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Blast Load Simulator Experiments for Computational Model Validation

Report 4

Andrew T. Barnes, Carol F. Johnson, and James L. O'Daniel

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Blast Load Simulator Experiments for Computational Model Validation

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Andrew T. Barnes, Carol F. Johnson, and James L. O'Daniel

*Geotechnical and Structures Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199*

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Modeling

Abstract

The Department of Defense (DoD) needs the capability to accurately predict airblast environments produced by explosive detonations and their interaction with geometrically complex objects that create complex flow fields, such as buildings, bridges, dams, etc. First-principles computer codes are typically used to generate high-fidelity simulations of these explosive events and their effects. These codes are continuously improving, yet still require validation against experimental data to establish confidence in the results produced by simulations. This report describes three sets of replicate experiments in which two steel box-type structures were installed in a Blast Load Simulator (BLS) with varying spacing between them and subjected to a simulated blast loading to provide pressure-time data at multiple locations on the surfaces of the structures. The BLS is a highly tunable, compressed-gas-driven, closed-end shock tube designed to simulate blast waveforms for explosive yields up to 20,000 lb of TNT equivalent at a peak reflected pressure up to 80 psi and a peak reflected impulse up to 1,100 psi-msec. Pressure and impulse waveforms are presented, and comparisons are made among the replicated experiments to evaluate repeatability. The uncertainty in the experimental pressures and impulses was evaluated by computing 95% confidence intervals on the results.

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Preface

This study was conducted for the Defense Threat Reduction Agency (DTRA). The ERDC technical monitor was Dr. James L. O'Daniel. The DTRA technical monitor was Dr. Culbert B. Laney.

The work was performed by the Structural Mechanics Branch (GSM) and the Research Group (GSR) of the Geosciences and Structures Division (GS), U.S. Army Engineer Research and Development Center, Geotechnical and Structures Laboratory (ERDC-GSL). At the time of publication, Mr. Bradford A. Steed was Chief, CEERD-GSM; Mr. James L. Davis was Chief, CEERD-GS; and Ms. Pamela G. Kinnebrew, CEERD-GZT, was the Technical Director for Military Engineering. The Deputy Director of ERDC-GSL was Dr. William P. Grogan, and the Director was Mr. Bartley P. Durst.

COL Bryan S. Green was the Commander of ERDC, and Dr. David W. Pittman was the Director.

Unit Conversion Factors

Multiply	By	To Obtain
degrees (angle)	0.01745329	radians
feet	0.3048	meters
inches	0.0254	meters
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.45359237	kilograms

1 Introduction

1.1 Background

The U.S. Department of Defense (DoD) needs the capability to accurately predict the airblast environment produced by explosive detonations and its interaction with geometrically complex objects (such as buildings, bridges, and dams) that create complex flow fields. First-principles computer codes are typically used to generate high-fidelity simulations of these explosive events and their effects. These codes are continuously improving, but they still require validation against experimental data to establish confidence in the simulation results specific to their intended use.

One method for providing experimental data for computational model validation is the use of a blast load simulator, such as a shock tube, to produce a simulated high-explosive blast environment. Generally, a shock tube can provide a repeatable blast environment at a significantly lower cost than field experiments conducted with explosives. Repeated experiments are often necessary to quantify the uncertainty in the experimental results for validating computational models.

1.2 Objective

The objective of this effort was to conduct a set of repeated experiments in the U.S. Army Engineer Research and Development Center (ERDC) Blast Load Simulator (BLS) to measure the pressure loading on two nonresponding box-type structures located in the flow of the BLS-simulated blast environment for use in evaluating computational models.

1.3 Approach

To meet the objective of this effort, three series of five to six replicate experiments were conducted in the BLS, using what is referred to as the 8-ft×8-ft BLS configuration (Dallriva et al. 2016). In order to reduce the influence of the reflected pressure from the calibration plate on the recorded data, the BLS configuration maintained a 4-ft gap prior to the target vessel as described in Johnson et al. (2017). The nonresponding structures were installed in the BLS at a distance far enough downstream of the driver and near the reflecting target plate to provide increased testing

time undisturbed by the interface (contact surface) between the driver gases and the driven gases. Otherwise, the contact surface impinging on the structures would result in turbulent effects that significantly reduce experiment repeatability. Data from the five experiments were used to calculate 95% confidence intervals in the results. The confidence intervals account for uncertainties associated with any small unknown or uncontrollable variations in experiment setup and conditions and for any inherent random variability in the dynamic environment produced in this BLS experimental process.

Pressure gauges were installed on the four sides and the top of each structure, in the wall of the BLS near the structures, and in a fixed steel reflecting plate (referred to as the calibration plate) at the end of the BLS, all for recording pressure vs. time at the gauge locations. Data plots that include pressure-time and impulse-time histories are provided, and a few comparison plots are provided for visual evaluation of test repeatability.

2 Experiment Descriptions

2.1 Blast load simulator

The ERDC BLS (Figure 1) is a highly tunable, compressed-gas-driven shock tube designed to simulate blast waveforms for explosive yields up to an equivalent of 20,000 lb of TNT at a peak reflected pressure up to 80 psi and a peak reflected impulse up to 1,100 psi-msec (Johnson and Simmons 2008). The BLS has been used to evaluate the blast response of various structural test articles including windows, walls, and structural retrofit systems. It can simulate blast waveforms from very low pressures (1 to 2 psi) related to failures of conventional annealed glass and hollow concrete masonry unit walls to higher blast pressures required to evaluate the performance of protective construction methods.

Figure 1. ERDC Blast Load Simulator (BLS).

A recent addition to the BLS, referred to as the 8-ft×8-ft configuration shown in Figure 2, includes a section to transition from the circular cross-section that begins just downstream of the driver to a square cross-section for testing 8-ft×8-ft-square test articles, such as windows and walls. A detailed description of the BLS is provided in the first report of this series (Dallriva et al. 2016).

Figure 2. View from exterior of 8-ft×8-ft configuration.

2.2 Two-structure experiments with a 6-in., 13.25-in., and 20-in. spacing in the BLS 8-ft×8-ft configuration with a 4-ft gap

The BLS configuration for the set of experiments described herein is a modification of that described for the unrotated case for a single structure in the BLS 8-ft×8-ft configuration with a 4-ft gap in the third report of this series (Johnson et al. 2017). The configuration was modified by replacing the aluminum box and steel pedestal structure with a single steel structure at the same location and adding a second nonresponding steel structure located at varying distances behind the first structure. The upstream structure was maintained at the same location as the unrotated case in Johnson et al. (2017) for all three sets of experiments. The second structure was then placed downstream and directly behind the first upstream structure. The location of the downstream structure was varied to conduct three sets of experiments with varying spacings between the back face of the first structure and the front face of the second structure. The spacings were 6 in., 13.25 in., and 20 in. This second downstream structure was introduced to assess the ability of the codes to predict the pressures on a structure shielded from the incident blast wave by an upstream structure.

