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WINTER HIGH WIND TORNADO & FLASH FLOOD VERIFICATION PROCEDURES

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SUMMARY OF REVISIONS: This supplement replaces National Weather Service Central Region Supplement 07-2003 dated March 21, 2005.

Winter and high wind verification sections have been updated for FY06 collecting statistics by individual months in FY06 instead of cumulatively and quarterly as in FY05.

Some references to NWSI 10-1601 have been changed to reflect the new version effective November 1, 2005.

Remove second PANDA entry for tornado and flash flood statistics near the fourteenth (14) of the month. This requirement has been dropped by National Oceanic and Atmospheric Administration National Weather Service Headquarters (NOAA NWSH).

(Signed By) _____ May 23, 2006
Lynn P. Maximuk _____ Date
Director, Central Region

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1. Introduction. The purpose of the verification programs for winter storms, high winds, tornadoes and flash floods is to assess National Weather Service (NWS) warning performance and identify areas for improvement in service to NWS customers.

This supplement will specify additional instructions which Central Region Weather Forecast Offices (WFOs) will follow for winter storm, high wind, tornado, and flash flood warning verification.

2. Winter Storm Warnings. Unless otherwise stated in this supplement, WFOs will follow instructions in NWSI 10-1601, section 1.6 for verification of winter storm warnings.

Central Region Headquarters (CRH) will verify winter storm warnings. WFOs may verify outlooks, watches, and advisories, as well as wind chill warnings if they desire.

Central Region WFOs will enter the following winter storm statistics via the Central Region Intranet:

- Number of winter storm warnings;
- Number of verified winter storm warnings;
- Number of winter storm events for which no warning was issued. These are also called missed events;
- Number of unverified winter storm warnings;
- Number of verified winter storm warnings, which were preceded by a watch;
- Total lead time for all winter storm events.

The number of winter storm events is the sum of the number of winter storm warnings verified plus the number of missed events. CRH will calculate this plus the following parameters via the Intranet spread sheet for each WFO and for the entire Central Region:

- Number of warned winter storm events;
- Average lead time;
- Probability of Detection (POD);
- False Alarm Ratio (FAR);
- Critical Success Index (CSI).

WFOs may compute these statistics for their own use.

NWSI 10-1601, table 1 (page 12), and NWSI 10-1605, sections 7.3, 7.21, 7.25, 7.27, 7.36, 7.47 and 7.48 provide guidance for determining winter events. NWSI 10-1601 section 1.6, subjective judgment, common sense, and integrity will be used as guiding factors in determining winter storm events and lead times. Some points WFOs should consider when deciding whether or not a warning verified:

- a. WFO criteria for winter storm thresholds are locally determined and posted on the Central Region Intranet.
- b. WFOs should consider areal extent. Was the event over a large enough area that the WFO should have issued a warning?
- c. WFOs in Colorado and Wyoming, as well as Jackson, Kentucky, will consider elevation. Criteria for mountain zones areas in Colorado and Wyoming are posted on the Central Region Intranet.
- d. WFOs should verify winter storm warnings using quality assessed surface observations and reports from Local Climatological Data (LCD) site observers (see NWSI 10-1311 for guidance) or cooperative observers (see NWSI 10-1307 for guidance). Other types of snow depth observations or ice accumulation observations may be used if the WFO staff judges these to be an accurate estimation of what precipitation fell.
- e. For zones with insufficient surface observations and reports, WFOs may estimate snowfall amounts or ice accumulation using information from radar data, satellite precipitation estimates, as well as surface observations and reports from nearby zones.

- f. WFOs should consider whether or not the storm created a life-threatening hazard due to snow, ice accumulation, or in combination with other parameters such as blowing snow or wind chill. Forecasting this life-threatening situation is the mission of the winter storm warning program as indicated in NWSI 10-513, section 6.1.
- g. Events, beginning after a warning has been downgraded to an advisory, are missed events.
- h. Events, beginning after the warning expires or is cancelled, are missed events.
- i. Events, ending before the warning is issued, are missed events.
- j. For a warning issued after an event begins, but before the event ends, the warning is verified, but the lead time is zero.
- k. Written instructions cannot address every situation. The final determination will reside with the WFO Meteorologist in Charge as to whether or not an event occurred or a warning verified.
- l. For local application and to build a suitable archive of a WFO's verification efforts, CRH strongly encourages all WFOs to complete a very brief account of the observations or data which verified each zone.
- m. To avoid a "last minute" rush to complete winter storm verification, CRH strongly recommends WFOs perform verification soon after each storm.

