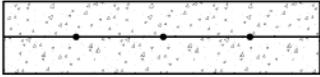
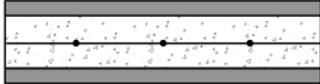
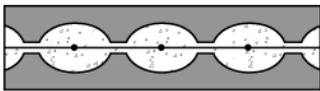
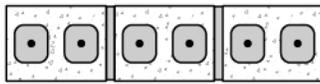
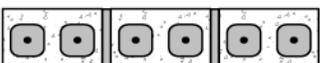
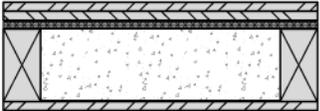
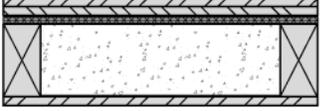
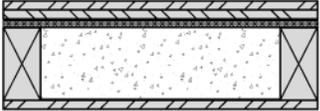
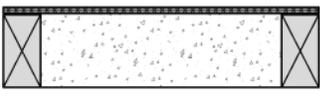
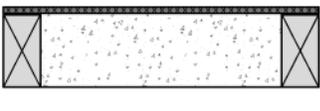
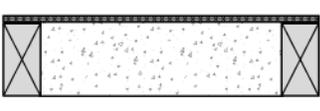
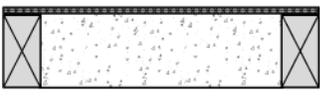


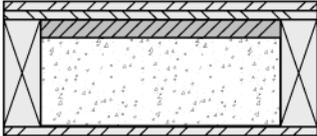
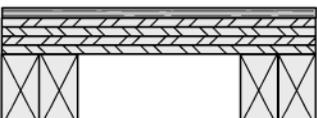
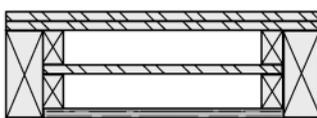
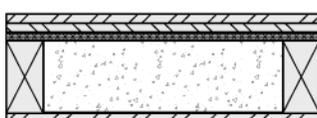
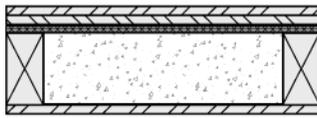

Appendix E

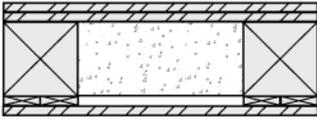
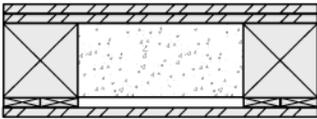
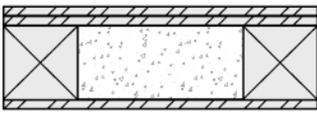
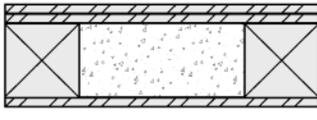
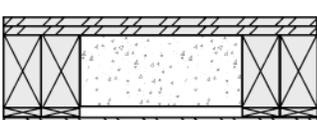
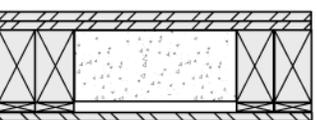
Wall Sections That Passed the Missile Impact Tests

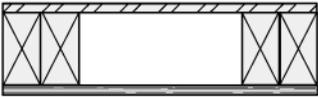
The following sheets document the performance of wall sections that passed the missile impact tests. The following information is provided for each wall section: description of the wall construction (e.g., stud wall with plywood and/or metal sheathing, stud wall with concrete infill, reinforced CMU wall, ICF wall), cross-section illustration, test missile speed, and description of damage.