An elevation drawing of the BLS configuration with a 6-in. structure-to-structure separation is shown in Figure 3; a photograph of the gap between the square section and the target vessel is shown in Figure 4, and a cross-section view from inside the GSA cascade section of the BLS looking towards the target vessel showing the vertical location of the box structures is shown in Figure 5. The tops of the box structures were located 19.5 in. below the horizontal centerline of the BLS. The centerline of the BLS is always defined with respect to the centerline of the pressure vessel, regardless of asymmetry of the C2SQ section observable in Figure 3. The box structures were 13 in. x 13 in. x 26.5 in. tall, as shown in Figure 6. Figure 7 shows a photograph inside the BLS, viewing both the structures at 6-in. separation and the steel calibration plate. Figures 8 through 10 show the spacing between the two structures from a side view at 6-in., 13.25-in., and 20-in. spacings. Figures 11 through 13 show the two structures from a top front or rear view at 6-in., 13.25-in. and 20-in. spacings. The faces of the structure were defined as follows: the front side of the structure faces the pressure vessel, and the rear side faces the calibration plate. The left and right sides of the structure are defined looking upstream from the target vessel towards the pressure vessel.

Figure 3. BLS 8-ft×8-ft configuration with two box structures at 6-in. spacing.

Figure 4. BLS 8-ft×8-ft configuration with 4-ft gap.

Figure 5. BLS cross-section showing the location of the box structures.

Figure 6. Box structure dimensions.

Figure 7. Photograph of the box structures at 6-in. spacing and the calibration plate.

Figure 8. 6-in. spacing between structures.

Figure 9. 13.25-in. spacing between structures.

Figure 10. 20-in. spacing between structures.

Figure 11. Front-top view of structures at 6-in. spacing.

Figure 12. Rear-top view of structures at 13.25-in. spacing.

Figure 13. Front-top view of structures at 20-in. spacing.

Instrumentation included 4 pressure gauges mounted on the steel calibration plate, 2 pressure gauges mounted in the wall of the BLS, and 40 pressure gauges mounted on the box structures. Figure 14 shows the gauge layout on the calibration plate. Figure 15 shows the gauge layout on the sidewall of the BLS in the square and the C2SQ sections. Figures 16 through 20 show the gauge layouts on the surfaces of box structure 1 and the direction of flow. Figures 21 through 25 show the gauge layouts on the surfaces of box structure 2 and the direction of flow. The grayed-out locations on the structures in Figures 16 through 25 were inactive during this series of experiments.

Figure 14. Gauge layout on the calibration plate.

Figure 15. Gauge layout on the BLS sidewall.

Figure 16. Gauge layout on the front of box structure 1.

Figure 17. Gauge layout on the back of box structure 1.

Figure 18. Gauge layout on the top of box structure 1 and direction of flow.

Figure 19. Gauge layout on the left side of box structure 1 and direction of flow.

Figure 20. Gauge layout on the right side of box structure 1 and direction of flow.

Figure 21. Gauge layout on the front of box structure 2.

Figure 22. Gauge layout on the back of box structure 2.

Figure 23. Gauge layout on the top of box structure 2 and direction of flow.

Figure 24. Gauge layout on the left side of box structure 2 and direction of flow.

Figure 25. Gauge layout on the right side of box structure 2 and direction of flow.

Pressure measurements were made using either Kulite Model HKS-11-375 or XT-190 piezoresistive pressure transducers. The data were transmitted over shielded mil-spec cable and recorded on a 16-bit Pacific Model 5810 Data Acquisition System. The acquisition system's sample rate was set for 1.0 μ sec per point for the pressure measurements. The data after collection were post-processed using a 100-kHz low-pass filter.

In each test, the pressure vessel was pressurized, using air only (i.e., not helium or dry nitrogen) to 800 psi. A mechanical striker was used to initiate the pressure release through rupturing of diaphragms. The diaphragms consisted of three layers that included two layers of 0.033-in. to 0.0370-in.-thick steel and one layer of 0.0230-in. to 0.0265-in.-thick aluminum.

3 Experimental Results

3.1 Comparison of pressure waveforms

3.1.1 6-in. spacing

Reflected pressures on the calibration plate were very consistent among the five tests conducted at 6-in. spacing, demonstrating a high degree of repeatability. Figures 26 and 27 show comparisons of the pressure and impulse from all five tests for gauges CP3 and CP5, respectively, located on the calibration plate. Pressures along the sidewall of the BLS near the structure were very consistent until approximately 50 msec, after which minor variability can be observed in the histories. Figures 28 and 29 show comparisons of the pressure and impulse from all five tests for gauges G1 and G2, respectively, located on the sidewall of the BLS. The greater variation observed after approximately 50 msec corresponds to the arrival of the driver gases and associated contact surface at the sidewall and structure gauge locations. In the second set of experiments in this series (Dallriva et al. 2017), the phenomenon was not observed. In those experiments, the BLS was unvented, and the calibration plate was nearer the location of the structure, resulting in a reflected pressure wave that prevented the driver material from reaching the pressure gauges during the recorded time frame for those experiments. A comparison of representative pressure waveforms recorded on the front of Structure 1 is shown in Figures 30 and 31, on the back of Structure 1 in Figures 32 and 33, on the right side of Structure 1 in Figures 34 and 35, and on the top of Structure 1 in Figures 36 and 37. All of these show excellent repeatability among the replicate experiments until about 45 msec, after which the effect of the contact surface at the pressure gauge locations manifests in higher experimental variability. Similar results were observed for Structure 2 for the front face in Figures 38 and 39, the back face in Figures 40 and 41, the right face in Figures 42 and 43, and the top face in Figures 44 and 45.

Spurious peaks in the pressure data occur at several gauge locations (e.g., during test 1 around 80 msec at gauge location PB1-R2, Figure 34) due to the interaction of the reflected shock with the hardened junction box located inside the BLS tunnel, which contains the junction board used to connect the data acquisition system to the gauges. The spurious peaks are a separate phenomenon from the contact surface and occur late enough in time that the suitability of the data for computational validation is unaffected.

Individual plots showing both pressure and impulse for all of the gauges from Experiments 1 through 5 are shown in Appendix A.

Figure 26. Comparison of pressure records on the calibration plate – 6-in. spacing – Gauge CP3.

Figure 27. Comparison of pressure records on the calibration plate – 6-in. spacing – Gauge CP5.

