SurvivalRing

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This digital document created and presented by Richard Fleetwood. He is the founder, author, producer, and webmaster of the **SurvivalRing** *(http://www.survivalring.org)* and **Civil Defense Now!** *(http://www.survivalring.org/cd-main.htm)* websites.

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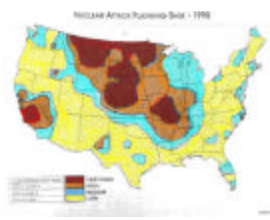

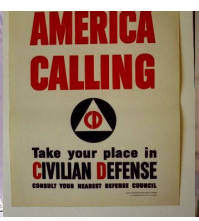

Appendix F
Doors and Hardware That Passed the Missile Impact Tests

The tables on the following pages document the performance of some available doors and door hardware that passed the wind pressure and impact requirements of FEMA 320, *Taking Shelter From the Storm*. However, the testing program focused on a variety of doors and hardware systems rather than multiple tests of a single type of door system. The data presented are single-test results, which are intended to be used as indicators of expected performance.

A residential shelter in FEMA 320 is considered an enclosed structure ("enclosed" and "partially enclosed" buildings are defined by ASCE 7-98), that uses an internal pressure coefficient of $GC_{Pi} = \pm 0.18$ for components and cladding (C&C) design. Although impact requirements have not changed, the pressure coefficients for C&C of a community shelter are different from those used in FEMA 320. A community shelter is a larger building that will react differently to wind loads, requiring a design approach using internal pressure coefficients for partially enclosed buildings ($GC_{Pi} = \pm 0.55$). The use of higher internal pressure coefficients is described in Section 5.3.2, on page 5-10.

The change in pressure coefficients increased the design wind pressures for doors and windows in community shelters. Most of the door systems discussed in this manual and presented in this appendix have been successfully tested to wind pressure values associated with a 200-mph wind or Wind Zone III (Figure 2-2). However, many shelters will be located in Wind Zone IV (250 mph). The maximum wind pressures on a shelter occur at building corners. As of the time this manual was published, door/door hardware systems tested have not been tested to the maximum design pressures associated with Wind Zone IV at building corners. Therefore, any shelter door system in Wind Zone IV should be protected by an alcove or debris barrier until further testing can be performed or until other door and hardware systems are successfully tested for the design wind pressures.

This manual attempts to identify door/door hardware systems that are readily available from manufactures. All doors in this appendix have passed the missile impact criteria. Chapter 6 discussed wide single-door systems (greater than 36 inches wide, specifically 44-inch width) and double-door systems.

The wide single-door systems failed at 1.19 psi, which is less than the design wind pressures associated with 250-mph wind pressures. The double-door systems (composed of two 3-foot by 7-foot doors) were tested to the wind pressures of 1.37 psi without failure (the FEMA 320 design criteria). These doors were not tested to the 250-mph wind pressure levels.

It is important to note that the size of the door that is being tested will affect the design wind pressure to which a door should be designed. Specifically, the external pressure coefficient (GC_p) will vary with location along the wall (proximity to the building corner) and with the area of the door when calculating C&C loads using ASCE 7-98.

The testing of standard doors and door hardware will continue after the publication of this manual. The goal of this testing is to determine whether available doors and door hardware will be capable of resisting the highest of wind pressures associated with Wind Zone IV 250-mph winds. Updates on tested door systems will be posted on the Texas Tech University (TTU) web page at www.wind.ttu.edu. Questions regarding continued door testing may be directed to the TTU Outreach Center at 1-888-946-3287.

The information presented in this appendix includes the test date, a description of the door and door hardware tested, a brief description of the test results, and the test pressures or the missile impact speeds. The designer should note that these test results were derived from door systems that used door hardware systems that may not be accepted for egress under some occupancy classifications.

Results of Wind Pressure Tests on Doors With Individually Activated Latching Mechanisms

