American Association for Wind Engineering

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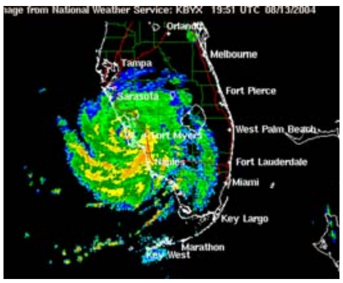
THE WIND ENGINEER

SEPTEMBER 2004

In this Issue:



Category 4 Hurricane Charley at landfall. Below: Hurricane Frances covering entire Florida peninsula.

Story below

(NOAA radar and GOES-12 images)

BREAKING NEWS

10ACWE deadline for submission of abstracts extended to November 15.

Story on page 2

DEVELOPMENT OF AN ENHANCED FUJITA SCALE

James R. McDonald, Ph.D., P.E.
Kishor C. Mehta, Ph.D., P.E.

Introduction

A project is nearing completion to develop an Enhance Fujita Scale (EF Scale) for estimating the intensity of tornado winds. Drs. McDonald and Mehta are the Co-PI's on the project. The objective of the project is to improve on the original Fujita Scale by providing additional damage indicators and developing a better correlation between appearance of damage and wind speed. Twenty-eight damage indicators (DI's), consisting of buildings, structures and trees, are defined with varying degrees of damage (DOD's). Estimates of wind speed to cause the DOD's are obtained from a panel of experts through a process of expert elicitation. The EF Scale also needed a correlation with the original F Scale in order to preserve the usefulness of the historical tornado database. A panel of National Weather Service personnel assigned an F-Scale rating to each DOD. A correlation was then obtained between F-Scale and EF-Scale wind speeds by

(Continued on page 4)

Hurricanes of 2004

Residents of Florida, the southeast United States, and the Caribbean have endured a nearly unprecedented onslaught of major hurricanes in the several week period from mid-August to late September. The destruction left by Hurricanes Charley, Frances, and Ivan will no doubt lead to skyrocketing property insurance rates. On the positive side—hurricane awareness must be at an all time high, given the round-the-clock storm coverage on all major news channels.

Many AAWE members have been participating in pre– and post-landfall research activities. The Wind Engineer will bring you results of these investigations in upcoming editions.

As if three major hurricane landfalls weren't enough for a single season—while I sit here finishing up the newsletter on Sept. 23, Ivan the Terrible has just returned to life as Tropical Storm Ivan off the coast of Louisiana. Its headed for Texas bringing potentially heavy rainfall and associated flooding. After killing over a thousand in Haiti and with hundreds more unaccounted for, Hurricane Jeanne is heading for Florida/Georgia/Carolinas— its not clear where yet. Might this mean the fourth major evacuation in Florida in less than six weeks? At least Hurricane Karl and Tropical Storm Lisa are not any threat to land. At the moment. And we still have 2^{+} months left in hurricane season.

Update - 10th Americas Conference on Wind Engineering -

May 31-June 4, 2005
Baton Rouge, Louisiana, USA

Abstract deadline extended to November 15

The abstract submission deadline for 10ACWE has been extended to November 15, 2004. The conference will feature three types of presentations:

- Oral presentation with full paper
- Poster presentation (paper optional)
- Oral presentation-professional track (paper optional)

Two-page extended abstracts are required for traditional oral presentations with full papers. Poster presentations and oral presentations for the professional track require one page abstracts. Abstract format and submission information is provided on the conference web site. Authors will be notified of acceptance in December.

The professional track is intended primarily for engineers, architects and other interested practitioners for presentation of case studies of challenging wind design issues, unique design solutions, forensic investigations, and other wind-related problems and solutions. The purpose of the professional track is to actively engage a broader audience than the traditional research community. This track will help make the conference more attractive to professionals interested in wind engineering issues, and thus foster more interaction between the research and professional communities.

Conference participants will be provided with a printed book of abstracts and proceedings on CD-ROM. The CD will include all abstracts, full papers, and presentations (at author's discretion).

Call for Sponsors

Organizations wishing to help support the conference through sponsorships are strongly encouraged to contact the conference chairman. Sponsorship opportunities include meals, breaks, meeting bags, student travel awards and other items/events.

