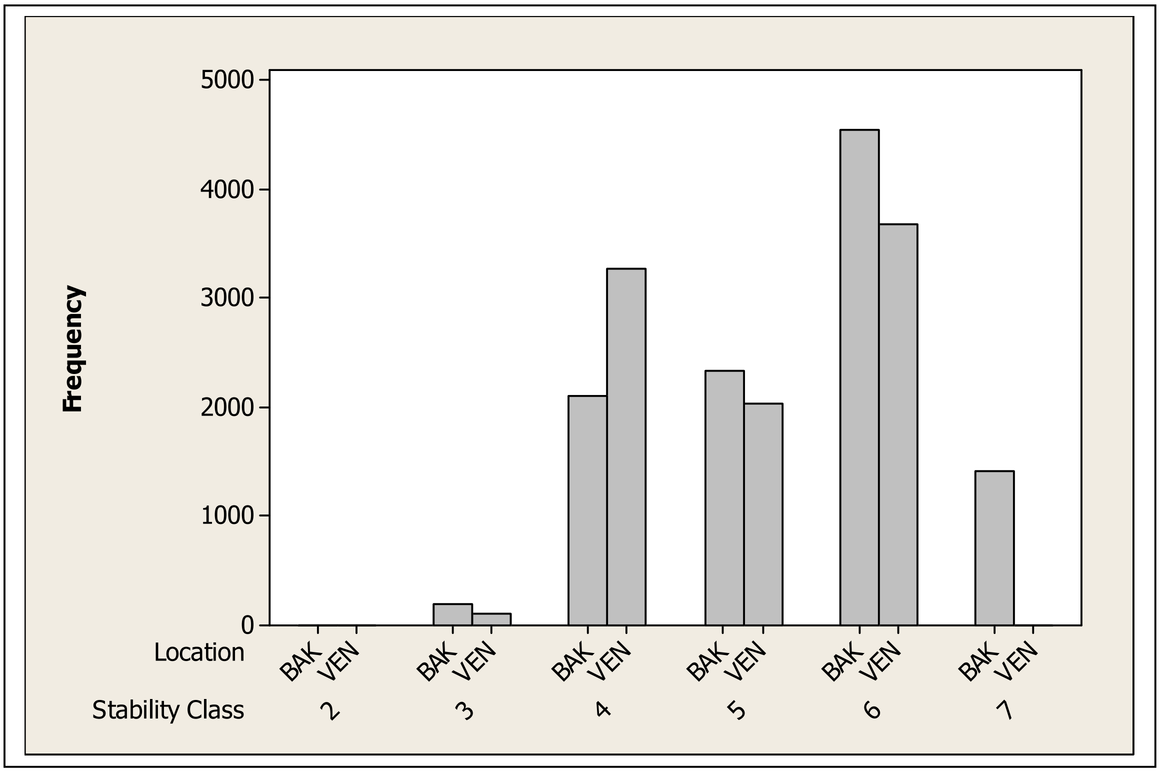

Figure 12. Intermittent sprinkler, period 1 (0600 hrs–1300 hrs) stability class frequency distribution. Frequency is number of hours.

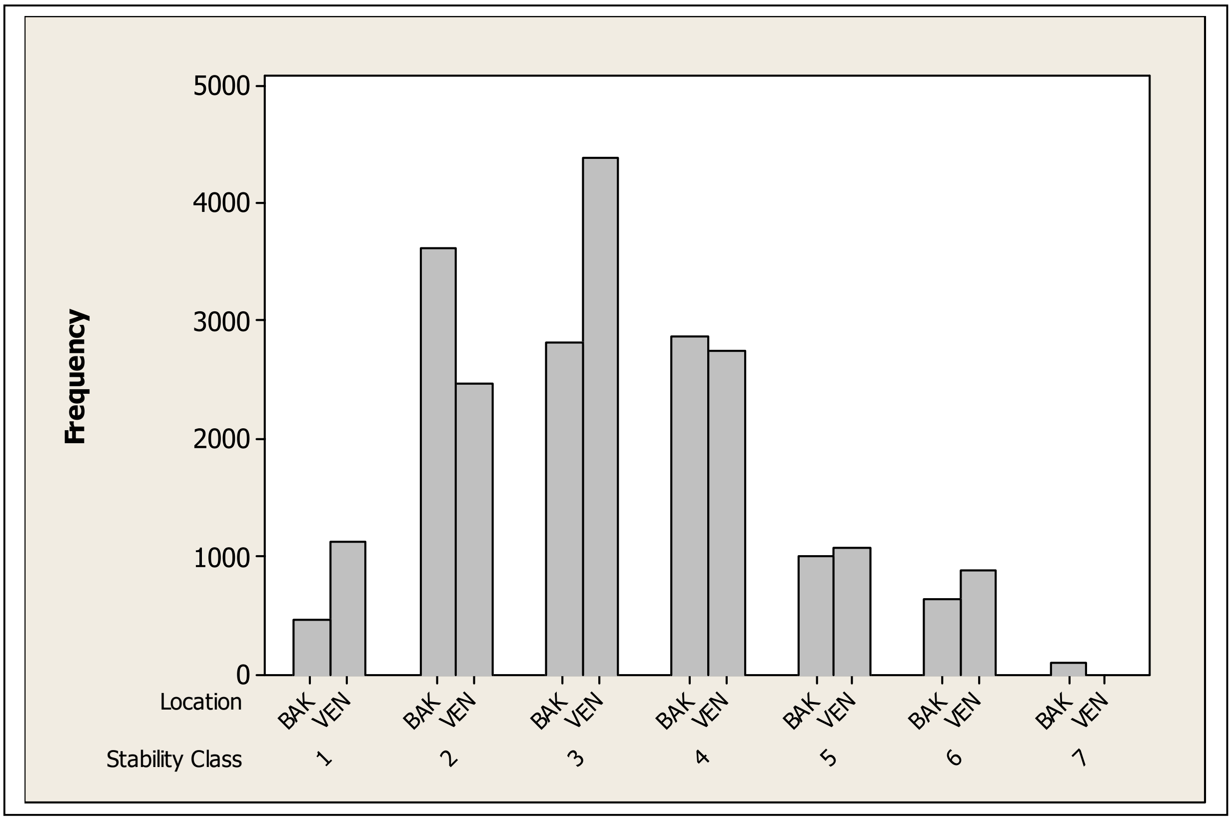

Figure 13. Intermittent shank, period 2 (1600 hrs–2300 hrs) stability class frequency distribution. Frequency is number of hours.