These winter storm verification statistics will be due at CRH close of business the fifteenth (15) day of the following month. If the fifteenth of the month falls on a weekend, winter storm verification statistics will be due at CRH close of business the next business day.

Like all verification statistics, if new information becomes available, numbers may be amended. For example, a WFO enters its statistics on November 15. Newspaper articles, verifying a winter storm in October for five previously unverified counties, arrive at the WFO November 22. The Warning Coordination Meteorologist enters this data November 25. The data becomes part of the October monthly statistics upon entry.

3. High Wind Warnings. Unless otherwise stated in this supplement, Central Region WFOs will follow instructions in NWSI 10-1601, section 1.7 for verification of high wind warnings.

CRH will verify high wind warnings. WFOs may verify outlooks, watches, and advisories, as well as dust storm, excessive heat, or freeze warnings.

Central Region WFOs will enter the following high wind statistics via the Central Region Intranet:

- Number of high wind warnings;
- Number of verified high wind warnings;
- Number of high wind events for which no warning was issued. These are also called missed events;
- Number of unverified high wind warnings;
- Number of verified high wind warnings, which were preceded by a watch;
- Total lead time for all high wind events.

The number of high wind events is the sum of the number of high wind warnings verified plus the number of missed events. CRH will calculate this plus the following parameters via the Intranet for each WFO and the entire Central Region:

- Number of warned high wind events;
- Average lead time;
- POD;
- FAR;
- CSI.

WFOs may compute these statistics for their own use.

NWSI 10-1601, table 1, and NWSI 10-1605, sections 7.23 and 7.38 provide guidance for determining high wind events. NWSI 10-1601 section 1.7, subjective judgment, common sense, and integrity will be the guiding factors in determining high wind events and lead times. Some points WFOs should consider when deciding whether or not a warning verified:

- a. WFO criteria for high wind thresholds are locally determined and are posted on the Central Region Intranet.
- b. WFOs should consider areal extent. Was the event over a large enough area that the WFO should have issued a warning?
- c. WFOs in Colorado and Wyoming, as well as Jackson, Kentucky, will consider elevation. Criteria for mountain zones areas in Colorado and Wyoming are posted on the Central Region Intranet.

- d. WFOs should verify high wind warnings using quality assessed surface observations from Automated Surface Observing Systems (ASOS), Automated Weather Observing Systems (AWOS), or mesoscale networks meeting NWS standards (see NWSI 10-1302 for guidance). Other types of wind observations may be used if the WFO staff judges these to be an accurate estimation of what actually occurred.
- e. For zones with insufficient surface observations, WFOs may estimate winds using surface observations from nearby zones.
- f. WFOs should consider whether or not the storm created a life-threatening hazard due to wind or in combination with other parameters such as wind chill. Forecasting this life-threatening situation is the mission of the high wind-warning program as indicated in NWSI 10-515, section 6.1.
- g. Events, beginning after a warning has been downgraded to an advisory, are missed events.
- h. Events, beginning after the warning expires or is cancelled, are missed events.
- i. Events, ending before the warning is issued, are missed events.
- j. For a warning issued after an event begins, but before the event ends, the warning is verified but the lead time is zero.
- k. Written instructions cannot address every situation. The final determination will reside with the WFO Meteorologist in Charge as to whether or not an event occurred or a warning verified.
- l. For local application and to build a suitable archive of a WFO's verification efforts, CRH strongly encourages all WFOs to complete a very brief account of the observations or data which verified each zone.
- m. To avoid a "last minute" rush to complete high wind verification, CRH strongly recommends WFOs perform verification soon after each storm.

These high wind verification statistics will be due at CRH close of business the fifteenth (15) day of the following month. If the fifteenth of the month falls on a weekend, high wind verification statistics will be due at CRH close of business the next business day.

Like all verification statistics, if new information becomes available, numbers may be amended. For example, a WFO enters its statistics on November 15. Newspaper articles verifying a high wind event in October for three previously unverified counties arrive at the WFO November 21. The Warning Coordination Meteorologist enters this data November 23. The data becomes part of the October monthly statistics upon entry.

4. Tornado Warnings. For verification of tornado warnings, Central Region WFOs will follow instructions in NWSI 10-1601, section 2.1, except for the following.

Central Region will use the computer program, PANDA, to produce preliminary verification statistics for tornadoes. CRH will run PANDA for the entire region shortly after the first of the month to give CRH and NWS Headquarters a quick picture of Central Region tornado warning performance.