Call for Proposals for Fee-Based Short Courses

Anticipating a large turnout of practicing engineers and architects, several seminars and short courses for continuing professional development will be offered as part of the conference. *These seminars will be fee-based, proceeds of which will be split between the seminar instructors and the conference.* Persons or organizations interested in offering a wind-related seminar or short course should contact the conference organizers to discuss the proposed topic, duration, fee structure, etc.

Exhibitor Showcase/Presentation Sessions

Another new feature of the conference will be sessions for exhibitor presentations. This will provide additional opportunities for conference participants to learn about the latest products and services available in support of wind engineering research and practice. Companies and institutions wishing to set up display booths and/or participate in exhibitor presentation sessions should contact the conference organizers for more information.

For More Information

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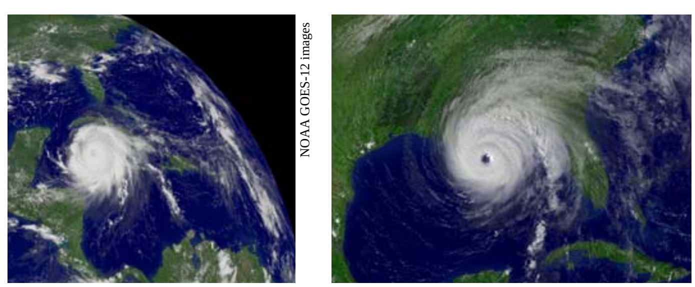


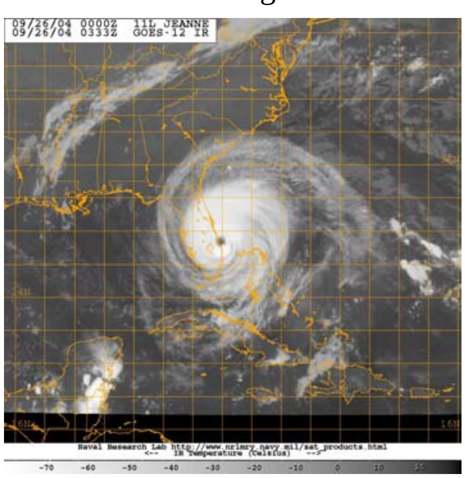
Hurricane Ivan unleashes his fury on Caribbean islands (left) before making landfall near the Florida/Alabama border. Category 4 Ivan approaching central Gulf Coast (right).

President's Corner

Bogusz Bienkiewicz

As the 2004 hurricane season rages on, members of wind engineering community continue to be involved in activities of relevance to the present (and potential future) strong wind events. These efforts have included assistance provided to local and federal emergency authorities, and directly to communities affected by recent hurricanes and related hazards, wind damage investigations, mapping of wind field during life-cycle of hurricane landfalls and others. We intend to report on these activities in the forthcoming issues of The Wind Engineer.

The cover story of the current issue of this newsletter is a report on the development of an Enhanced Fujita Scale (EF) – a multi-year effort coordinated by a team from Texas Tech University (TTU) and involving a number of experts representing various US constituencies. The paper by Jim McDonald and Kishor Mehta provides background information and an overview of the proposed EF scale. As indicated in the paper more information (including a 95-page report) can be found on the website of the Wind Science and Engineering Center at TTU (www.wind.ttu.edu). The report also has been posted on the AAWE website (www.aawe.org). We encourage all the AAWE members to provide feedback on the proposed EF scale. For your convenience an AAWE Ballot is enclosed with this newsletter. We would appreciate receiving from you the ballot (with your comments) by October 31, 2004. Results of the balloting will be presented in a forthcoming issue of the Wind Engineer.