Type of Wall Section (Target)	Description of Wall Section	Missile Speed (mph)	Description of Damage
Reinforced concrete wall, at least 6 in. thick, reinforced with #4 rebar every 12 in. (both vertically and horizontally)		100+	The target has been proven successful in previous tests.
Insulating concrete form (ICF) flat wall section at least 4" thick reinforced with #4 rebar every 12 in. (both vertically and horizontally)		100+	The target has been proven successful in previous tests.
Insulating concrete form (ICF) waffle grid wall section at least 6 in. thick reinforced with #5 rebar every 12 in. vertically and #4 rebar every 16 in. horizontally		100+	The target has been proven successful in previous tests.
Brick cavity wall reinforced with #4 rebar every 12 in. and concrete infill		100+	The target has been proven successful in previous tests.
8 in. CMU reinforced with concrete and #4 rebar in every cell		100+	The target was impacted over 30 times with the design missile. This was done for demonstration purposes. Only the first (verification) test was conducted as part of G&O contract.
6 in. CMU reinforced with concrete and #4 rebar in every cell		106.7	No damage was visible. 1/8 to 3/16 in. indentation on impact side.
6 in. CMU reinforced with concrete and #4 rebar in every cell		103.4	The missile impacted the target at a mortar joint. The target was cracked from the point of impact to the top of the target both in the front and in the back. The mortar spalled out of the joint on the back of the target.
6 in. CMU reinforced with concrete and #4 rebar in every cell		97.0	This target was tested previously. The second missile impacted the target in the same place as the first. The existing crack was extended into the base. A new crack appeared in the next joint 8 in. away and extended to the top of the target. The missile perforated the target and spalled the concrete fill out of the back of the target.

Type of Wall Section (Target)	Description of Wall Section	Missile Speed (mph)	Description of Damage
6 in. CMU reinforced with concrete and #4 rebar in every cell		No Time	No penetration of the target occurred. The target was cracked from the point of impact to the top of the target.
6 in. CMU reinforced with concrete and #4 rebar in every cell		111.3	The target was impacted at a vertical mortar joint. There was a 1/16 in. indentation on the impact face but no visible damage to either side of the target.
6 in. CMU reinforced with concrete and #4 rebar in every cell		106.9	The target was impacted at a vertical mortar joint. There was a 1/16 in. indentation on the impact face. The joint spalled slightly on the non-impact side. A small crack was detected at the impact point terminating at the top of the target.
2x4 stud wall with CD grade plywood, 14 ga. 1/2 in. expanded metal, and concrete infill		105.0	The missile impacted 4 in. to the left of a stud. No damage was visible on the back of the target.
2x4 stud wall with CD grade plywood, 14 ga. 1/2 in. expanded metal, and concrete infill		106.1	The missile impacted 1 1/2 in. to the left of a stud. No damage was visible on the back of the target.
2x4 stud wall with CD grade plywood, 14 ga. 1/2 in. expanded metal, and concrete infill		105.4	The missile impacted 1 in. to the right of a stud. No damage was visible on the back of the target.
2x4 stud wall filled with concrete with no plywood and 14 ga. 1/2 in. expanded metal on the non-impact face		107.7	The missile made partial contact with the stud. The concrete was cracked around the impact area.
2x4 stud wall filled with concrete with no plywood and 14 ga. 1/2 in. expanded metal on the non-impact face		107.2	The missile made partial contact with the stud. The concrete was severely damaged, and a 4 in. deflection on the back of the target was observed.
2x4 stud wall filled with concrete with no plywood and 14 ga. 1/2 in. expanded metal on the non-impact face		107.1	The missile impacted the concrete. No damage was visible.
2x4 stud wall filled with concrete with no plywood and 14 ga. 1/2 in. expanded metal on the non-impact face		104.5	The missile hit the stud fully. There was 3 in. of deflection to the back of the target but no perforation.

