CORE PARTNER COLLABORATION THROUGH A JOINT SEVERE WEATHER FUNCTIONAL EXERCISE

Trenton B. Pittman*
Johnson County Emergency Management and Communications, Olathe, Kansas

Jennifer M. Laflin and Albert E. Pietrycha
NOAA/NWS Kansas City/Pleasant Hill, Missouri

1. Introduction

a. Motivation

Over time, a natural partnership has developed between the National Weather Service (NWS) and Emergency Managers (EMs) due to their shared goal of public safety, and shared responsibility of public warning. Strong, effective communication between the NWS and EMs is key during active weather (Cavanaugh et al. 2016), in order to efficiently set in motion the notification and response processes triggered by severe weather warnings such as siren activation, text/email/phone alerts, and radio communication with first responders. In addition, collaboration between the NWS and EMs — as well as other core partner agencies — contributes to the consistent messaging that influences the public to take necessary action (Mileti and Sorensen 1990, Hammer and Schmidlin 2002, NOAA 2009, NOAA 2011), especially during hazardous weather situations. The importance of this partnership highlights the need for regular interaction between the two groups, and the need to practice and test capabilities and communications prior to an event.

b. Exercises in Emergency Management

A number of exercises of varying complexity are routinely performed each year by EMs, to test specific skills and serve as a refresher for non-routine duties. Emergencies and disasters are not routine events but have a large impact on the communities served by EMs, therefore exercising those situations and scenarios is a high priority, and in some cases, such exercises can be a requirement for state or federal funding. In Johnson County, Kansas, the last Presidential disaster declaration occurred over 15 years ago and the last tornado fatality was in 1957, illuminating the rarity of high-impact events in a relatively small geographic area. In fact, despite the primary responsibility of their EM department for activating the county's outdoor warning sirens for tornado events and warnings, in Johnson County's staff of six EMs, only two staff members (33%) have performed this operationally.

To gain and maintain familiarity with pivotal but rarely-used severe weather procedures like siren activation, Johnson County began an annual functional exercise in 2015 that simulated real-time severe weather operations to train the duty officer role. This exercise replaced their previous, more informal on-the-job training, and was motivated by recent staff turnover. Unfortunately, the case used for the exercise in 2015 occurred within the county earlier that year, and it was quickly recognized even by the EMs who were not working during the real event, leaving participants with little to do other than to walk through the motions of siren activation. Although all policies and procedures were successfully simulated in this event, the suspense and unfamiliarity that comes with an emergency or disaster was lost, and the realism of the exercise was limited.

*Corresponding author address: Trenton B. Pittman, Johnson County, Kansas Emergency Management email: tpittman@jocogov.org

c. National Weather Service Training

Since the release of the Weather Ready Nation Roadmap 2.0 in 2013, the NWS has increasingly focused on their mission to provide decision support services (DSS) to core partner organizations. This shift is occurring at all levels of the NWS organization and requires the involvement of all employees throughout the workforce, precipitating the need for DSS training. Available training for employees to hone their DSS skills and learn to better support partners is expanding in response to the increasing need, and currently includes programs such as national webinars and boot camps, as well as internal drills and other types of exercises. Some offices have even begun to incorporate communications into their annual severe weather exercises that historically focused more on the warning forecaster role, pairing up a communicator with the radar operator and simulating partner requests and briefings throughout the training. In 2013, the NWS office in Pleasant Hill brought in several EM partners during the office's annual winter weather training, and allowed forecasters to participate in partner briefings during a simulated high-impact winter weather event. These types of interactive exercises not only teach or refine necessary communication and DSS skills, but also give the opportunity to connect with the partners that are a key component of the warning process.

When training is performed in conjunction with core partner organizations, these partnerships grow and strengthen through interaction and collaboration. In addition to this relationship-building, joint training provides unscripted realism for all organizations involved as questions and challenges arise, particularly in functional or full-scale exercises that occur at a pace similar to real-time operations. For example, even when injects are provided, reactions and conversations sparked through the exercise allow for realistic back-and-forth and prepare NWS employees for the types of queries and concerns that partners may raise during a real event. Finally, one key element of successful training is feedback, which is achieved naturally and genuinely during the exercise by the interchange between participants. As a result of these needs for training of both NWS and EM personnel, as well as the desire for collaboration between partnering agencies, a joint severe weather functional exercise was developed and conducted between Johnson County, Kansas EM and the NWS office in Pleasant Hill, MO on 26 July 2016.