Figure 28. Comparison of pressure records on the BLS sidewall – 6-in. spacing – Gauge G1.

Figure 29. Comparison of pressure records on the BLS sidewall – 6-in. spacing – Gauge G2.

Figure 30. Comparison of pressure records on the front of Structure 1
– 6-in. spacing – Gauge PB1-F2.

Figure 31. Comparison of pressure records on the front of Structure 1 –
6-in. spacing – Gauge PB1-F8.

Figure 32. Comparison of pressure records on the back of Structure 1
– 6-in. spacing – Gauge PB1-B1.

Figure 33. Comparison of pressure records on the back of Structure 1
– 6-in. spacing – Gauge PB1-B4.

Figure 34. Comparison of pressure records on the side of Structure 1
– 6-in. spacing - Gauge PB1-R2.

Figure 35. Comparison of pressure records on the side of Structure 1
– 6-in. spacing - Gauge PB1-R4.

Figure 36. Comparison of pressure records on the top of Structure 1 – 6-in. spacing - Gauge PB1-T1.

Figure 37. Comparison of pressure records on the top of Structure 1 – 6-in. spacing - Gauge PB1-T3.

Figure 38. Comparison of pressure records on the front of Structure 2
– 6-in. spacing – Gauge PB2-F1.

Figure 39. Comparison of pressure records on the front of Structure 2
– 6-in. spacing – Gauge PB2-F4.

Figure 40. Comparison of pressure records on the back of Structure 2
– 6-in. spacing – Gauge PB2-B2.

Figure 41. Comparison of pressure records on the back of Structure 2
– 6-in. spacing – Gauge PB2-B8.

Figure 42. Comparison of pressure records on the side of Structure 2 – 6-in. spacing - Gauge PB2-R2.

Figure 43. Comparison of pressure records on the side of Structure 2 – 6-in. spacing - Gauge PB2-R4.

Figure 44. Comparison of pressure records on the top of Structure 2 – 6-in. spacing - Gauge PB2-T1.

Figure 45. Comparison of pressure records on the top of Structure 2 – 6-in. spacing - Gauge PB2-T3.

3.1.2 13.25-in. spacing

Six tests were conducted at 13.25-in. structure-to-structure spacing. During the second test, the diaphragms burst early at 761 psi. The results from that test are included in neither the analysis nor the appendix. Additionally, gauges PB2L-2 and PB2T-3 malfunctioned during this test series and are excluded from the analysis. Furthermore, the wiring to several of the calibration plate gauges was damaged at about 50 msec during the first test of this series. The peak pressure and impulse were collected prior to the wiring being damaged. However, for clarity, the first test is not included in the comparison images in this section for those locations in which the wiring was damaged.

The pressures at the calibration plate and the sidewall gauges exhibited behavior similar to those in the 6-in. spacing case. Figures 46 and 47 show comparisons of the pressure and impulse from all five tests with burst pressure of 800 psi for gauges CP3, located on the calibration plate, and G1, located on the BLS sidewall, respectively.

A comparison of representative pressure waveforms recorded on the front of Structure 1 is shown in Figures 48 and 49, on the back of Structure 1 in Figures 50 and 51, on the right side of Structure 1 in Figures 52 and 53, and on the top of Structure 1 in Figures 54 and 55. With the exception of the impulse for test 1 at gauge location PB1-R2, all of these show excellent repeatability among the replicate experiments until about 45 msec, after which the effect of the contact surface at the pressure gauge locations manifests in higher experimental variability. Similar results were observed for Structure 2 for the front face in Figures 56 and 57, the back face in Figures 58 and 59, the right face in Figures 60 and 61, and the top face in Figures 62 and 63.

Notably higher peak impulses are observed at several gauge locations (e.g. PB1-R2 and PB1-R4) for test 1 than for the remaining tests. The only difference between test 1 and tests 3 through 6 was that test 1 was performed one day prior to the remaining tests in the series and had an ambient relative humidity of 41% versus 62% relative humidity for tests 3 through 6, performed the following day.

Individual plots showing both pressure and impulse for all of the gauges from the experiments with a burst pressure of 800 psi are shown in Appendix B.

Figure 46. Comparison of pressure records on the calibration plate – 13.25-in. spacing – Gauge CP3.

Figure 47. Comparison of pressure records on the BLS sidewall – 13.25-in. spacing – Gauge G1.

Figure 48. Comparison of pressure records on the front of Structure 1
– 13.25-in. spacing – Gauge PB1-F2.

Figure 49. Comparison of pressure records on the front of Structure 1
– 13.25-in. spacing – Gauge PB1-F8.

Figure 50. Comparison of pressure records on the back of Structure 1
– 13.25-in. spacing – Gauge PB1-B1.

Figure 51. Comparison of pressure records on the back of Structure 1
– 13.25-in. spacing – Gauge PB1-B4.

Figure 52. Comparison of pressure records on the side of Structure 1 – 13.25-in. spacing - Gauge PB1-R2.

Figure 53. Comparison of pressure records on the side of Structure 1 – 13.25-in. spacing - Gauge PB1-R4.

Figure 54. Comparison of pressure records on the top of Structure 1 – 13.25-in. spacing - Gauge PB1-T1.

Figure 55. Comparison of pressure records on the top of Structure 1 – 13.25-in. spacing - Gauge PB1-T3.

Figure 56. Comparison of pressure records on the front of Structure 2
– 13.25-in. spacing – Gauge PB2-F1.

Figure 57. Comparison of pressure records on the front of Structure 2
– 13.25-in. spacing – Gauge PB2-F4.

Figure 58. Comparison of pressure records on the back of Structure 2
– 13.25-in. spacing – Gauge PB2-B2.

Figure 59. Comparison of pressure records on the back of Structure 2
– 13.25-in. spacing – Gauge PB2-B8.

Figure 60. Comparison of pressure records on the side of Structure 2
– 13.25-in. spacing - Gauge PB2-R2.

Figure 61. Comparison of pressure records on the side of Structure 2–
13.25-in. spacing – Gauge PB2-R4.

Figure 62. Comparison of pressure records on the top of Structure 2 – 13.25-in. spacing - Gauge PB2-T1.

Figure 63. Comparison of pressure records on the top of Structure 2 – 13.25-in. spacing – Gauge PB2-T2.

3.1.3 20-in. spacing

Six tests were conducted at 20-in. structure-to-structure spacing. Gauges CP3 and PB2-F3 malfunctioned during the first test of this series and were replaced on subsequent tests.

The pressures at the calibration plate and the sidewall gauges exhibited behavior similar to the 6- and 13.25-in. spacing cases. Figures 64 and 65 show comparisons of the pressure and impulse from all six tests for gauges CP3, located on the calibration plate, and G1, located on the BLS sidewall, respectively.

