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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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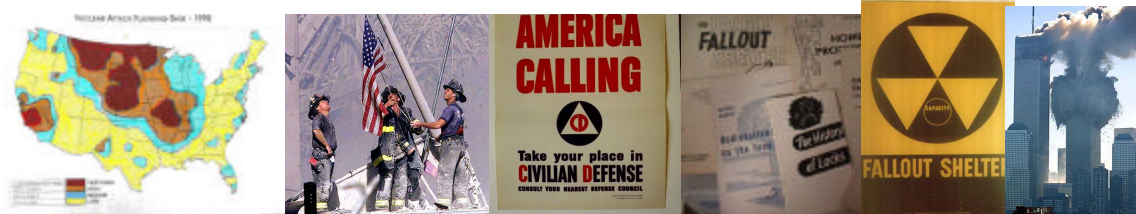
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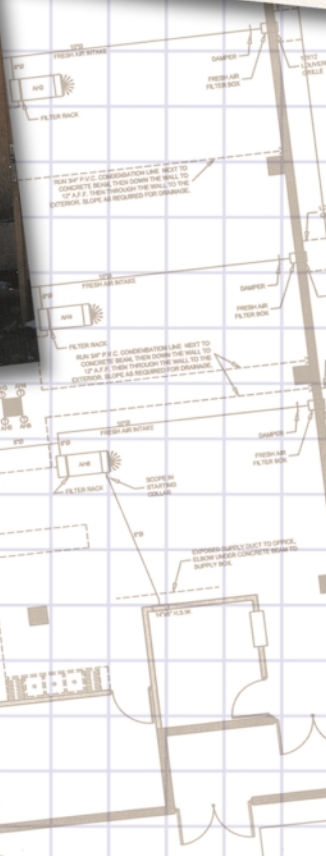
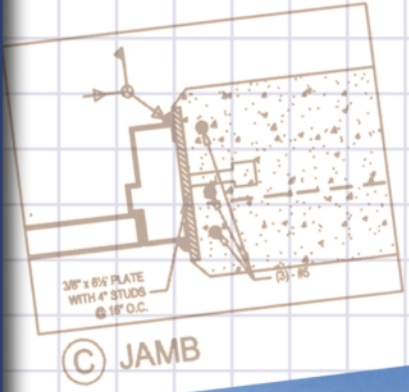
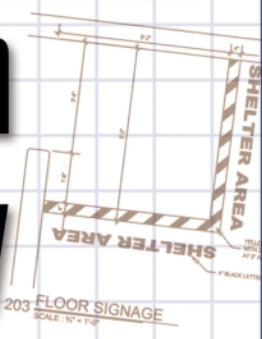
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# Design and Construction Guidance for Community Shelters



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TEXAS TECH UNIVERSITY



Federal Emergency Management Agency  
Mitigation Directorate  
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# Preface

Having personally seen the devastation caused by natural disasters, I am heartened to now see hundreds of communities commit to becoming disaster-resistant through FEMA's nationwide initiative, Project Impact. Project Impact operates on three simple principles: preventive actions must be decided at the local level; private sector participation is vital; and long-term efforts and investments in prevention measures are essential. The Federal Emergency Management Agency is committed to continue to develop tools, such as this manual, to help individuals, communities, states, and others create sustainable, disaster-resistant communities.

When severe weather threatens, individuals and families need to have a safe place to go and time to get there. Thousands of safe rooms have been built based on FEMA designs, providing protection for families in their homes. Where will these people go if they are not at home? This manual provides specific guidance on how to provide effective shelter that can save lives when severe weather threatens away from home.



James L. Witt  
Director, Federal Emergency Management Agency

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# Project Team

The Project Team comprised engineers from FEMA’s Mitigation Directorate, consulting design engineering firms, and university research institutions. The role of the Project Team was to follow the plan indicated by the Conceptual Report and produce this guidance manual. All engineering and testing efforts required to complete this project were performed by the Project Team.

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# Review Committee

The Review Committee was composed of design professionals; representatives of Federal, state, and local governments; and members of public and private sector groups that represent the potential owners and operators of community shelters. The role of the Review Committee was to provide peer, industry, and user group review for the guidance manual. The committee helped direct the development of shelter design and construction guidance to ensure that the information presented in this manual is accurate, clear, and useful to the intended users.

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# Acronyms and Abbreviations

The following acronyms and abbreviations are used in this manual.

## Acronyms

ACI – American Concrete Institute International

ADA – Americans with Disabilities Act

APC – atmospheric pressure change

ASCE – American Society of Civil Engineers

ASD – Allowable Stress Design

B/C – benefit/cost

BPAT – Building Performance Assessment Team

C&C – components and cladding

CMU – concrete masonry unit

EOC – Emergency Operations Center

FEMA – Federal Emergency Management Agency

HAZMAT – hazardous material

HVAC – heating, ventilating, and conditioning

IBC – International Building Code

ICC – International Code Council

ICF – insulating concrete forms

IDR – Institute for Disaster Research

IMC – International Mechanical Code

IRC – International Residential Code

LRFD – Load and Resistance Factor Design

MRI – mean recurrence interval

MWFRS – main wind force resisting system

NCDC – National Climatic Data Center  
NEHRP – National Earthquake Hazard Reduction Program  
NFIP – National Flood Insurance Program  
NOAA – National Oceanic and Atmospheric Administration  
NPC – National Performance Criteria for Tornado Shelters  
NWS – National Weather Service  
o.c. – on center  
RCC – Regional Climate Center  
RO – Regional Office  
SERCC – Southeast Regional Climate Center  
SFHA – Special Flood Hazard Area  
SPC – Storm Prediction Center (NOAA)  
TTU – Texas Tech University  
UBC – Uniform Building Code  
WERC – Wind Engineering Research Center (TTU)  
WLTF – Wind Load Test Facility (Clemson University)

## Abbreviations

$C_p$  – external pressure coefficient (for MWFRS)  
D – dead load  
F – lateral force  
fps – feet per second  
 $ft^2$  – square foot/square feet  
G – gust effect factor  
 $GC_p$  – external pressure coefficient (for C&C and attachments)  
 $GC_{pi}$  – internal pressure coefficient  
I – importance factor  
 $I_e$  – impact energy  
 $I_m$  – impact momentum  
k – stiffness

$K_d$  – directionality factor  
 $K_z$  – velocity pressure exposure coefficient  
 $K_{zt}$  – topographic factor  
L – live load  
lb – pound/pounds  
M – mass  
mph – miles per hour  
p – pressure (in psf)  
psf – pounds per square foot  
psi – pounds per square inch  
 $q_z$  – velocity pressure (in psf)  
V – design wind speed  
W – wind load as prescribed by code or ASCE 7-98  
 $W_x$  – extreme wind load