Date	Test Type	Door Description	Lock Description	Failure Pressure	Pressurization Results
3/31/98	Pressure	14 ga. steel door with 20 ga. metal ribs. The door was installed and tested as a swing-out door.	Sargent mortise lock with deadbolt function.	0.97 psi	Lock held to 0.97psi. The lock failed internally when the bar connecting the deadbolt bent, allowing the door to swing open.
3/6/98	Pressure	14 ga. steel door with polystyrene infill. The door was installed and tested as a swing-out door.		1.37 psi	The door failed at a pressure of 1.37 psi. The door failure was due to the failure of the lock set; also, the door did open due to the pressure.
3/26/98	Pressure	14 ga. door with a polystyrene infill. The door was mounted and tested as a swing-in door.	Yale mortise lock set with deadbolt function.	1.2 psi	The door failed at a pressure of 1.2 psi. The door failure was due to the failure of the lock set; also, the door did open due to the pressure.
3/31/98	Pressure	20 ga. door, a honeycomb infill, with a 14 ga. steel plate mounted on the non-impact side. The door was mounted and tested as a swing-in door.	Standard heavy-duty lock with three 1.2 in. slide bolts mounted opposite the hinges.	1.36 psi	The modified door held a pressure of 1.36 psi for 5 seconds.
4/1/98	Pressure	20 ga. door, a honeycomb infill, with a 14 ga. steel plate mounted on the non-impact side. The door was mounted and tested as a swing-in door.	Standard heavy-duty lock with three 1.2 in. slide bolts mounted opposite the hinges.	1.46 psi	The modified door held a pressure of 1.46 psi for 5 seconds.
5/98	Pressure	Six-panel metal-covered wood-frame door with a sheet of 14 ga. steel attached.	Standard off-the-shelf doorknob with three deadbolt locks placed opposite the hinges.	1.21 psi	The modified door failed at the location of the deadbolts at 1.21 psi. The hardware appeared to cause the door to fail.
5/98	Pressure	Solid-core wood door with a sheet of 14 ga. steel attached.	Standard off-the-shelf doorknob with three deadbolt locks placed opposite the hinges.	1.13 psi	The modified door failed at the location of the deadbolts at 1.13 psi. The hardware appeared to cause the door to fail.
5/98	Pressure	Six-panel solid-wood door with a sheet of 14 ga. steel attached.	Standard off-the-shelf doorknob with three deadbolt locks placed opposite the hinges.	1.12 psi	The modified door failed at the location of the deadbolts at 1.12 psi. The hardware appeared to cause the door to fail.

Results of Missile Impact Tests on Doors With Individually Activated Latching Mechanisms

Date	Test Type	Door Description	Lock Description	Missile Threshold (mph)	Impact Results	Impact Speed (mph)
	Missile	14 ga. steel door with 20 ga. metal ribs. The door was installed and tested as a swing-out door.	Sargent mortise lock with deadbolt function.	> 100	The door withstood several impacts at the midpoint of the door next to the hardware and at the upper and lower corners next to the hinges and on the lock side, respectively.	82.35 81.99 104.83 106.57
3/26/98	Missile	14 ga. door with a polystyrene infill. The door was mounted and tested as a swing-in door.	Yale mortise lock with deadbolt function.	81	Door failed the impact test due to hardware failure. When modified with three slide bolt locks, mounted opposite the hinges, the door is successful.	81.3
3/31/98	Missile	20 ga. door, a honeycomb infill, with a 14 ga. steel plate mounted on the non-impact side. The door was mounted and tested as a swing-in door.	Standard heavy duty lock with three 1/2 in. slide bolts mounted opposite the hinges.	104	There was a local failure of the hardware, but the redudndanies in the hardware held the door in place. The missile penetrated the impact skin, but did not perforate the non-impact side or the 14 ga. steel plate. There was permanent deformation.	103.88
4/1/98	Missile	20 ga. door, a honeycomb infill, with a 14 ga. steel plate mounted on the non-impact side. The door was mounted and tested as a swing-in door.		104	The missile did not penetrate the door, but it caused permanent deformation in the internal door frame. (The door buckled around the standard lock set.)	104.09

Results of Wind Pressure and Missile Impact Tests on Double-Door Set With Panic Bar Hardware and Single-Action Lever Hardware

Date	Test Type	Door Description	Hardware Description	Test Results
5/00	Pressure and Missile	3 ft. x 7 ft steel 14 ga. door with 14 ga. steel channels as hinge and lock rails and 16 ga. channels at top and bottom (see page 6-14, Section 6.4.1.1). Polystyrene infill or honeycomb core. 14 ga. steel frame with 14 ga. center steel mullion (see page 6-15, Section 6.4.1.3).	Externally mounted three-point latching mechanism with panic bar release, 5/8 in. headbolt and footbolt with 1 in. throw, and mortised center deadbolt.	Pressure reached 1.37 psi without failure. Missile impact at 100 mph did not perforate.
5/00	Pressure and Missile	3 ft. x 7 ft steel 14 ga. door with 14 ga. steel channels as hinge and lock rails and 16 ga. channels at top and bottom (see page 6-14, Section 6.4.1.1). Polystyrene infill or honeycomb core. 14 ga. steel frame with 14 ga. center steel mullion (see page 6-15, Section 6.4.1.3)	Externally mounted three-point latching mechanism with single-action lever release, 1 in. solid mortised center deadbolt with 1 in. throw, and two 1 in. x 3/8 in. solid hookbolts, one below and one above the deadbolt.	Pressure reached 1.37 psi without failure of door, although top hookbolt failed. Missile imapct at 100 mph pushed door through frame, causing center mullion to rotate. Testing inconclusive; further testing required.