A comparison of representative pressure waveforms recorded on the front of Structure 1 is shown in Figures 66 and 67, on the back of Structure 1 in Figures 68 and 69, on the right side of Structure 1 in Figures 70 and 71, and on the top of Structure 1 in Figures 72 and 73. All of these show excellent repeatability among the replicate experiments until about 45 msec, after which the effect of the contact surface at the pressure gauge locations manifests in higher experimental variability. Similar results were observed for Structure 2 for the front face in Figures 74 and 75, the back face in Figures 76 and 77, the right face in Figures 78 and 79, and the top face in Figures 80 and 81. Additional higher-magnitude pressure peaks, positive and/or negative, were observed at several gauge locations on Structure 1 during test 3 between about 45 to 55 msec (e.g., PB1-F2, PB1-F8, and PB1-R2) that were not observed for the other tests in this series. The cause of these features could not be ascertained from the pressure histories alone. These features occurred after the arrival of the contact surface, around 45 msec, corresponding to the cut-off time for analysis, and therefore do not affect the suitability of the data for computational validation.

Individual plots showing both pressure and impulse for all of the gauges from the six experiments are shown in Appendix C.

Figure 64. Comparison of pressure records on the calibration plate – 20-in. spacing – Gauge CP3.

Figure 65. Comparison of pressure records on the BLS sidewall – 20-in. spacing – Gauge G1.

Figure 66. Comparison of pressure records on the front of Structure 1 – 20-in. spacing – Gauge PB1-F2.

Figure 67. Comparison of pressure records on the front of Structure 1 – 20-in. spacing – Gauge PB1-F8.

Figure 68. Comparison of pressure records on the back of Structure 1
– 20-in. spacing – Gauge PB1-B1.

Figure 69. Comparison of pressure records on the back of Structure 1
– 20-in. spacing – Gauge PB1-B4.

Figure 70. Comparison of pressure records on the side of Structure 1
– 20-in. spacing - Gauge PB1-R2.

Figure 71. Comparison of pressure records on the side of Structure 1
– 20-in. spacing - Gauge PB1-R4.

Figure 72. Comparison of pressure records on the top of Structure 1 - 20-in. spacing - Gauge PB1-T1.

Figure 73. Comparison of pressure records on the top of Structure 1 - 20-in. spacing - Gauge PB1-T3.

Figure 74. Comparison of pressure records on the front of Structure 2
– 20-in. spacing – Gauge PB2-F1.

Figure 75. Comparison of pressure records on the front of Structure 2
– 20-in. spacing – Gauge PB2-F4.

Figure 76. Comparison of pressure records on the back of Structure 2
– 20-in. spacing – Gauge PB2-B2.

Figure 77. Comparison of pressure records on the back of Structure 2
– 20-in. spacing – Gauge PB2-B8.

Figure 78. Comparison of pressure records on the side of Structure 2 – 20-in. spacing - Gauge PB2-R2.

Figure 79. Comparison of pressure records on the side of Structure 2 – 20-in. spacing – Gauge PB2-R4.

Figure 80. Comparison of pressure records on the top of Structure 2 – 20-in. spacing - Gauge PB2-T1.

Figure 81. Comparison of pressure records on the top of Structure 2 – 20-in. spacing - Gauge PB2-T3.

3.2 Experiment uncertainty

The uncertainty in the experimental values of peak pressure and peak impulse was evaluated for each set of replicate experiments for which, as closely as possible, the identical BLS setup was used from test to test. The analysis assumes that the data values constitute a sample population drawn from an underlying Gaussian parent population. Ninety-five percent confidence intervals were computed to provide the range within which one should expect the next data value to lie if an additional test was to be conducted.

The 95% confidence interval for a sample of N measurements of X drawn from a Gaussian distribution was based on the precision index, P , defined by the equation

$$P_x = tS_x$$

and the estimated 95% confidence interval is defined by

$$\bar{X} \pm P_x$$

where

- $\bar{X}$ = the sample mean of X
- S_x = the sample standard deviation
- t = the value from the t distribution with $N-1$ degrees of freedom corresponding to the 95% confidence limit.

For each set of replicate experiments, the peak pressure and peak impulse associated with the positive phase of the simulated blast wave were compared. The initial peak pressure and peak impulse are both evaluated between 0 and 45 msec to exclude the effect of the contact surface on the measurement. For gauge locations where a small initial peak is immediately followed by a larger sharply defined peak, Figure 35 for example, the peak pressure is simply defined as the maximum value occurring between 0 and 45 msec.

3.2.1 6-in. spacing experimental uncertainty

Figures 82 and 83 present the mean values and 95% confidence intervals computed for the peak pressures at the BLS and Structure 1 gauge locations and at the Structure 2 gauge locations, respectively, for all five tests conducted at the 6-in. spacing. Figures 84 and 85 present the mean values and 95% confidence intervals computed for the peak impulse at the BLS and Structure 1 gauge locations and at the Structure 2 gauge locations, respectively, for all five tests conducted at 6-in. spacing. The data can be found in tabular form in Tables 1 and 2.

As indicated by the confidence intervals in Figures 82 through 85 and the waveform comparisons presented in Section 3.1.1, the data exhibited an excellent degree of repeatability among the five experiments prior to the arrival of the contact surface at about 45 msec.

Figure 82. 95% confidence intervals on measured peak pressure for BLS and Structure 1 gauge locations at 6-in. spacing.

Figure 83. 95% confidence intervals on measured peak pressure for Structure 2 gauge locations at 6-in. spacing.

Figure 84. 95% confidence intervals on measured peak impulse between 0 and 45 msec for BLS and Structure 1 gauge locations at 6-in. spacing.

Figure 85. 95% confidence intervals on measured peak impulse between 0 and 45 msec for Structure 2 gauge locations at 6-in. spacing.

Table 1. Data confidence intervals – BLS and Structure 1 at 6-in. spacing.