Naval Research Lab Monterey Marine Meteorology Division

Hurricane Jeanne making landfall in Florida

Record Number of Tornadoes in August

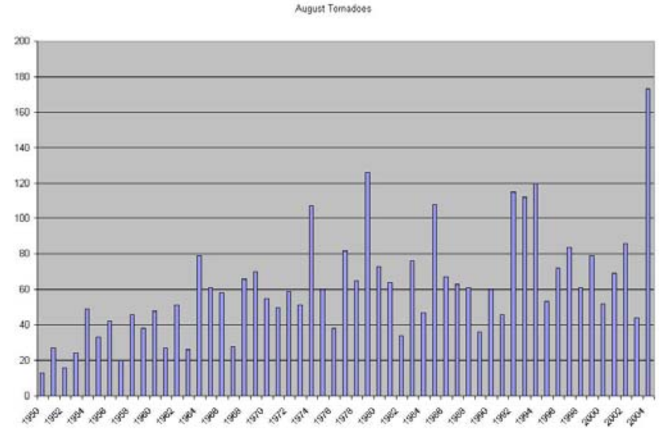
NOAA News Story—Sept. 2, 2004

A land-falling hurricane and a tropical storm helped push the total number of tornado reports to a record high for the month of August across the United States, according to the NOAA Storm Prediction Center in Norman, Okla. Preliminary numbers indicate a total of 173 tornadoes reported during the month, said Dan McCarthy, SPC's warning coordination meteorologist. Based on tornado records going back to 1950, this significantly tops the previous August record of 126 tornadoes set in 1979. Other high numbers for August include: 120 tornadoes in 1994; 115 in 1992; 112 in 1993; and 108 in 1985.

"The active tropical storm season can be partially blamed for the high number of tornado reports," McCarthy said. Four named tropical storms affected the mid-Atlantic and Southeast seaboards during the month. Tornadoes frequently occur in the forward-right quadrant of a tropical storm or hurricane. This is the sector where wind shear is the greatest, he explained.

"The most active time for tornadoes was August 12-14 when Tropical Storm Bonnie moved from the Florida panhandle northeastward along a weak frontal boundary into the Carolinas. Hurricane Charley immediately followed, which caused extensive damage near Ft. Myers northeastward across Florida into the Carolinas," McCarthy said.

Even with all the tornadoes, only three tornado-related fatalities occurred in August. The three fatalities were caused by a tornado associated with the remnants of Tropical Storm Bonnie that heavily damaged a trailer park near Rocky Point, N.C.



Annual number of reported August tornadoes, 1950-2004

(Continued from page 1)
means of a regression analysis. The wind speed ranges of each EF-Scale category were then derived from the regression equation. The EF Scale consists of the 28 DI's and their corresponding DOD's, expected, upper and lower bound wind speed for each DOD and six EF categories ranging from EF0 to EF5.

The concept of the EF Scale has been presented to NWS upper management for their consideration in adopting it as the new standard for estimating the intensity of tornadoes. The concept was well received by NWS. They would like to see evidence of a consensus among both the meteorology and engineering communities. This paper presents the strategy and development plan used in arriving at the proposed EF Scale. The concept has been presented at several professional meetings as progress was being made. Input has been very helpful from both engineers and meteorologists. The AAWE Board is requested to endorse the concept on behalf of the membership. Please provide input to the Board after reviewing the remainder of this paper. A form for your input is provided at the end of this paper.

The full 95 page report with appendices can be viewed on Texas Tech's wind engineering web site, www.wind.ttu.edu. Click *Fujita Scale* on the left, then click on *View the Enhanced Fujita Scale Report* at the top. It can be downloaded if desired.

Background

Dr. Ted Fujita introduced the Fujita Scale (F-Scale) in 1971 (Fujita, 1971). His stated purpose was to distinguish weak tornadoes from strong ones. He established 12 intensity categories by fitting a smooth curve that connected Fujita F1 with Beaufort B1 and Fujita F12 with Mach 1 wind speeds. Beaufort B0 indicates calm or no wind and Fujita F0 denotes little or no damage. Because tornado wind speeds are not expected to exceed 300 mph categories F0 to F5 are sufficient to describe tornado wind speed. The categories are assigned based on damage observed in the tornado path. Based on his experience and intuition, Fujita defined word descriptions of damage in each F-Scale category. The descriptions were based on vague descriptions of damage to "well constructed" wood-framed houses, tree damage and windborne debris. Refer to Table 1 for a synopsis of F-Scale wind speeds and damage descriptions.

Table 1. Original Fujita Scale:
Wind speeds (in mph) and damage descriptions.