Type of Wall Section (Target)	Description of Wall Section	Missile Speed (mph)	Description of Damage
4 in. concrete block in a 2x6 stud wall with 1½ in. of polystyrene between block and two layers of ¾ in. CD grade plywood.		111.3	The missile penetrated the target. There was no visible damage to the back side of the target.
Double 2x4 stud wall with 4 layers of ¾ in. CD grade plywood and 14 ga. steel on the back face		104-107	1 in. of deformation on the back face of the steel.
Double 2x4 stud wall with 4 layers of ¾ in. CD grade plywood and 14 ga. steel on the back face		106.6	The target was impacted next to a stud. Several heads of screws were popped off the back of the target. The steel had 1 in. of deformation.
Double 2x4 stud wall with 4 layers of ¾ in. CD grade plywood and 14 ga. steel on the back face		104.9	The target was impacted on the stud line. The stud was cut in two. No deformation was visible on the back side
4 layers of ¾ in. plywood with 14 ga. steel insert with spacers between the insert and the back face		109.4	The missile penetrated the target 1½-2 in. A crack in the plywood on the back face caused bending, but total separation did not occur.
14 ga. steel insert with spacers between all the inserts; the back face has two layers of ¾ in. CD grade plywood		108-110	The missile penetrated the target 1½-2 in. There was a crack in the plywood on the back face caused by bending, but total separation did not occur.
4 in. concrete block in a 2x4 stud wall with two layers of ¾ in. CD grade plywood and one layer of 14 ga. ½ in. expanded metal on the non-impact side and one layer of plywood on the impact side		106.7	¾ in. of penetration. There was no visible damage to the non-impact side.
4 in. concrete block in a 2x4 stud wall with two layers of ¾ in. CD grade plywood and one layer of 14 ga. ½ in. expanded metal on the non-impact side and one layer of plywood on the impact side		106.1	The missile impacted the stud and sheared it in two. There was no visible damage to the non-impact side.
2x4 stud wall with 3 layers of ¾ in. CD grade plywood inserts with 14 ga. metal on the non-impact side		105.7	The first insert of plywood failed in shear while the interior two failed in bending. The studs started to be torn in half, and there was 3 in. of deformation of the 14 ga. metal.

Type of Wall Section (Target)	Description of Wall Section	Missile Speed (mph)	Description of Damage
4x4 stud wall with 1x4's on the studs, containing 4 in. concrete block, gypsum board infill, and one layer of 3/4 in. CD grade plywood on the impact face and two layers on the non-impact face		111.2	The missile impacted the stud, and 1/2 in. of deflection occurred on the non-impact side.
4x4 stud wall with 1x4's on the studs, containing 4 in. concrete block, gypsum board infill, and one layer of 3/4 in. CD grade plywood on the impact face and two layers on the non-impact side		106.5	Missile penetrated the target, but did not perforate the target when it impacted at the interface between the block and the 4x4 stud.
4x4 stud wall, containing 4 in. concrete block, with one layer of 3/8 in. CD grade plywood on the impact face and two layers of 3/4 in. CD grade plywood on the non-impact face		115.7	There was no missile penetration.
4x4 stud wall, containing 4 in. concrete block, with one layer of 3/8 in. CD grade plywood on the impact face and two layers of 3/4 in. CD grade plywood on the non-impact face		109.0	The missile impacted the interface between the block and the 4x4 stud, perforating the target 3 ft.
Double 2x4 stud wall with furring, containing 4 in. block, with two layers of 3/4 in. CD grade plywood on the non-impact face, one layer on the impact face, and a layer of 3/8 in. gyp. board on the impact face.		103	The missile impacted 1/2 in. on the stud and 1/2 in. on the concrete block infill. There was 1/2 in. of deformation on the non-impact side.
Double 2x4 stud wall with furring, containing 4 in. block, with two layers of 3/4 in. CD grade plywood on the non-impact face, one layer on the impact face, and a layer of 3/8 in. gyp. board on the impact face.		100.7	The missile impacted next to the stud. There was 1/2 in. of deformation and cracking on the non-impact side.

Type of Wall Section (Target)	Description of Wall Section	Missile Speed (mph)	Description of Damage
Double 2x4 stud wall with one layer of 12 ga. steel on the impact side and one layer of 3/4 in. CD grade plywood on the non-impact side.		No time	The missile impacted near the stud and was deflected.
Double 2x4 stud wall with one layer of 12 ga. steel on the impact side and one layer of 3/4 in. CD grade plywood on the non-impact side.		No Time	The missile impacted the stud and was deflected, there was some damage to the non-impact face.
Double 2x4 stud wall with one layer of 12 ga. steel on the impact side and one layer of 3/4 in. CD grade plywood on the non-impact side.		105.2	The missile impacted next to the stud and was destroyed.
Double 2x4 stud wall with one layer of 12 ga. steel on the impact side and one layer of 3/4 in. CD grade plywood on the non-impact side.		103.6	The missile impacted next to the stud and was destroyed.