Gauge	95% Confidence on P (psi)	95% Confidence on P_{mean} (psi)	95% Confidence on I (psi-msec)	95% Confidence on I_{mean} (psi-msec)
CP2	15.6 +/- 0.6	15.6 +/- 0.3	47 +/- 1	47 +/- 1
CP3	22.5 +/- 2.4	22.5 +/- 1.1	56 +/- 1	56 +/- 0
CP5	18.3 +/- 1.7	18.3 +/- 0.8	52 +/- 1	52 +/- 0
CP9	20.9 +/- 1.1	20.9 +/- 0.5	59 +/- 0	59 +/- 0
G1	10.6 +/- 0.7	10.6 +/- 0.3	82 +/- 2	82 +/- 1
G2	10.2 +/- 1.0	10.2 +/- 0.5	53 +/- 0	53 +/- 0
B1-B1	32.3 +/- 1.2	32.3 +/- 0.5	79 +/- 3	79 +/- 1
B1-B2	24.2 +/- 0.5	24.2 +/- 0.2	81 +/- 1	81 +/- 1
B1-B3	16.5 +/- 2.2	16.5 +/- 1.0	72 +/- 2	72 +/- 1
B1-B4	20.1 +/- 0.3	20.1 +/- 0.1	78 +/- 1	78 +/- 0
B1-F1	28.9 +/- 1.1	28.9 +/- 0.5	108 +/- 3	108 +/- 1
B1-F2	25.7 +/- 2.4	25.7 +/- 1.1	112 +/- 4	112 +/- 2
B1-F3	24.5 +/- 1.8	24.5 +/- 0.8	109 +/- 3	109 +/- 1
B1-F5	30.1 +/- 1.4	30.1 +/- 0.6	113 +/- 3	113 +/- 2
B1-F6	26.7 +/- 0.7	26.7 +/- 0.3	103 +/- 3	103 +/- 1
B1-F7	23.1 +/- 1.7	23.1 +/- 0.7	108 +/- 3	108 +/- 2
B1-F8	23.7 +/- 1.8	23.7 +/- 0.8	106 +/- 3	106 +/- 1
B1-L2	11.1 +/- 0.4	11.1 +/- 0.2	55 +/- 2	55 +/- 1
B1-L3	10.6 +/- 0.8	10.6 +/- 0.3	67 +/- 2	67 +/- 1
B1-L4	10.0 +/- 0.3	10.0 +/- 0.1	51 +/- 2	51 +/- 1
B1-R2	10.5 +/- 0.4	10.5 +/- 0.2	54 +/- 4	54 +/- 2
B1-R3	10.7 +/- 0.4	10.7 +/- 0.2	48 +/- 3	48 +/- 1
B1-R4	12.2 +/- 0.9	12.2 +/- 0.4	63 +/- 2	63 +/- 1
B1-T1	12.5 +/- 0.4	12.5 +/- 0.2	52 +/- 8	52 +/- 4
B1-T2	10.9 +/- 0.6	10.9 +/- 0.3	65 +/- 7	65 +/- 3
B1-T3	13.1 +/- 1.0	13.1 +/- 0.5	76 +/- 2	76 +/- 1

Table 2. Data confidence intervals – Structure 2 at 6-in. spacing.

Gauge	95% Confidence on P (psi)	95% Confidence on P _{mean} (psi)	95% Confidence on I (psi-msec)	95% Confidence on I _{mean} (psi-msec)
B2-B1	8.6 +/- 0.4	8.6 +/- 0.2	63 +/- 2	63 +/- 1
B2-B2	9.6 +/- 1.2	9.6 +/- 0.5	67 +/- 2	67 +/- 1
B2-B3	9.1 +/- 0.3	9.1 +/- 0.1	65 +/- 3	65 +/- 1
B2-B5	9.6 +/- 0.4	9.6 +/- 0.2	67 +/- 1	67 +/- 0
B2-B6	9.0 +/- 0.3	9.0 +/- 0.1	58 +/- 4	58 +/- 2
B2-B7	8.2 +/- 0.1	8.2 +/- 0.0	58 +/- 4	58 +/- 2
B2-B8	9.7 +/- 0.7	9.7 +/- 0.3	74 +/- 1	74 +/- 1
B2-F1	25.5 +/- 1.6	25.5 +/- 0.7	83 +/- 1	83 +/- 1
B2-F2	23.9 +/- 1.6	23.9 +/- 0.7	77 +/- 2	77 +/- 1
B2-F3	17.0 +/- 0.9	17.0 +/- 0.4	78 +/- 2	78 +/- 1
B2-F4	19.4 +/- 1.4	19.4 +/- 0.6	77 +/- 1	77 +/- 1
B2-L2	11.0 +/- 0.4	11.0 +/- 0.2	72 +/- 2	72 +/- 1
B2-L3	10.0 +/- 0.4	10.0 +/- 0.2	73 +/- 1	73 +/- 0
B2-L4	11.2 +/- 0.5	11.2 +/- 0.2	73 +/- 1	73 +/- 0
B2-R2	10.8 +/- 0.5	10.8 +/- 0.2	72 +/- 3	72 +/- 1
B2-R3	10.0 +/- 0.5	10.0 +/- 0.2	73 +/- 1	73 +/- 1
B2-R4	9.5 +/- 0.7	9.5 +/- 0.3	70 +/- 3	70 +/- 1
B2-T1	11.1 +/- 0.7	11.1 +/- 0.3	75 +/- 2	75 +/- 1
B2-T2	10.8 +/- 1.4	10.8 +/- 0.6	74 +/- 1	74 +/- 1
B2-T3	11.2 +/- 1.3	11.2 +/- 0.6	69 +/- 1	69 +/- 0

3.2.2 13.25-in. spacing experimental uncertainty

Figures 86 and 87 present the mean values and 95% confidence intervals computed for the peak pressures at the BLS and Structure 1 gauge locations and at the Structure 2 gauge locations, respectively, for all five tests conducted with an 800 psi burst pressure at 13.25-in. spacing. Figures 88 and 89 present the mean values and 95% confidence intervals computed for the peak impulse at the BLS and Structure 1 gauge locations and at the Structure 2 gauge locations, respectively, for all five tests conducted with an 800 psi burst pressure at 13.25-in. spacing. The data can be found in tabular form in Tables 3 and 4.

As indicated by the confidence intervals in Figures 86 through 89 and the waveform comparisons presented in Section 3.1.2, the data exhibited an excellent degree of repeatability among the five experiments prior to the arrival of the contact surface at about 45 msec.

Figure 86. 95% confidence intervals on measured peak pressure for BLS and Structure 1 gauge locations at 13.25-in. spacing.

Figure 87. 95% confidence intervals on measured peak pressure for Structure 2 gauge locations at 13.25-in. spacing.

Figure 88. 95% confidence intervals on measured peak impulse between 0 and 45 msec for BLS and Structure 1 gauge locations at 13.25-in. spacing.

Figure 89. 95% confidence intervals on measured peak impulse between 0 and 45 msec for Structure 2 gauge locations at 13.25-in. spacing.

Table 3. Data confidence intervals – BLS and Structure 1 at 13.25-in. spacing.