No	Wind Speeds	Abbreviated Damage Description
F0	40 - 72	Light damage: some damage to chimneys
F1	73 - 112	Moderate damage: Peel surfaces off roofs; Mobile homes pushed off foundations and overturned
F2	113 - 157	Considerable damage: Roof torn off framed houses; Mobile homes destroyed
F3	158 - 206	Severe damage: Roof and some walls torn from well constructed houses
F4	207 - 260	Devastating damage: Well constructed houses leveled; Structures with weak foundations blown off some distances
F5	261 - 318	Incredible damage:Strong frame houses lifted from foundation and carried considerable distances to disintegrate

Invention of the F-Scale appeared to solve a number of problems regarding tornado intensity in 1971. Wind speed estimates were needed for tornado risk assessment and design criteria. F-Scale categories could be assigned to tornadoes in the historical database from descriptions of the damage. The concept provided a relatively easy way to classify the intensity of tornadoes from observed damage on the ground or from an aerial survey. The meteorological and engineering communities almost immediately accepted the Fujita-Scale concept.

Despite the rapid acceptance, both professional groups recognized limitations. The F Scale fails to account for variations in construction quality and strength, is difficult to apply consistently, needs additional and better defined damage indicators and is not based on a systematic correlation of damage descriptions and wind speed.

Several studies showed that less intense winds could cause more damage than suggested by the F-Scale wind speed ranges. Minor et al. (1997) showed that F4 and F5 damage to residences could occur at wind speeds considerably less than the indicated ranges. Phan and Simiu (1998) concluded that F5 wind speeds were not necessary to cause observed F5 damage in the Jarrell, TX tornado. Doswell and Burgess (1988) pointed out problems with consistent application of the F Scale in rating tornadoes. More recently, Marshall (2003) pointed out additional problems of overestimating tornado wind speeds by use of the F Scale.

Recognizing the F-Scale limitations, the Wind Science and Engineering (WISE) Center at Texas Tech University initiated a program to examine and improve the F Scale. The first step was to organize a steering committee, charging them to organize a forum and invite the participants. Thirty persons were invited and 22 attended the forum, which was held in Grapevine, Texas March 7-8, 2001. Objectives of the forum were

1. To identify key issues
2. To make recommendations for a new or enhanced F Scale
3. To develop a strategy for reaching a consensus from a broad cross section of users

Key issues included the need for additional and more specific damage indicators, a correlation between damage and wind speed and a correlation between the original F Scale and the EF Scale so the existing tornado database is preserved. At the close of the meeting, each participant was invited to submit written comments and suggestions. These comments were published in the forum summary report (McDonald and Mehta, 2001).

The TTU project team was directed to develop an Enhanced F Scale that addressed the limitations and issues identified by the forum participants. They were to explore opportunities for workshops and symposiums to involve a more extensive audience with the goal of obtaining a consensus. The TTU project team, headed by Jim McDonald and Kishor Mehta, pursued the following steps, which are discussed in detail in this paper:

1. Identify additional damage indicators (DI's)
2. Define varying degrees of damage (DOD's) for each DI
3. Correlate DOD's with wind speeds expected to cause the damage
4. Propose and EF Scale and relate it to the original F Scale
5. Keep both the meteorological and engineering communities appraised of the progress

Damage Indicators (DI's) and Degrees of Damage (DOD's)

Buildings and other objects, including towers, poles and trees, are the defined DI's. Crops and missiles are other possibilities but were not included in the initial set because of large uncertainties and a lack of data. Associated with each DI are increasing degrees of damage caused by higher wind speeds. The DI's and DOD's are selected to be recognizable by National Weather Service personnel, who, in general, have little or no engineering training. Thus, specific-use buildings, structures and trees are selected for the initial set of DI's (see Table 2). Additional ones can be added in the future as more data becomes available.