2. Exercise Design

In order to realistically and effectively exercise severe weather operations, the simulated event should occur in the area of jurisdiction of both the NWS office and participating partners in EM. As a result, many exercises utilize previous events which occurred in the local area, and are typically at least somewhat familiar to the exercise participants. Unfortunately, the use of previous events can eliminate the element of surprise for those who recognize it, rendering the exercise at least partially ineffective. In addition, high-impact events are relatively rare, limiting the pool of potential events on which to exercise. To mitigate these challenges while still simulating an event over the local area, the program l2munger (see appendix A for a description) can be used to shift radar data from an external radar site to the local Weather Surveillance Radar 1988-Doppler (WSR-88D). The case selected for the 26 July exercise was an EF-3 tornado which occurred near Tipton, OK on 16 May 2015. This tornado trekked approximately 30 km northwest of the KFDR Frederick, OK WSR-88D, which placed the tornado track squarely over populated portions of Johnson County, KS when the radar site was converted to KEAX Pleasant Hill, MO WSR-88D (Fig. 1).

As an operations-based exercise, the selection of a functional exercise was made for its use of a real-time format and simulated response and deployment of resources. This format requires the rapid problem solving and action that would occur in a real event,

and allows plans, policies, and procedures to be tested in a high-stress but no-fault environment. Since the primary objective of the exercise was to practice and test severe weather procedures and communications, the exercise simulated the immediate response to an ongoing severe weather event; in this case, a tornado moving through Johnson County, KS. Approximately 70 minutes of radar data were selected for use in this exercise, which were run forward in simulated real time after a 15-minute spin-up period in which no new data were presented.

3. Exercise Operations

To best replicate typical operations and practice communications, the functional exercise took place in three locations: the primary Johnson County, KS Emergency Operations Center (EOC), the alternate EOC located within Johnson County's dispatch center, and at the NWS office in Pleasant Hill, MO. One facilitator was placed in each location, and two EM teams comprised of two participants each were placed in each EOC. No additional participants were placed in the NWS office, however there are many opportunities to involve additional participants in that location during future exercises (see section 5). In addition, three observers were placed in the primary EOC and two at the NWS office to evaluate the effectiveness of the exercise and the potential for future use in other NWS forecast offices and areas.

The exercise began with a webinar briefing, which served both as a tool to brief all participants and sync up the simulation clock at each location, and as an overview of the simulated severe weather scenario. These webinars are typically conducted by the NWS in advance of a potential high-impact severe weather event, and supplied both realism to the exercise and an opportunity for the NWS to practice this non-routine form of communication. After the briefing concluded, the 15 minute spin-up period commenced in which no new data were presented and participants were able to activate their EOC, simulate placing spotters throughout the county, and complete the checklists and forms that are required when severe weather is imminent. PowerPoint slides of the radar images with overlaid warnings and the simulation clock (Fig. 2) were then displayed by the NWS facilitator, and were shared with both EOCs concurrently via Join.Me (https://www.join.me; also used for the webinar briefing) in order to keep all locations synced. Once radar data began advancing and simulated severe weather warnings were issued, these warnings were announced by the NWS over the Kansas 800 MHz radio system and were also posted in NWSChat (refer to https://nwschat.weather.gov). In addition, printouts of the warning text were provided to participants by the facilitators when the simulated warnings were issued. When appropriate, outdoor warning siren activation was simulated using an "Easy Button" placed in each EOC.

NWSChat was also used as a tool to provide injects throughout the exercise. Three chat accounts were run by the NWS facilitator in a private chatroom set up for the event: one which simulated the nwsbot and provided simulated warning information; one which simulated a media personality and provided pre-scripted severe weather reports, and one which simulated an NWS employee in the communicator role, and was a combination of pre-scripted injects and unscripted two-way communication with the EOCs (Fig. 3). EM participants in the EOCs were able to use both NWSChat and 800 MHz radio to ask questions and provide reports to the NWS, and each EOC operated on a separate radio channel to keep communications private and prevent influencing the actions of the other participant group. Facilitators in each EOC were also given a packet with pre-scripted injects of severe weather reports, which they would only provide to the participants if a spotter had been placed in the location of the report. In total, seven simulated warnings/follow-up statements were issued for the county, and 43 severe weather report injects were provided by facilitators.

