OVERVIEW OF METHODS USED IN THE DEVELOPMENT OF TORNADO RISK MAPS FOR BUILDING DESIGN

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The National Institute of Standards and Technology (NIST) has funded Applied Research Associates, Inc. to develop tornado risk maps for contiguous US which will be used in Performance-Based Design Standards. The scope of the project includes development of maps for different facility sizes and return periods. The developed maps reflect best-estimate engineering and scientific probabilistic modeling with consideration of uncertainties. The analysis to develop the maps involves the following modeling components:

1. The Tornado Data analysis involves exploratory analysis of the NOAA/NWS Storm Prediction Center (SPC) database, data visualization, trends, and outliers. We also use the census data, and other data needed to correct the estimated tornado occurrence rates by population bias analysis.
2. Climatology Analysis involved the development of tornado climatology regions and subregions within the contiguous US. We use multivariate statistical analysis to develop broad regions of similar tornado climatology and the estimation of the uncertainties in these regional boundaries.
3. Probabilistic tornado wind field modeling implementation to simulate tornado wind field swaths that capture the variation in tornado path lengths, widths, path length intensity variation, radii of maximum winds, translation speed, path-boundary wind speeds and other tornado wind field parameters.
4. Tornado fragility and damage-to-wind speed modeling of a number of important DIs in order to probabilistically estimate the wind speeds associated with damage interpretations of the EF scale for those Damage Indicators. The wind speed distributions developed in this task

provide the engineering link from damage scale based tornado intensity to engineering-based wind speeds.

5. The Integrated Hazard Model component is where all the results of the previous components come together to produce a wind speed vs return period tornado hazard curve for each climatological region and subregion. We use a Monte Carlo simulation method, and epistemic and aleatory uncertainties to simulate tornadoes, produce damage swaths, and score wind speed exceedances numerically over a wind range of wind speeds. Wind speed exceedance frequencies are developed for both small (point) targets, large buildings, and large facilities, such as nuclear power plants.
6. The production of wind speed maps that capture the spatial variations in wind speed risk for each return period and target size category. The wind speed risk maps are being developed for return periods ranging from approximately 1,000 years to 10,000,000 years.

This presentation will highlight the approach used in the development of the tornado risk maps and important results to date.