Tornado warnings are automatically entered into the verification database.

WFOs will enter local storm reports (LSRs) or edit the PANDA database to ensure statistics will be as accurate as possible. WFOs will enter Storm Data as per NWSI 10-1605, section 3. NWSI 10-1605 section 7.40 provides guidance for entering tornado information in Storm Data. Storm data is run at NOAA NWSH around 60 days after the end of the month. After the Storm Data has been run, WFOs will no longer need to update PANDA.

. Some points to remember when verifying tornado data are:

- a. Tornado warnings are only verified with a tornado report, not a hail or damaging wind report.
- b. Lead time, in this context, is event lead time.
- c. All reported tornado events have a lead time.
- d. A tornado warning may be used to calculate lead time for more than one tornado event.
- e. For a warning issued after an event begins, but before the event ends, the warning is verified but the lead time is zero.

5. Flash Flood Warning. For verification of flash flood warnings, Central Region WFOs will follow instructions in NWSI 10-1601, section 4.1 except for the following

Central Region will use the computer program, PANDA, to produce preliminary verification statistics for flash floods. CRH will run PANDA for the entire region shortly after the first of the month to give CRH and NWS Headquarters a quick picture of Central Region flash flood warnings performance.

Flash Flood Warnings are automatically entered into the verification database.

WFOs will enter local storm reports (LSRs) or edit the PANDA database ensure statistics will be as accurate as possible. WFOs will enter Storm Data as per NWSI 10-1605, section 3. NWSI 10-1605 section 7.13 provides guidance for entering flash flood events in Storm Data. Storm data is run at NOAA NWSH around 60 days after the end of the month. After the Storm Data has been run, WFOs will no longer need to update PANDA.

Some points to remember are:

- a. Lead time, in this context, is event lead time.
- b. For a warning issued after an event begins, but before the event ends, the warning is verified, but the lead time is zero.
- c. Flash Flood - a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters. For warning operations, a "flash flood" definition may be restricted to a beginning time frame of less than six hours of the causative event depending on local warning criteria.
- d. In an effort to estimate flash flood warning lead times objectively and consistently, WFOs in Central Region should use the following methods and information. Although some subjectivity will remain, these actions should reduce ambiguity in determining when a flash flood began, or when a low-impact flood became life threatening. This, in turn, should facilitate better consistency in reports between offices and reporting periods.
 - 1) Use information provided by spotters, dispatch personnel, media, and other public officials; ask specific questions, such as those listed in NWSI 10-1605, section 7.13.3. Additional actions which can be performed to determine when low-impact flooding became life threatening include:
 - a) Use flash flood emergency 911 Natural Disaster Information Cards. Provide spotters with information cards and guidelines.
 - b) Use E-spotter or a similar application to obtain reports.
 - c) Train spotters to report the depth of water, whether or not the water is moving, the water's impact, and timing issues, if known.
 - 2) Perform storm surveys for flash flood events; interview people and ask for locations of hot spots, specific water impacts, and other information; this effort will help refine lead times.
 - 3) Where spotter, public or media information is lacking, use radar data, FFMP, or other precipitation estimates, such as Mountain Mapper or satellite-derived precipitation estimates, to approximate the time period of intense rainfall. Then, estimate the lag time from the time of intense rainfall to the flash flood.
 - 4) Urban areas will have a nearly instantaneous response (near zero lag time); flooding is likely during the period of heaviest rainfall; in general, a rainfall rate

of about one inch or more per hour may result in some degree of urban flooding. Use current guidelines for flash flood guidance (FFG) in impervious locations.

- 5) In non-urban areas, a modest lag time may occur between the time of heaviest rainfall and the time creeks and streams rise over bankfull, especially in relatively flat terrain.
- 6) Compare FFG values to radar estimates and other quantitative precipitation estimates (QPE) to approximate the beginning time of low-impact flooding (i.e., when QPE exceeds FFG).
- 7) Consider limitations to accurate radar estimates (e.g., high storm precipitation efficiency, hail contamination, etc.).
- 8) Based on terrain, basin characteristics, ongoing heavy rainfall, or the degree to which QPE exceeds FFG (e.g., by 0.5-1.0 inch or more); estimate the time of impact flooding, and then compare this to the warning dissemination time.
- 9) In burn scarred areas, use the appropriate guidelines from the River Forecast Center (RFC) and partner agencies such as the United States Geological Survey (USGS).