4. Results and Summary

a. Hot Wash

In accordance with the Homeland Security Exercise and Evaluation Program guidelines, a hot wash was conducted immediately following the conclusion of the exercise. The hot wash involved all participants and facilitators, and focused on immediate reactions to and observations of the exercise, as well as a preliminary identification of a few of its strengths and weaknesses. One overwhelming consensus reached was the unique strength of exercising two teams at two different sites simultaneously, since it allowed more players to participate within a shorter timeframe than the previous year's exercise permitted. Exercise participants also reacted positively to the simulated real-time radar data displayed throughout the exercise, which built familiarity with the comparison of radar reflectivity to velocity in a testing environment. In addition, many participants commented on the successful collaboration with the NWS through the 800 MHz radio system and NWSChat. Participants in the primary EOC did report some confusion regarding the radio communication, and it was quickly discovered that both 800 MHz channels had unintentionally been turned on in the primary EOC, creating uncertainty in the intended audience of radio transmissions from the NWS. Despite this, overall initial reactions to the exercise were overwhelmingly positive, and it was immediately clear that an improvement had been made over the previous year's training.

b. Participant Survey

To allow participants and facilitators more time to collect their thoughts and reflect on the exercise, an online survey was sent out following the hot wash, and survey responses were collected over the next several days. All respondents listed experiencing at least minor improvement in the areas and skills tested/practiced during the exercise, and overall feedback of the exercise format, design, content, and operations was positive. Open-ended survey questions allowed all respondents to detail what they believed worked well and where improvements could be made in future similar exercises, and their general takeaways and experiences from the exercise. Many comments were made on the realism of the exercise and the successful integration of multiple platforms for communication, and all respondents commented positively on the collaboration between agencies. Areas for improvement included better clarification of simulation time versus real time, adding a looping functionality to the radar imagery, and adding some images or video clips as injects, but no major issues were raised that prevented the exercise from being a successful learning and collaborative experience.

c. After-Action Report

The After-Action and Improvement Planning (AAR/IP) process is the final — and in many ways the most important — step of the exercise process. It allows the organization to formalize processes and practices that were successful, and identify and track areas for improvement in operations, versus the improvements for future exercises which was the primary focus of the hot wash and participant survey. This step was completed in August of 2016, and involved all of the EM participants/facilitators and the NWS facilitator. Many of the deficiencies uncovered during the exercise involved the tools and technology available at the alternate EOC, and likewise the majority of the IP involved better replicating the resources available in the primary EOC and making them available in both locations. Strengths that were identified during the exercise far outweighed the areas for improvement, and included timely activation of both EOCs, successful deployment of spotters, efficient use of new notification tools and WebEOC, and successful interagency collaboration and

communication between EMs and the NWS. Although the AAR/IP only formally addressed actions and improvements for EM operations, brainstorming and collaboration during the AAR/IP allowed the NWS to identify several takeaways for their operations, including color-coding (by importance) the assignment cards for roles during severe weather operations, and the performance of informal, internal hot washes following significant severe weather events.

5. Future Work

This simulated tornado track continued onward to the northeast, which would have impacted portions of Jackson County, MO and the city of Kansas City, MO; both core partners to the NWS office in Pleasant Hill, and comprising the majority of the Pleasant Hill County Warning Area population outside Johnson County, KS. These partners could have been included in the exercise without many additional modifications or resources, which suggests that future similar exercises could be expanded to include neighboring jurisdictions and geographic areas. In addition, several other NWS personnel could be involved in future exercises, leaving the scripted injects to one facilitator and allowing other NWS participants to communicate in chat and on the radio, and to create graphics, briefings, or other requested resources. Interest in such an expansion was gauged at the 2017 Integrated Warning Team meeting in Kansas City, MO when this research was initially presented, and the authors plan to move forward in planning additional functional exercises that involve multiple parties in the Kansas City Metropolitan Area.