The type of construction for each damage indicator is carefully described. For example, the general description of an Elementary School (ES) is:

- These buildings are typically single story with flat roofs
- Facility may include a small gym or cafeteria with moderately long spans between supports
- Building has long interior hallways with bearing or non-bearing walls
- Expect BUR, single-ply membrane or metal standing-seam roof panels
- Metal or plywood roof decking supporting a light-weight poured gypsum deck
- Roof structure consisting of open web steel joists bearing on exterior walls and steel roof girders
- Exterior non-bearing walls constructed with CMU's, glass curtain walls or metal studs with brick veneer, stucco of EIFS cladding
- CMU bearing walls with brick veneer, stucco or EIFS cladding
- Walls may have a large percentage of window glass

The evaluator matches the damage with the appropriate DI. Some training will be necessary for persons who may not be familiar with different types of construction and materials.

The number of DOD's for each DI depends on the complexity of construction. The DOD's range from threshold of visible damage to total destruction

Table 2. Twenty-Eight Damage Indicators

No	Symbol	Damage Indicator
1	SBO	Small Barn or Outbuilding
2	FR12	1- or 2-Family Residence
3	MHSW	Manufactured Home-Single Wide
4	MHDW	Manufactured Home-Double Wide
5	ACT	Apartments, Condos, Townhouses
6	M	Motels
7	MAM	Masonry Apartments or Motels
8	SRB	Small Retail Building
9	SPB	Small Professional Building
10	SM	Strip Mall
11	LSM	Large Shopping Mall
12	LIRB	Large, Isolated Retail Building
13	ASR	Automobile Showroom
14	ASB	Automobile Service Building
15	ES	Elementary School
16	JHSH	Junior or Senior High School
17	LRB	Low-Rise Building (1-4 stories)
18	MRB	Mid-Rise Building (5-20 stories)
19	HRB	High-Rise Building (> 20 stories)
20	IB	Institutional Building
21	MBS	Metal Building System
22	SSC	Service Station Canopy
23	WHB	Warehouse Building
24	ETL	Electrical Transmission Line
25	FST	Free-Standing Towers
26	FSP	Free-Standing Poles
27	TH	Trees: Hardwood
28	TS	Trees: Softwood

of the building. The DOD's are arranged in order of increasing wind speed to cause the damage. Table 3 is an example of DOD's for the elementary school. The wind speeds in the table are discussed in the next section.

The wind speed to cause a particular DOD varies because of conditions that affect the loading or the resistance of a structural element. That is why expected, upper or lower bound wind speeds are estimated for each DOD. The expected value of wind speed causes damage under "normal" construction practice. A weak connection, inappropriate materials or material deterioration would result in failure at a lower-than-expected wind speed. On the other hand, stronger than normal connections, e.g. using hurricane clips rather than toe nailing, might require higher-than-expected wind speeds to produce the damage. Other factors might include the duration of tornado winds or a well-enforced building code. Thus, a person applying the EF Scale will have the option to estimate the wind speed to cause a DOD above or below the expected value but within the range of the upper and lower bounds.

Correlation of Damage and Wind Speeds

The major challenge to the F-Scale enhancement project was how to obtain a correlation between degrees of damage and wind speed. A search of the literature found very few definitive correlations. Mehta et al. (1976) estimated wind speed based on structural analysis of the damaged structure. Although the approach has merit, it requires more effort than the resources for this project allowed. Texas Tech personnel have the experience to estimate wind speeds, but without a detailed technical study, it would be simply the team's opinion, just like Fujita's original estimate. A more definitive solution was needed.

The concept of expert elicitation has been used successfully to estimate certain unknown parameters related to probabilistic seismic hazard analysis. The Senior Seismic Hazard Analysis Committee formalized the process

Table 3. Degrees of Damage (DOD) for Elementary School Correlated with Expected (EXP), Lower Bound (LB) and Upper Bound (UP) Wind Speeds (in mph)

DOD	Damage description	EXP	LB	UB
1	Threshold of visible damage	65	47	80
2	Loss of roof covering (<20%)	79	66	99
3	Broken windows	87	71	106
4	Exterior door failures	99	85	118
5	Uplift of some roof decking; significant loss of roofing material (>20%); loss of rooftop HVAC	101	82	121
6	Damage to or loss of wall cladding	108	92	127
7	Uplift or collapse of roof structure	125	108	148
8	Collapse of non-bearing walls	139	117	162
9	Collapse of load-bearing walls	153	130	180
10	Total destruction of a large section of building or entire building	176	152	203

(SSHAC 1997), while working under the auspice of the U.S. Nuclear Regulatory Commission, the U.S. Department of Energy, and the Electric Power Research Institute. Boissonnade, et al. (2000) at Lawrence Livermore National Laboratory successfully applied expert the elicitation process to estimate parameters for tornado hazard assessment.

