

As expected, the more open Layout 2 resulted in more predicted window failure locations for a given charge size, compared to the more extensively built-out Layout 3. Furthermore, the larger 9 lb explosive charge resulted in more window failures than the corresponding 2 lb charge analyses, predominantly on the east face of the building.

D.4 PHASE III: 1-D ACOUSTIC ANALYSIS

Based on the results from Phase II, representative overpressure waveforms from the predicted broken windows on the north and east faces, as well as from open areas at the southwest corner from WTC 1 debris damage, were used to make sound-distance propagation predictions.

The tool used to make the prediction, NLAWS, is a non-linear acoustic wave propagation solver that was developed about 30 years ago by the U.S. Air Force. The code takes the blast wave parameters of peak overpressure, material velocity and positive duration and constructs a triangular wave. It then uses the radius from the burst at the window to the point where conditions are specified for divergence of the wave. The code then uses spherical divergence to continue propagation of the wave in a constant atmosphere to a distance up to 1 km from the burst.

Figure D-15 shows a typical waveform at a broken window location and its Fourier transformation. Most of the sound lies below 200 Hz. Approximately 40 Hz is the lower limit for human audible perception. In this frequency range, the blast would sound like a low rumble. Figure D-16 illustrates a typical waveform in the vicinity of the open window locations in the southwest corner.

Figure D-17 and Figure D-18 show the results of the acoustic analysis for both floor layouts, in which overpressure and sound pressure level vs. distance from the opening are plotted. Intense audible sound was predicted from all building faces for all four combinations of layout and charge size. If propagation were unobstructed, as would be the case for a person standing on a street with a direct view of any WTC 7 face with open windows, the sound level from all building perimeter openings at 1 km would be approximately 130 to 140 dB. Adjacent buildings and their effect on the sound propagation was not considered in this analysis. The analysis was intended to be a simple estimate of the sound potential emanating from the building due to blast pressures.

To check the validity of the results, the close range values predicted by NLAWS are similar to the limited published data available for sound pressures from small explosives. Specifically, Hamby (2004) lists 190.6 dB for 2 lb of TNT at a close standoff. Further, 1 lb of TNT is listed as generating 194.1 dB at 6 ft, 186.1 dB at 10 ft and 180.0 dB at 15 ft standoff (Kinney 1985). These values correlate well with the range of values predicted by the NLAWS model.