6. Acknowledgements

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7. References

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8. Figures

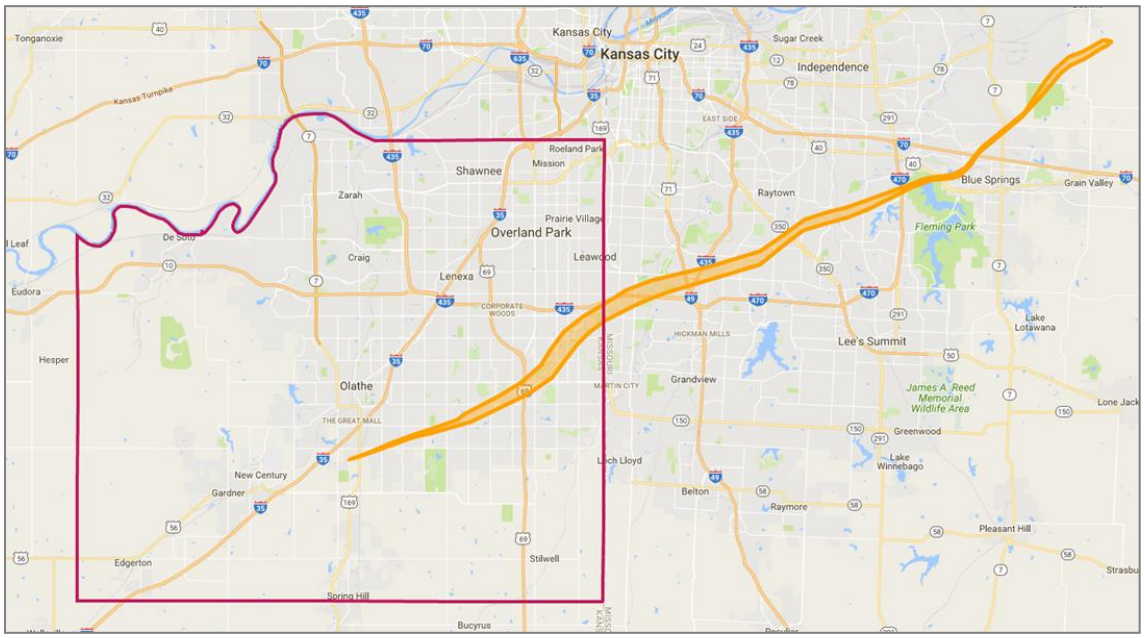

Figure 1. The 16 May 2015 Tipton, OK EF-3 tornado damage path (orange fill and orange outline), shifted to Johnson County, KS (red outline).

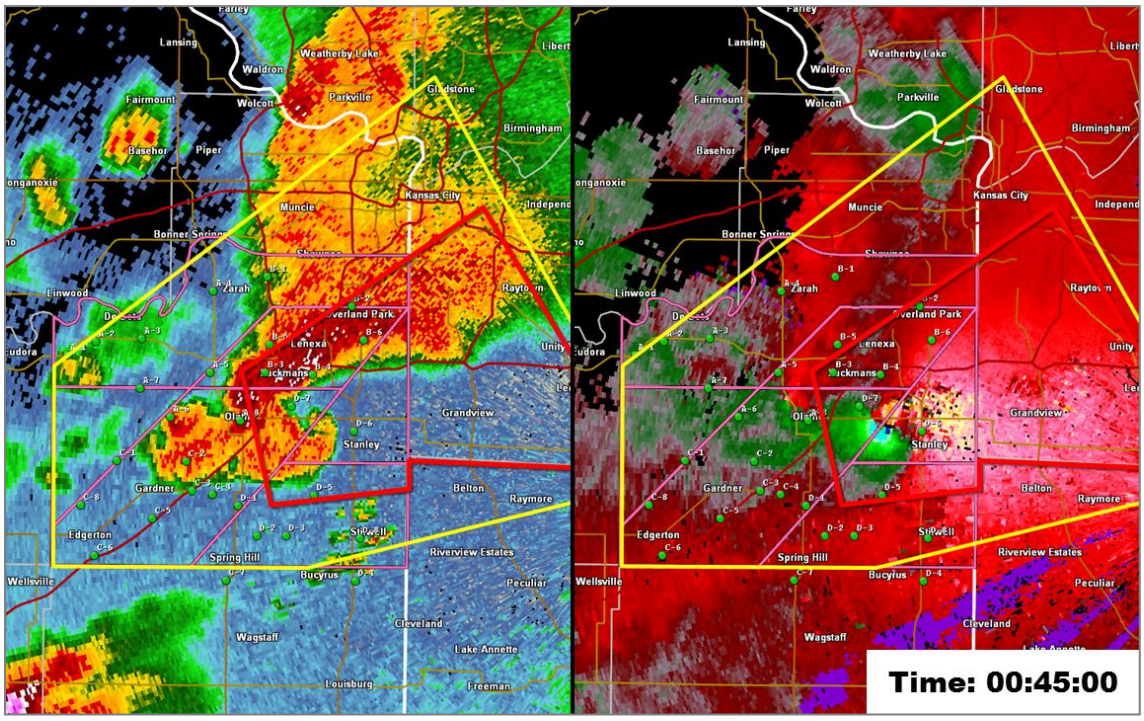

Figure 2. PowerPoint slide of radar data from KFDR shifted to KEAX, with warnings overlaid (red and yellow polygons) and simulation clock (lower left).