The SSHAC protocol specifies the following steps, which were followed in the present study:

- Assemble a panel of experts
- Discuss and refine the issues with the experts; provide all available data
- Train the experts for elicitation
- Conduct individual elicitations and group interactions
- Analyze and aggregate elicitations and resolve issues
- Document and communicate the process and final results

Members of the expert elicitation panel, their background and affiliation are listed in Table 4. Each person has strong relevant expertise, professional reputation, academic training, experience, and peer-reviewed publications. All have specific knowledge of tornadoes and tornado damage. The experts met for a day and a half to initiate the elicitation process. After discussing the issues, providing available data, and explaining the process, the experts were ready to perform the elicitations.

Table 4. Members of Expert Elicitation Panel

Name	Background	Affiliation
Don Burgess	Meteorologist	NSSL (retired)
Greg Forbes	Meteorologist	The Weather Channel
Doug Smith	Engineer	Texas Tech University
Tim Reinhold	Engineer	Clemson University
Tim Marshall	Engineer/ Meteorologist	Haag Engineering
Tom Smith	Architect	Roofing Consultant

Each expert estimated the expected wind speed to produce the degree of damage (DOD) to a damage indicator (DI) or building structure type. In addition, they estimated upper and lower bound wind speeds, taking into account uncertainties in the damage. The wind speed frame of reference is a 3-second gust at 33 ft. in open, unobstructed terrain. After the first round, results were tabulated and reviewed by the group. The DOD statements were refined and clarified. New DI's were added and others were eliminated. The experts went home with instructions to conduct a second round of elicitations. The second round results were tabulated and distributed to the group. The group was given the opportunity to refine its estimates a third time. Very few changes were made after the second round. The final elicitation results are tabulated and plotted as charts. The DOD's are ordered in ascending values of the expected wind speeds. Figure 1 contains the chart for the Elementary School DI. The numbers along the abscissa correspond to the DOD's in Table 3. The ordinate is wind speed. The range between upper and lower bound wind speeds is approximately 40 mph . The expected values fall about halfway between upper and lower bound values. All elicitation results for the 28 DI's are posted on the Wind Science and Engineering website at Texas Tech University (www.wind.ttu.edu).

EF-Scale and F-Scale Correlation

Forum participants were emphatic in the need to preserve the historical tornado database. A relationship between the two wind speeds was needed. To accomplish this objective, a panel of NWS meteorologists was assembled and asked to assign original F-Scale ratings to each DOD. The six experts chosen routinely assign F-Scale ratings to tornadoes based on observed damage. Persons from different parts of the country were invited to serve on the panel in order to incorporate the variation of construction practices around the country.

The F-Scale rating of each DOD was expressed as wind speed by converting the median wind speed to a 3-second gust speed. The expected EF-Scale wind speeds and the F-Scale wind speeds are plotted as ordinate and abscissa, respectively, in Figure 2. A regression analysis was performed on these data points. A linear relationship with a 0.91 correlation coefficient gives the best fit. The regression equation is

$$y = 0.6246x + 36.393 \quad \text{(Eq.1)}$$

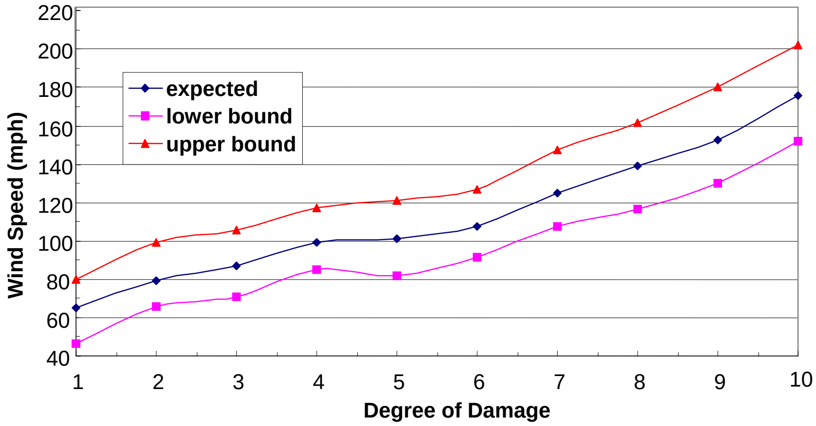


Figure 1. Wind Speed versus DOD's for Elementary School. See Table 3 for description of DOD's.

