Potential Impact from Induced Winds for High Speed Trains

Background
A passing train induces an airflow in its surroundings that diminishes as the distance from the train increases. Concern has been expressed that the wind gusts induced by the proposed high speed trains might negatively impact the bees that pollinate almond trees that are along the potential high-speed train routes. Trains for the California High Speed Rail system could reach maximum speeds of 220 miles per hour (mph).

This memo summarizes a review of information about potential induced wind gusts and meteorological data for the Merced Regional Airport / Macready Field (KMCE) and for the Fresno Yosemite International Airport (KFAT).

Induced Wind
In the Federal Railroad Administration document “Assessment of Potential Aerodynamic Effects on Personnel and Equipment in Proximity to High-Speed Train Operations: (U.D. Department of Transportation, 1999) the potential hazards created from the aerodynamic effects of passing high speed trains was assessed. The document reviewed both the theoretical and experimental data available at the time and limits its conclusions to trains with speed of 150 mph or less. Based on their review, they conclude that at a distance of 8 meters (26 feet) from a train traveling at 150 mph the induced wind would be in the range of 10 mph to 40 mph. There is a range in speed because of variations between trains and uncertainties in the experimental data.

A literature search for aerodynamics of high speed trains showed that most research in this area is concerned with determining the dynamic forces on the high speed train itself (Schetz, 200; Baker, 2010). That research is done to facilitate the design of high speed trains that are both safe and comfortable. In addition to that body of work, recent papers by Chris Baker and Mark Sterling on the induced wind caused by high speed trains were found (Baker, et al., 2001; Sterling, et al., 2008; Jordan, et al.; 2010). Sterling and Baker are both professors at the School of Civil Engineering, at the University of Birmingham, Birmingham, UK. Their studies focus mainly on the impact of the induced wind (which they refer to as the “slipstream”) on people waiting along the track (both workers and public) in regards to safety.
Professors Sterling and Barker were contacted (Sterling and Baker, 2010). They said were not aware of any research done on the impact of high speed trains on bees or pollination. They said that European safety standards for high speed trains are specified at 3 meters from the track center. They said they did not know of any data from measurements beyond 3 meters. They referred to Figure 18 from their recent paper (Sterling, et al, 2008) as presenting two sets of induced wind profiles from the German Intercity Connect (ICE) high speed train. They indicated that they considered these to be high quality data that show the slipstream velocity as a function of the distance from the train. These data show that for trackside measurements the induced winds are between 5% and 10% of the speed of the train at 3 meters.

In their most recent paper (Jordan, et al., 2010) the authors note that the induced winds caused by a high speed train have three distinct components: (1) flow around the nose of the train, (2) flow along the train, and (3) flow in the wake of the train. Exact analytical solutions for these flow fields are not possible. This is especially true of the flow in the wake of the train. However, it is known that the average magnitude of the induced wind does diminish as the distance from the train increases. For the analysis in their most recent paper the authors represent the induced velocity in the wake of the train as the product of an exponential and parabolic function of the distance with each function having a separate decay constant.

**Meteorological Data**

Meteorological data for the Merced Regional Airport / Macready Field (KMCE) for the period of record of August 1998 to December 2008 (Western Regional Climate Center, 2010a) and for the Fresno Yosemite International Airport (KFAT) for the period of record of July 1996 to December 2008 (Western Regional Climate Center, 2010b) were reviewed. The wind data for these two airports are very similar. Wind statistics are organized by month of the year.

**Merced Regional Airport/ Macready Field (KMCE):** The Daily Average Wind Speed ranges from 4.2 mph for November to 8.2 mph for June. The Daily Average Maximum 2-minute wind speed ranges from 12.1 mph for November to 16.7 mph in May. The Daily Average Peak Gust, which is a maximum 5-second average, ranges from 15.0 mph in November to 21.3 mph in May. The Maximum Daily Average wind speed ranges from 10.9 mph for August to 22.1 mph for May. The Maximum 2-Minute Average wind speed range from 24 mph for September to 43 mph for December. The Maximum Peak Gust ranges from 29 mph for September to 51 mph for December.

**Fresno Yosemite International Airport (KFAT):** The Daily Average Wind Speed ranges from 4.0 mph for December to 8.5 mph for June. The Daily Average Maximum 2-minute wind speed ranges from 11.5 mph for November to 17.7 mph in May. The Daily Average Peak Gust, which is a maximum 5-second average, ranges from 14.2 mph for both November and December to 21.7 mph in May. The Maximum Daily Average wind speed ranges from 12.6 mph for July to 19.3 mph for March. The Maximum 2-Minute Average wind speed range from 25 mph for August to 38 mph for January. The Maximum Peak Gust ranges from 33 mph for both August and September to 46 mph for January.
CONCLUSION

Using the relationships from the ICE data, induced winds from a 220 mph high-speed train would be expected to range from 11 mph to 22 mph at 3 meters (9.8 feet) from the train. At 50 feet and 100 feet the induced winds would be significantly less. A 430 meter long train traveling at 220 mph would completely pass by an observer in less than 5 seconds; therefore a comparable wind statistic would be the Daily Average Peak Gust, where a Peak Gust is a maximum 5-second average wind speed. For KMCE and KFAT the Daily Average Peak Gusts ranged from 15.0 mph to 21.3 mph and 14.2 mph to 21.7, respectively. These ranges of speed are equivalent to the expected range of speeds of the induced winds at 3 meters (9.8 feet) from the train. Consequently, at 50 feet and 100 feet from the train the magnitude of the speeds of the induced winds would be expected to be less than, and consequently, indistinguishable from, the naturally occurring wind gusts. Therefore, no impact to bee pollination from induced winds from the proposed high speed train would be expected to occur.

References:


