ASCE/SEI Tornado Wind Speed Estimation (TWSE) Standard: Background and Introduction

Marc Levitan, NIST
James LaDue, NWS

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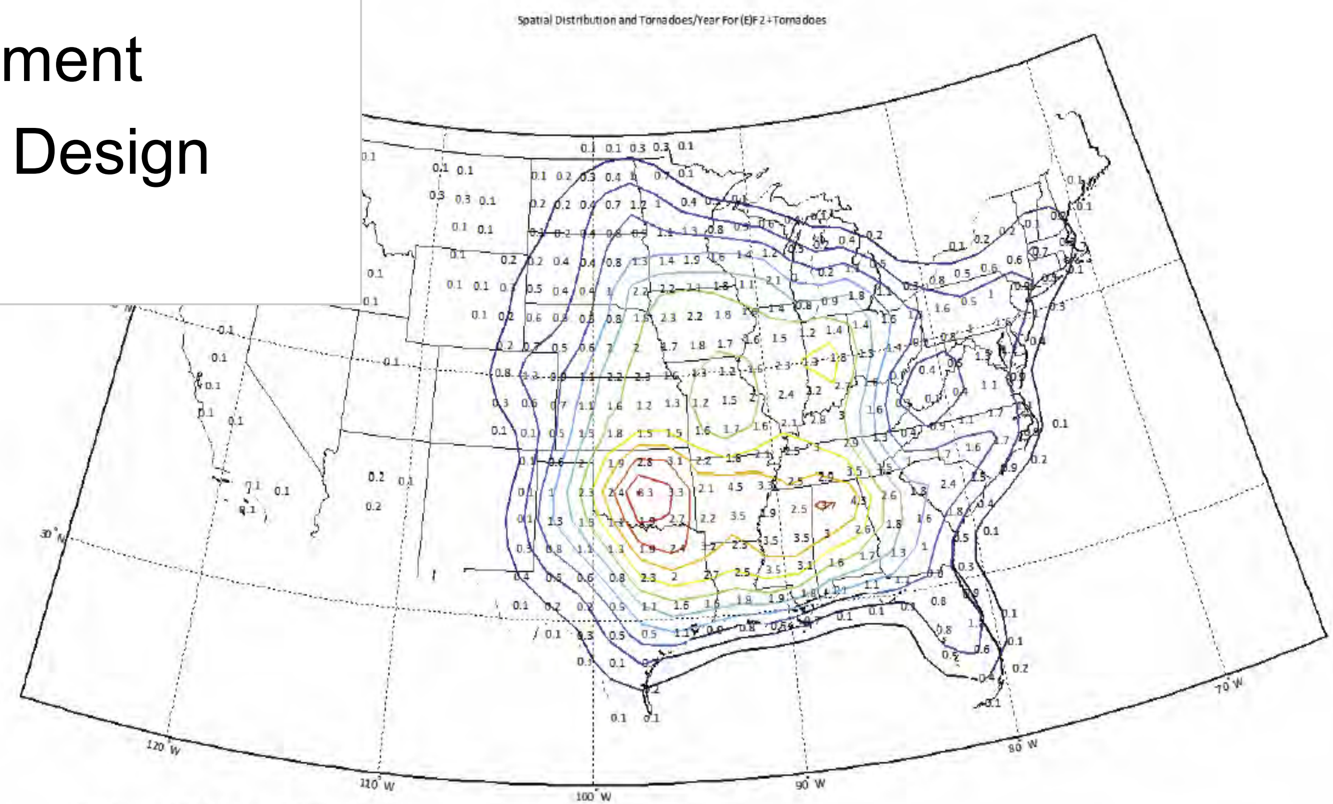
The need for tornado intensity estimation

- Improved Forecasts and Warnings
- Risk Assessment
- Engineering Design



Data Source: NOAA. Analysis by NIST.

Figure 2– 33. Probability density of EF–2 or greater tornadoes from 1980 through 2011 with EF–2 or stronger tornadoes per year values shown at each grid point.

NIST 2013

Fujita Scale, Adopted by NWS in 1973

SCALE	WIND ESTIMATE (MPH)*	TYPICAL DAMAGE
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yds); trees debarked; incredible phenomena will occur.