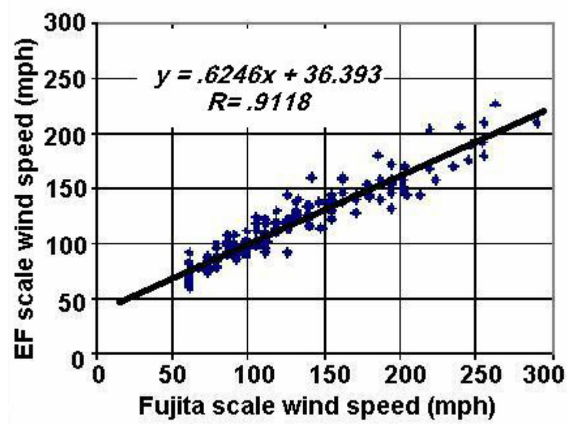


Figure 2. Correlation of F-Scale and EF-Scale wind speeds.

where *y* is the EF-Scale wind speed and *x* is the F-Scale wind speed, both being 3-second gust speeds.

Now, with the regression equation, the wind speeds that define the F-Scale ranges were converted to equivalent EF-Scale wind speeds. These define the EF-Scale wind speed ranges. Table 5 shows the original F-Scale ranges and the equivalent EF-Scale ranges converted to three-second gusts. In order not to imply more accuracy than justified, the EF-Scale values are adjusted to the nearest 5 mph as shown in Table 6. By correlating the F-Scale wind speeds with the EF-Scale wind speeds, a tornado rated by the F-Scale will have the same "EF-number," e.g. F3 translates to EF3, although the wind speed ranges are different.

Table 5. F-Scale wind speed ranges converted to 3-second gusts and compared to EF-Scale 3-second gust wind speeds

Corrected F Scale		New EF-Scale	
F Scale	3-sec. gust speed, mph	EF Scale	3-sec. gust speed, mph
F0	45-78	EF0	65-85
F1	79-117	EF1	86-109
F2	118-161	EF2	110-137
F3	162-209	EF3	138-167
F4	210-261	EF4	168-199
F5	262-317	EF5	200-234

Application of The EF Scale

The EF-Scale is intended for application to an individual building or other damage indicator. Members of the forum were very specific in their opinion that a single DI should not be used to rate the intensity of a tornado event. Therefore, items other than buildings were added to increase the likelihood that more than one DI will be available for use in rating the tornado intensity.

A damaged building or object is rated by the EF-Scale by taking the following four steps. First, the building or object is matched with one of the 28 DI's. Second, the observed damage is matched with one of the DOD's of the DI. Third, the wind speed within the range of the DOD wind speed is estimated. Fourth and finally, the EF number that contains the estimated wind speed is assigned to the ob-

Table 6. Recommended EF-Scale wind speed ranges

EF Categories	Wind Speed Ranges (mph)
EF0	65 - 85
EF1	86 - 110
EF2	111 - 135
EF3	136 - 165
EF4	166 - 200
EF5	> 200

served damage.

Under normal conditions, the expected value is representative of the observed damage. However, there are factors that can cause a deviation (either higher or lower) from the expected value. The evaluator makes a judgment, within the range of upper and lower bounds, as to whether the wind speed to cause the observed damage is higher or lower that the expected value. For example, if the evaluator estimates the damaging wind at 140 mph, then, from Table 6, the rating for the damaged building or object would be EF3.

The rating of a tornado event should represent an integrated estimate of the highest wind speed that occurred during the life cycle of the tornado. It is well known that intensity varies both along the length and across the width of a tornado damage path. Unless the DI is located in the damage path where the highest winds occurred, an estimate of wind speed will be low. Likewise, if actual wind speed is greater than the upper bound of the DOD being considered, the estimate based on the DOD will be too low. Thus, the rating of a tornado event must involve an aggregate of all available data, including nearby structures that were not damaged.