Gauge	95% Confidence on P (psi)	95% Confidence on P _{mean} (psi)	95% Confidence on I (psi-msec)	95% Confidence on I _{mean} (psi-msec)
CP2	16.9 +/- 1.0	16.9 +/- 0.4	47 +/- 1	47 +/- 1
CP3	28.1 +/- 2.1	28.1 +/- 0.9	70 +/- 2	70 +/- 1
CP5	18.8 +/- 1.7	18.8 +/- 0.8	52 +/- 1	52 +/- 1
CP9	20.8 +/- 0.7	20.8 +/- 0.3	59 +/- 1	59 +/- 0
G1	11.6 +/- 1.0	11.6 +/- 0.5	83 +/- 2	83 +/- 1
G2	9.7 +/- 1.0	9.7 +/- 0.5	53 +/- 2	53 +/- 1
B1-B1	19.6 +/- 0.6	19.6 +/- 0.3	75 +/- 1	75 +/- 1
B1-B2	25.3 +/- 0.4	25.3 +/- 0.2	77 +/- 3	77 +/- 1
B1-B3	14.0 +/- 0.9	14.0 +/- 0.4	71 +/- 2	71 +/- 1
B1-B4	23.3 +/- 0.7	23.3 +/- 0.3	78 +/- 3	78 +/- 1
B1-F1	28.4 +/- 2.2	28.4 +/- 1.0	110 +/- 2	110 +/- 1
B1-F2	26.3 +/- 2.1	26.3 +/- 1.0	114 +/- 2	114 +/- 1
B1-F3	24.8 +/- 1.5	24.8 +/- 0.7	111 +/- 2	111 +/- 1
B1-F5	29.7 +/- 1.2	29.7 +/- 0.5	115 +/- 2	115 +/- 1
B1-F6	24.2 +/- 1.2	24.2 +/- 0.6	115 +/- 21	115 +/- 9
B1-F7	24.0 +/- 1.7	24.0 +/- 0.8	111 +/- 2	111 +/- 1
B1-F8	23.8 +/- 1.0	23.8 +/- 0.4	108 +/- 2	108 +/- 1
B1-L2	11.1 +/- 0.7	11.1 +/- 0.3	47 +/- 4	47 +/- 2
B1-L3	10.5 +/- 0.6	10.5 +/- 0.3	70 +/- 3	70 +/- 2
B1-L4	10.1 +/- 0.6	10.1 +/- 0.3	55 +/- 4	55 +/- 2
B1-R2	10.4 +/- 0.4	10.4 +/- 0.2	50 +/- 11	50 +/- 5
B1-R3	10.6 +/- 0.5	10.6 +/- 0.2	48 +/- 7	48 +/- 3
B1-R4	11.7 +/- 1.6	11.7 +/- 0.7	62 +/- 5	62 +/- 2
B1-T1	12.4 +/- 0.7	12.4 +/- 0.3	53 +/- 4	53 +/- 2
B1-T2	10.7 +/- 0.6	10.7 +/- 0.3	63 +/- 2	63 +/- 1
B1-T3	12.8 +/- 0.4	12.8 +/- 0.2	74 +/- 6	74 +/- 3

Table 4. Data confidence intervals – Structure 2 at 13.25-in. spacing.

Gauge	95% Confidence on P (psi)	95% Confidence on P_{mean} (psi)	95% Confidence on I (psi-msec)	95% Confidence on I_{mean} (psi-msec)
B2-B1	9.0 +/- 1.0	9.0 +/- 0.4	60 +/- 2	60 +/- 1
B2-B2	11.8 +/- 1.9	11.8 +/- 0.8	65 +/- 2	65 +/- 1
B2-B3	10.1 +/- 1.2	10.1 +/- 0.5	63 +/- 3	63 +/- 1
B2-B5	10.4 +/- 1.1	10.4 +/- 0.5	66 +/- 2	66 +/- 1
B2-B6	8.2 +/- 0.7	8.2 +/- 0.3	51 +/- 5	51 +/- 2
B2-B7	8.2 +/- 0.3	8.2 +/- 0.1	55 +/- 2	55 +/- 1
B2-B8	10.2 +/- 1.2	10.2 +/- 0.5	71 +/- 2	71 +/- 1
B2-F1	27.2 +/- 2.0	27.2 +/- 0.9	87 +/- 2	87 +/- 1
B2-F2	25.6 +/- 1.1	25.6 +/- 0.5	85 +/- 2	85 +/- 1
B2-F3	18.3 +/- 1.6	18.3 +/- 0.7	90 +/- 2	90 +/- 1
B2-F4	22.0 +/- 1.4	22.0 +/- 0.6	82 +/- 2	82 +/- 1
B2-L3	10.1 +/- 0.8	10.1 +/- 0.3	71 +/- 1	71 +/- 0
B2-L4	10.8 +/- 0.4	10.8 +/- 0.2	73 +/- 0	73 +/- 0
B2-R2	10.1 +/- 0.3	10.1 +/- 0.1	72 +/- 1	72 +/- 1
B2-R3	10.1 +/- 0.7	10.1 +/- 0.3	69 +/- 2	69 +/- 1
B2-R4	9.7 +/- 0.5	9.7 +/- 0.2	71 +/- 1	71 +/- 1
B2-T1	11.0 +/- 1.4	11.0 +/- 0.6	69 +/- 2	69 +/- 1
B2-T2	11.1 +/- 1.4	11.1 +/- 0.6	71 +/- 2	71 +/- 1

3.2.3 20-in. spacing experimental uncertainty

Figures 90 and 91 present the mean values and 95% confidence intervals computed for the peak pressures at the BLS and Structure 1 gauge locations and at the Structure 2 gauge locations, respectively, for all six tests conducted at a 20-in. spacing. Figures 92 and 93 present the mean values and 95% confidence intervals computed for the peak impulse at the BLS and Structure 1 gauge locations and at the Structure 2 gauge locations, respectively, for all six tests conducted. The data can be found in tabular form in Tables 5 and 6.

As indicated by the confidence intervals in Figures 90 through 93 and the waveform comparisons presented in Section 3.1.3, the data exhibited an excellent degree of repeatability among the six experiments prior to the arrival of the contact surface at about 45 msec.

Figure 90. 95% confidence intervals on measured peak pressure for BLS and Structure 1 gauge locations at 20-in. spacing.

Figure 91. 95% confidence intervals on measured peak pressure for Structure 2 gauge locations at 20-in. spacing.

Figure 92. 95% confidence intervals on measured peak impulse between 0 and 45 msec for BLS and Structure 1 gauge locations at 20-in. spacing.

Figure 93. 95% confidence intervals on measured peak impulse between 0 and 45 msec for Structure 2 gauge locations at 20-in. spacing.

Table 5. Data confidence intervals – BLS and Structure 1 at 20-in. spacing.