**NOTE: Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place – even from building to building. Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

NIST Technical Note 1426

The Fujita Tornado Intensity Scale: A Critique Based on Observations of the Jarrell Tornado of May 27, 1997

Long T. Phan and Emil Simiu

Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-0001

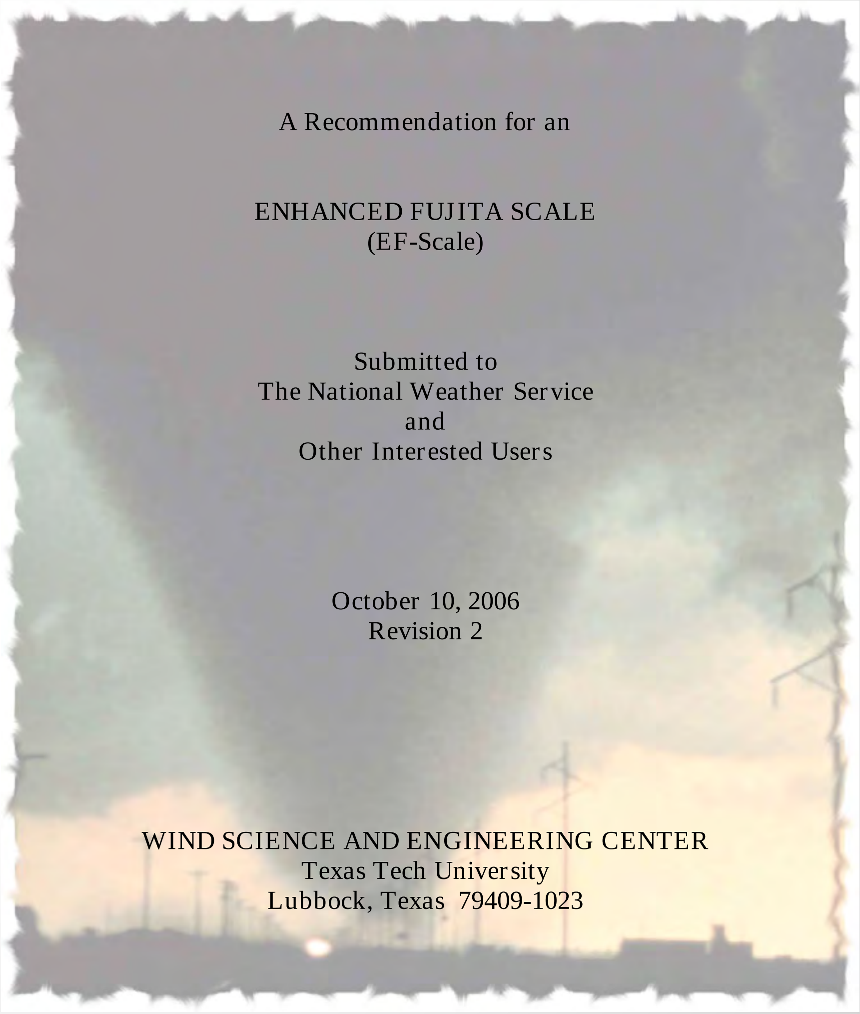
July 1998

assumed to explain that damage. We ascribe the NWS rating to the failure of the Fujita tornado intensity scale to account explicitly for the dependence of wind speeds causing specified types of damage or destruction upon the following two structural engineering factors: (1) quality of construction, defined as degree of conformity to applicable standards requirements, and (2) the basic design wind speed at the geographical location of interest.

EF-scale adopted by NWS in 2007

Purpose:

- A six-level numerical, damage-based classification of **estimated** wind speeds
- 28 damage indicators (DIs)
- Multiple degrees of damage (DOD) for each DI
- Developed by Drs. Kishor Mehta and Jim McDonald, TTU, with NIST support


A Recommendation for an

ENHANCED FUJITA SCALE
(EF-Scale)

Submitted to
The National Weather Service
and
Other Interested Users

October 10, 2006
Revision 2

WIND SCIENCE AND ENGINEERING CENTER
Texas Tech University
Lubbock, Texas 79409-1023

Concerns with present EF-scale

2013: Bull. Amer. Meteor. Soc., **94**, 641–653.
Incorrect vegetation DIs, need for new DIs
Lack of guidance for current DIs