Assigning an EF-Scale rating to a tornado event might involve the following steps:

- Conduct an aerial survey of the damage path to identify DI's and define extent of the damage path.
- Identify several DI's that tend to indicate the highest wind speeds in the path.
- Record specific locations of the DI's within the damage path.
- Conduct a ground survey and carefully examine the DI's of interest.
- Follow the procedure for assigning EF-Scale wind speeds to the individual DI's and document results.
- Considering all information, arrive at an aggregate maximum estimated wind speed, and assign the corresponding EF-Scale rating to the tornado event.
- Record the basis for assigning the EF-Scale rating.
- Record other pertinent data.

Implementation

Every opportunity has been taken to present the EF Scale concept and to receive comments and feedback. Presentations, workshops and symposiums have been held at the following meteorological and engineering professional meetings:

- Fujita Symposium, AMS National Conference, Long Beach, CA, January 2000.
- National Severe Storms Workshop, National Weather Service, Norman, OK, March 2001.
- EF-Scale Workshop, U. S. National Conference on Wind Engineering, Clemson University, June 2001.
- EF-Scale Session, AMS National Conference, Long Beach, CA, January 2002
- 21st AMS Conference on Severe Local Storms, San Antonio, TX, August 2002.
- 11th International conference on Wind Engineering, Lubbock, TX, June 2003.

A briefing was presented to the NWS upper management on June 28, 2004 in Silver Spring, Maryland. For the EF Scale to achieve general acceptance, the NWS must buy into the concept. The presentation was well received. The NWS leadership wants to see endorsements from various organizations and agencies that will make use of the EF-Scale, including the engineering community.

Conclusion

An Enhanced Fujita Scale (EF Scale) addresses major limitations of the original Fujita Scale. Enhancement was accomplished by identifying 28 specific damage indicators (DI's). Each DI has a specific set of degrees of damage that ranges from threshold of visible damage to totally destroyed. A process of expert elicitation provided estimates of tornado wind speed to produce the damage described by the DOD's. A correlation was obtained between the F-Scale and the EF-Scale wind speed ranges. The categories range from EF0 to EF5 just as the F Scale goes from F0 to F5. The damage associated with each EF-Scale and F-Scale category is equivalent but the wind speeds are different as indicated in Table 5. The EF5 wind speed range is about 30 percent lower that the original F Scale. The EF-Scale wind speed required to destroy a building and blow away the debris is less than predicted by the original F Scale.

The problem of no damage in open country remains. Research currently is underway to identify other damage indicators and to obtain estimates of wind speeds to cause the damage. Of particular interest are damage to crops, farm equipment, silos, grain storage facilities, fences, and irrigation equipment. These indicators can be incorporated, as DI's in the EF-Scale as reliable data becomes available. The technology of Doppler radar also should be a part of the EF-Scale process, either as direct measurements, when available, or as a means of validating the wind speeds estimated by the experts.

Ballot

Please complete the ballot inserted in this newsletter and fax or mail to the address indicated. The ballot and full report are also available on the AAWE web site. The authors and the AAWE Board are interested in your opinion regarding the proposed EF Scale.

Acknowledgement

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NEWS NOTES:
People, Research, Publications, etc.

Jim McDonald Retires from Texas Tech

After a long and illustrious career, Dr. James R. McDonald retired recently from Texas Tech University. It would take a whole issue of the newsletter to document his accomplishments. His successful collaboration with Kishor Mehta, Joe Minor, and others helped create a world class wind engineering program at TTU. In his later years, Jim led the Department of Civil Engineering, serving as Chairman. Jim remains active in wind engineering, consulting with the firm McDonald, Mehta, and Yin (MMY).

Nick Jones Returns to JHU as Dean

After serving for several years as Chairman of Civil and Environmental Engineering at the University of Illinois, Urbana-Champaign, Dr. Nicholas P. Jones has returned to Johns Hopkins University. He was appointed as the fourth Dean of the Whiting School of Engineering, effective August 2004.

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