Gauge	95% Confidence on P (psi)	95% Confidence on P_{mean} (psi)	95% Confidence on I (psi-msec)	95% Confidence on I_{mean} (psi-msec)
CP2	17.0 +/- 0.5	17.0 +/- 0.2	46 +/- 1	46 +/- 1
CP3	22.5 +/- 1.6	22.5 +/- 0.7	56 +/- 1	56 +/- 0
CP5	18.3 +/- 1.0	18.3 +/- 0.4	52 +/- 1	52 +/- 0
CP9	20.8 +/- 0.9	20.8 +/- 0.4	59 +/- 1	59 +/- 0
G1	11.5 +/- 0.9	11.5 +/- 0.4	83 +/- 1	83 +/- 1
G2	9.6 +/- 0.6	9.6 +/- 0.2	53 +/- 0	53 +/- 0
B1-B1	15.0 +/- 0.4	15.0 +/- 0.1	76 +/- 1	76 +/- 0
B1-B2	19.1 +/- 0.6	19.1 +/- 0.2	82 +/- 1	82 +/- 1
B1-B3	10.0 +/- 1.7	10.0 +/- 0.7	59 +/- 3	59 +/- 1
B1-B4	19.5 +/- 0.4	19.5 +/- 0.2	82 +/- 1	82 +/- 0
B1-F1	28.2 +/- 1.0	28.2 +/- 0.4	109 +/- 2	109 +/- 1
B1-F2	26.4 +/- 1.6	26.4 +/- 0.7	113 +/- 2	113 +/- 1
B1-F3	24.5 +/- 1.4	24.5 +/- 0.6	110 +/- 2	110 +/- 1
B1-F5	29.4 +/- 1.0	29.4 +/- 0.4	114 +/- 2	114 +/- 1
B1-F6	24.2 +/- 1.0	24.2 +/- 0.4	110 +/- 2	110 +/- 1
B1-F7	23.7 +/- 0.8	23.7 +/- 0.3	110 +/- 2	110 +/- 1
B1-F8	23.9 +/- 0.8	23.9 +/- 0.3	107 +/- 2	107 +/- 1
B1-L2	11.4 +/- 0.7	11.4 +/- 0.3	54 +/- 3	54 +/- 1
B1-L3	10.4 +/- 0.5	10.4 +/- 0.2	68 +/- 3	68 +/- 1
B1-L4	10.1 +/- 0.3	10.1 +/- 0.1	58 +/- 2	58 +/- 1
B1-R2	10.4 +/- 0.6	10.4 +/- 0.3	45 +/- 7	45 +/- 3
B1-R3	10.6 +/- 0.6	10.6 +/- 0.2	45 +/- 2	45 +/- 1
B1-R4	9.9 +/- 0.3	9.9 +/- 0.1	56 +/- 4	56 +/- 2
B1-T1	12.5 +/- 0.4	12.5 +/- 0.2	52 +/- 6	52 +/- 2
B1-T2	11.0 +/- 0.9	11.0 +/- 0.4	62 +/- 4	62 +/- 2
B1-T3	13.2 +/- 1.8	13.2 +/- 0.7	74 +/- 2	74 +/- 1

Table 6. Data confidence intervals – Structure 2 at 20-in. spacing.

Gauge	95% Confidence on P (psi)	95% Confidence on P_{mean} (psi)	95% Confidence on I (psi-msec)	95% Confidence on I_{mean} (psi-msec)
B2-B1	8.9 +/- 2.2	8.9 +/- 0.9	58 +/- 3	58 +/- 1
B2-B2	9.3 +/- 0.8	9.3 +/- 0.3	64 +/- 2	64 +/- 1
B2-B3	10.0 +/- 0.8	10.0 +/- 0.3	60 +/- 2	60 +/- 1
B2-B5	10.8 +/- 1.4	10.8 +/- 0.6	63 +/- 1	63 +/- 0
B2-B6	8.8 +/- 0.8	8.8 +/- 0.3	49 +/- 1	49 +/- 0
B2-B7	8.1 +/- 0.2	8.1 +/- 0.1	51 +/- 3	51 +/- 1
B2-B8	10.4 +/- 0.7	10.4 +/- 0.3	65 +/- 2	65 +/- 1
B2-F1	27.4 +/- 1.0	27.4 +/- 0.4	91 +/- 1	91 +/- 0
B2-F2	29.5 +/- 0.9	29.5 +/- 0.3	90 +/- 1	90 +/- 0
B2-F3	21.2 +/- 1.3	21.2 +/- 0.6	92 +/- 1	92 +/- 0
B2-F4	23.0 +/- 1.4	23.0 +/- 0.6	90 +/- 1	90 +/- 0
B2-L2	10.2 +/- 0.4	10.2 +/- 0.2	64 +/- 2	64 +/- 1
B2-L3	9.6 +/- 0.3	9.6 +/- 0.1	67 +/- 0	67 +/- 0
B2-L4	10.7 +/- 0.3	10.7 +/- 0.1	60 +/- 1	60 +/- 1
B2-R2	10.0 +/- 0.5	10.0 +/- 0.2	63 +/- 2	63 +/- 1
B2-R3	9.5 +/- 0.4	9.5 +/- 0.2	59 +/- 3	59 +/- 1
B2-R4	10.3 +/- 0.4	10.3 +/- 0.1	65 +/- 2	65 +/- 1
B2-T1	10.5 +/- 0.7	10.5 +/- 0.3	56 +/- 2	56 +/- 1
B2-T2	11.1 +/- 0.7	11.1 +/- 0.3	65 +/- 1	65 +/- 1
B2-T3	12.9 +/- 0.8	12.9 +/- 0.3	64 +/- 1	64 +/- 0

4 Conclusions and Recommendations

Replicate experiments conducted in the BLS produced very repeatable pressure data on the surfaces of the box structures, the walls of the BLS, and the calibration plate. One hundred thirty-six sets of peak pressure and peak impulse records were created for comparison. All except three of the peak pressure records produced 95% confidence intervals that were within $\pm 15\%$ of the mean. Furthermore, 117 of the peak pressure records measured 95% confidence intervals that were within $\pm 10\%$ of the mean. All but seven of the measured peak impulse records produced 95% impulse confidence intervals that were within $\pm 10\%$ of the mean. Furthermore, 114 of the measured peak impulse records produced 95% impulse confidence intervals that were within $\pm 5\%$ of the mean. Visual evaluation of overlaid waveforms for all five (or six) experiments at individual gauge locations showed excellent experiment repeatability. The pressure and impulse waveforms from the experiments combined with uncertainty information in the form of confidence intervals for peak pressure and impulse result in a data set that can be used to evaluate the accuracy of computational models. The computational reproduction of the experiments detailed herein is described in an upcoming report.¹