TORNADO INTENSITY ESTIMATION
Past, Present, and Future

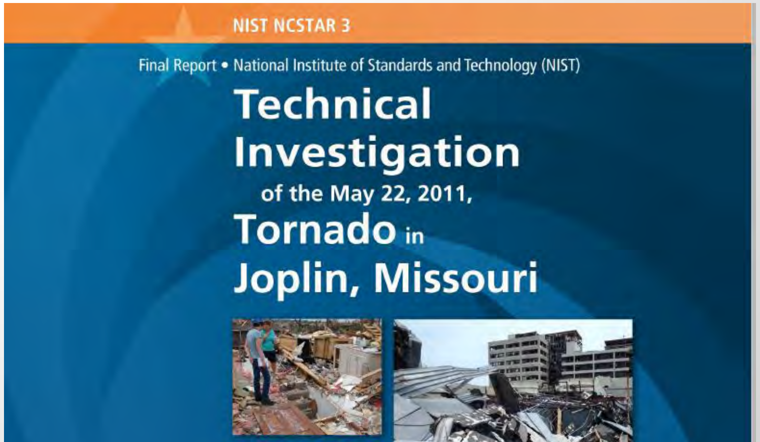
BY ROGER EDWARDS, JAMES G. LADUE, JOHN T. FERREE, KEVIN SCHARFENBERG, CHRIS MAIER, AND WILLIAM L. COULBOURNE

The enhanced Fujita scale, devised to rate wind damage more precisely, will need accountability and flexibility to keep pace with advances in mapping, documentation, and the growing understanding of structural responses to airflow.

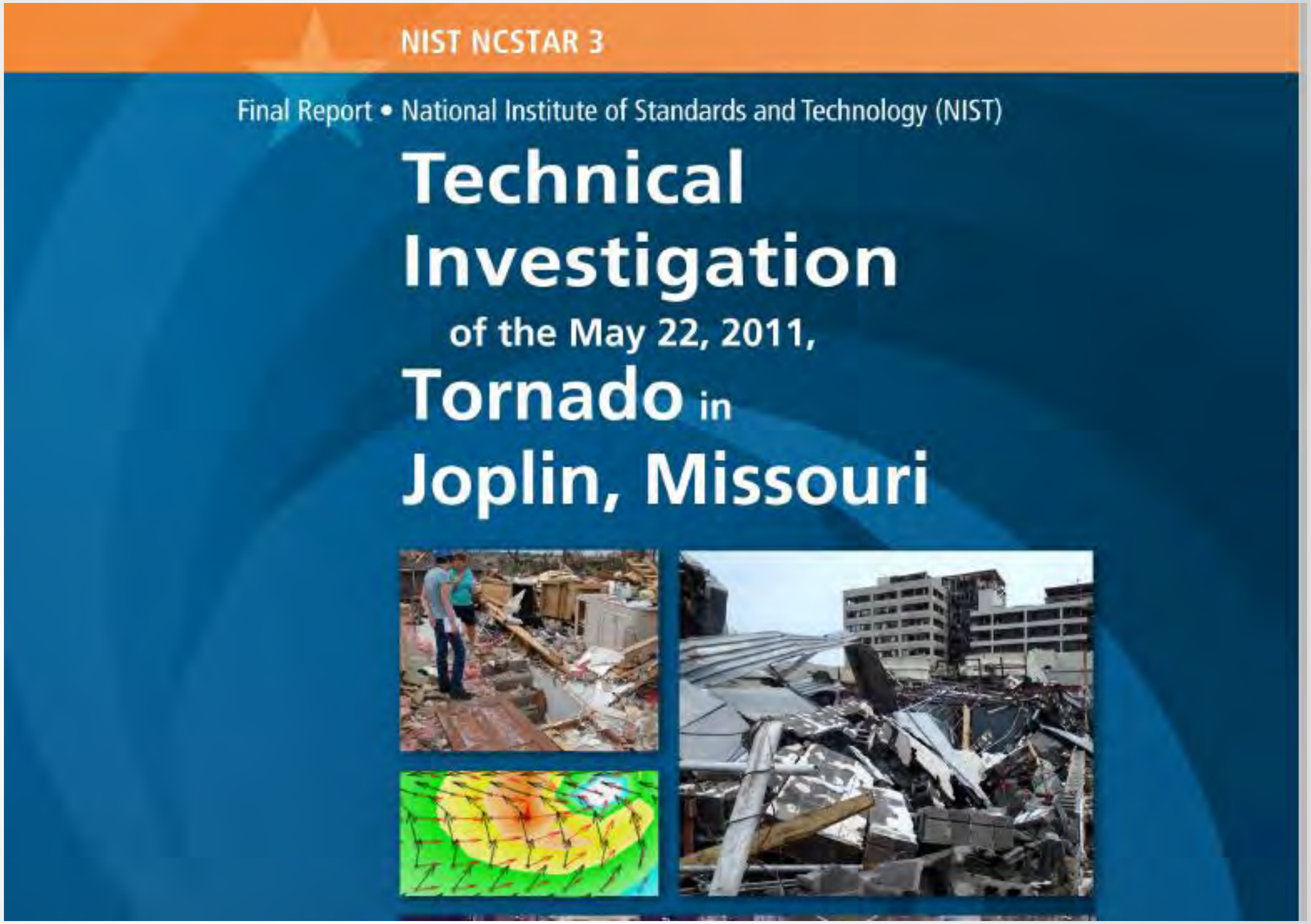
Mitigation Assessment Team Report
Spring 2011 Tornadoes: April 25-28 and May 22
Building Performance Observations, Recommendations, and Technical Guidance
FEMA P-908 / May 2012
FEMA