(15:11:37) NWS P-Hill-Jenni Laflin: We're seeing a debris signature on radar just northwest of Stanley.
(15:12:30) NWS P-Hill-Jenni Laflin: Hearing reports of damage to the Hy-Vee near 135th and Antioch in Overland Park
(15:13:34) media-bryan.busby: Reports of roof damage to the B&B movie theaters in OP
(15:15:35) nwsbot: EAX issues Tornado Warning (tornado: OBSERVED, tornado damage threat: CONSIDERABLE, hail: 2.75 IN) for Johnson (KS) and Jackson (MO) till 1:30 ST ...AT 050 PM ST...A CONFIRMED LARGE AND EXTREMELY DANGEROUS TORNADO WAS LOCATED NEAR OVERLAND PARK...AND MOVING NORTHEAST AT 30 MPH.
(15:17:53) em-terrence.l.kegin: spotter at 143rd and 69 hwy reports he sees cars flipped over and damaged
(15:18:08) NWS P-Hill-Jenni Laflin: Thanks Terry
(15:19:29) NWS P-Hill-Jenni Laflin: KCP&L reporting over 20,000 customers without power in Olathe and Overland Park
(15:19:50) em-dan.robeson: Johnson County KS trained spotter just observed cars flipped over and extensive damage to homes in Overland Park KS at 143rd & 69 Hwy.
(15:20:02) NWS P-Hill-Jenni Laflin: Thanks Dan
(15:20:31) media-bryan.busby: Traffic appears to be completely gridlocked on 435 between State Line and Hwy 69
(15:20:37) em-terrence.l.kegin: spotter at 93rd and glenwood in OP reports tennis ball size hail at their location
(15:21:01) media-bryan.busby: Seeing lots of pictures of the tornado now on twitter, looks like it's visible from 435
(15:21:54) em-dan.robeson: Johnson County KS trained spotter just observed tennis ball sized hail in Overland Park KS at 93rd and Glenwood.
(15:22:04) NWS P-Hill-Jenni Laflin: Thanks Dan
(15:22:30) NWS P-Hill-Jenni Laflin: New cell coming up from the southwest into Miami and Johnson counties, doesn't look tornadic and we expect that the environment is very worked over, but will be reissuing the severe to include it.
(15:23:44) nwsbot: EAX issues Severe Thunderstorm Warning (wind: 70 MPH, hail: 2.75 IN) for Johnson, Miami, Wyandotte (KS) and Clay, Jackson (MO) till 2:00 ST
(15:24:47) em-terrence.l.kegin: dispatch reports structural damage to menorah medical center
(15:24:52) NWS P-Hill-Jenni Laflin: Tornado looks likely to cross 435 just east of State Line.
(15:24:55) NWS P-Hill-Jenni Laflin: Thanks Terry
(15:25:35) NWS P-Hill-Jenni Laflin: Report of damage to the Town Center shopping area in Leawood
(15:26:01) media-bryan.busby: Lots of pictures coming in from Leawood. Homes look heavily damaged in that area

Figure 3. Sample of NWSChat log from the private chatroom operational during the exercise. Chat accounts run by the NWS are "NWS P-Hill-Jenni Laflin," "nwsbot," and "media-bryan.busby;" all other chat accounts were operated by participants in the exercise.

APPENDIX A

The C++ program l2munger is a simple utility to modify the location and time stamp of a level II NEXRAD file. It can be accessed at https://github.com/akrherz/l2munger and contains a README file with directions for use. Once converted, these radar files can be viewed in GR2Analyst or other radar display programs.

Note: Level II NEXRAD files will need to be decompressed prior to conversion. Radar files downloaded from NCEI and ending in the .gz or .z extension will need to be unzipped.