¹ Barnes, A. T., J. O'Daniel, and G. Bessette. 2018. *Nuclear airblast and thermal environments testing and modeling- FY16: Two-Structure scenarios*. Technical Report (in review). Vicksburg, MS: Engineer Research and Development Center

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Appendix A: Pressure and Impulse Data from Two-Structure Tests with 6-in. Spacing

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-B3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-B4**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-F7**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-F8**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-L2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-L3

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-R3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-R4**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-T1

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-T2

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB1-T3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-B1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-B2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-B3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-B7**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-B8**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-F1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-F2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-F3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-F4**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-L4**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-R2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-R3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-R4**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 1
PB2-T3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
CP2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-B2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-B3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-F2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-F3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-F7

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-F8

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-L4

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-R2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-R3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB1-R4

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-B7**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-B8**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-F1

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-F2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-L4

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-R2

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-T1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-T2**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 2
PB2-T3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
CP2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB1-R3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB1-R4

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-B2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-B3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-B7**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-B8**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-F1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-F2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-F3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-F4**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-L2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-L3

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-R3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-R4**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-T1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-T2**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 3
PB2-T3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
CP2

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
G2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-B1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-F2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-F3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-F5**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-F6**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-F7**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-F8**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-L4**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-R2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-R3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-R4**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-T1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-T2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB1-T3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-B1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-B2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-B3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-B5**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-B6**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-B7**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-B8**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-F1**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-F2**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-R3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-R4**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 4
PB2-T3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
CP2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
G2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB1-B1

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB1-F2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB1-F3

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB1-F7

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB1-F8

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB1-L2

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB1-L3

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB2-B7**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB2-B8**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB2-F3**

**NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB2-F4**

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB2-L4

NATE 8x8, Two-Structure, 6-in. Sep., 4-ft Gap, Test 5
PB2-R2

Appendix B: Pressure and Impulse Data from Two-Structure Tests with 13.25-in. Spacing

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
CP3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
CP5

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
CP9

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
G1

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
G2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-B3**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-B4

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-F1

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-F5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-F6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-F7**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-F8**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-L2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-L3

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-L4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-R2**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-R3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-R4

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-T2**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB1-T3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-B1

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-B5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-B6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-B7**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-B8**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-F4**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-L2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-L3

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-L4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 1
PB2-T2**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
CP2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
CP3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
CP5

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
CP9

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
G1

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
G2

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-B4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-F5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-F6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-F7**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-F8

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-L2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-L3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-L4

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-T2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB1-T3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-B5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-B6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-B7**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-B8**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-F1**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-F2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-F3

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-F4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-L2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-L3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-L4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 3
PB2-T2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
CP2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
CP3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
CP5**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
CP9

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
G1

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
G2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-B4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-F5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-F6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-F7**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-F8**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-L4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-T2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB1-T3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-B5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-B6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-B7**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-B8**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-F4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-L2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-L3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-L4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 4
PB2-T2**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
CP2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
CP3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
CP5

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
CP9

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
G1

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
G2

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-B2**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-B3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-B4

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-F5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-F6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-F7**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-F8

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-L2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-L3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-L4

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-R3**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-R4

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-T1

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-T2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB1-T3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-B5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-B6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-B7**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-B8**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-F3**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-F4

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-L2

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-L3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-L4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-T1**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 5
PB2-T2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
CP2

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
CP3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
CP5

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
CP9

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
G1

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
G2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-B1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-B4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-F5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-F6**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-F7

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-F8

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-L2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-L3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-L4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-R2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-T2**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB1-T3

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-B1

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-B2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-B3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-B5**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-B6**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-B7**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-B8**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-F1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-F2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-F3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-F4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-L2**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-L3**

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-L4

NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-R2

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-R3**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-R4**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-T1**

**NATE 8x8, Two-Structure, 13.25-in. Sep., 4-ft Gap, Test 6
PB2-T2**

Appendix C: Pressure and Impulse Data from Two-Structure Tests with 20-in. Spacing

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
CP5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
CP9

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
G1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
G2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-B1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-B2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-F1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-F5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-F6

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-F7

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-F8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-L3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-L4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-R2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-R3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB1-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB2-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB2-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB2-F4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB2-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB2-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 1
PB2-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
CP2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
CP3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
CP5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
CP9

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
G1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
G2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-F1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-F5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-F6

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-F7

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-F8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-R2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-R3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB1-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-B1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-B2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-B8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-F1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-F4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 2
PB2-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
CP2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
CP3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
CP5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
CP9

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
G1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
G2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-B1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-B2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-F1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-F5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-F6

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-F7

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-F8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-L3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-L4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-R2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-R3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-R4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB1-T1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB2-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB2-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB2-F4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB2-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB2-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 3
PB2-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
CP2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
CP3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
CP5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
CP9

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
G1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
G2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-B1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-B2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-F1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-F5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-F6

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-F7

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-F8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB1-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB2-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB2-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB2-F4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB2-L2

**NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB2-T2**

**NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 4
PB2-T3**

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
CP2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
CP3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
CP5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
CP9

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
G1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
G2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-F1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-F5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-F6

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-F7

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-F8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-R2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-R3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-R4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-T1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB1-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB2-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB2-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB2-F4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB2-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB2-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 5
PB2-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
CP2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
CP3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
CP5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
CP9

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
G1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
G2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-B1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-B2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-F1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-F2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-F3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-F5

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-F6

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-F7

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-F8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-L3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-L4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-R2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-R3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-R4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-T1

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB1-T3

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-B8

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-F1

**NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-F2**

**NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-F3**

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-F4

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-L2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-T2

NATE 8x8, Two-Structure, 20-in. Sep., 4-ft Gap, Test 6
PB2-T3

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14. ABSTRACT The Department of Defense (DoD) needs the capability to accurately predict airblast environments produced by explosive detonations and their interaction with geometrically complex objects that create complex flow fields, such as buildings, bridges, dams, etc. First-principles computer codes are typically used to generate high-fidelity simulations of these explosive events and their effects. These codes are continuously improving, yet still require validation against experimental data to establish confidence in the results produced by simulations. This report describes three sets of replicate experiments in which two steel box-type structures were installed in a Blast Load Simulator (BLS) with varying spacing between them and subjected to a simulated blast loading to provide pressure-time data at multiple locations on the surfaces of the structures. The BLS is a highly tunable, compressed-gas-driven, closed-end shock tube designed to simulate blast waveforms for explosive yields up to 20,000 lb of TNT equivalent at a peak reflected pressure up to 80 psi and a peak reflected impulse up to 1,100 psi-msec. Pressure and impulse waveforms are presented, and comparisons are made among the replicated experiments to evaluate repeatability. The uncertainty in the experimental pressures and impulses was evaluated by computing 95% confidence intervals on the results.					
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