#40 - DI lists incomplete
#41 – DOD categories inadequate
#42 – gradient of DODs
#43 – Incorrect order of DODs
#44 – lacking photographic DOD guidance
Differences between NWS and FEMA

Finding 7: Lacking adequate DIs and DODs;
Requires subjective, non–quantitative
assessment of tornado damage.



A process needed to evolve the EF scale



NIST Recommendation 4
A committee comprised of public and private entities should be formed with the ability to propose, accept, and implement changes to the EF Scale. The improved EF Scale should be adopted by NWS.

A path to a formal process

Ad-hoc EF scale Stakeholders group → Adopting a standards process → Formal standards committee

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First Meeting March 2015

Public Comment Draft Anticipated by 2019

Rationale for an ASCE/SEI Standard

- Well documented need for improving the EF Scale
- Recent research indicates that the EF Scale is underestimating tornadic wind speeds
- Standardization of new methods (e.g., radar analysis, forensic engineering) critical to capture best possible tornado hazard data
- Accuracy and precision of tornado climate data critical to tornado hazard characterization for engineering design and long-term risk assessment
- ASCE interest to develop performance-based standard for tornado resistant design of buildings and infrastructure

Scope of TWSE standard

- Radar method
- In-situ methods
- EF-scale method
- Forensic Engineering method
- Tree-fall pattern method
- Remote sensing imagery methods
- Data and Metadata Archival
- Considerations for International Use (Commentary)

Estimates Derived from Measurements (Radar method; In-situ methods)

Estimates Derived from Impacts (EF-scale method; Forensic Engineering method; Tree-fall pattern method; Remote sensing imagery methods)

Documentation Requirements for Estimates (Data and Metadata Archival)

1st Step Toward Internationally Consistent Tornado Climatology (Considerations for International Use)

TWSE Standards Committee Organization

Main Committee
Chair – James LaDue (NOAA/NWS)
Co-chair Dr. Marc Levitan (NIST)

Radar subcommittee
Chair – Dr. Josh Wurman (CSWR)
Co-chair – Dr. Karen Kosiba (CSWR)

Tree-fall subcommittee
Chair – Dr. Chris Karstens (NOAA/NSSL)
Co-chair – Dr. Chris Godfrey (UNC Ashevile)

In-situ committee
Chair – Dr. Frank Lombardo (UI)

Remote Sensing Imagery subcommittee
Chair – Dr. Arn Womble (WTAMU)

EF-scale subcommittee
Chair – Dr. Tanya Brown (IBHS)
Co-chair – Brian Smith (NOAA/NWS)

Data Archival subcommittee
Chair – John Robinson (retired NOAA/NWS)

Forensics subcommittee
Chair – Bill Coulbourne (Coulbourne Consulting)

International Working Grpup
Chair – Greg Kopp (UWO)

TWSE Committee Expertise

Discipline (31 Voting Members)	
Meteorologist	10
Wind Engineer/Meteorologist	3
Wind Engineer	1
Wind/Mechanical Engineer	1
Wind/Structural Engineer	5
Structural Engineer	9
Architect	1
Geospatial Data Analyst	1

Additional Disciplines in Associate Membership (68 Assoc. Members)

Forensic Engineers, Forensic Meteorologists, Forest Biologists, Horticulturists, Emergency Managers

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SEI ASCE

AMS American Meteorological Society