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.

SurvivalRing has as its goal the ideal of being the leading source of survival, preparedness, and self reliance information on the Internet. Linkage, assistance, and creation of digital content in areas that until now have only been hinted at or impossible to find, is being added to everyday via the Survival-Ring website and email lists.

Thousands of hours of searching, writing, and communications have been spent collecting over 2 gigabytes of digital content, as well as tens of thousands of pages of hard copy original public domain material in the areas of civil defense, survival, training, and preparedness, from all over the globe. As much as possible is being put online at his website at
http://www.survivalring.org

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There are too many situations and incidents that can come to pass in everyday life, that when time is taken to learn and skills obtained, can mean the difference between life and death. Sept. 11, 2001 proved to the world that no matter how safe a person thinks they may be, death and injury can come from the most UN-LIKELY place, at any time. The documents presented in this series of digitized works, can help the average person with the knowledge within, to know how to save those persons closest to them in REAL disaster. Help spread this idea of sharing SURVIVAL INFORMATION.

If you have documents from any era, on any disaster or civil defense area, PLEASE contact Richard at his email address of **RAFLEET@AOL.COM**. Check the website for the LATEST additions to the CIVIL DEFENSE NOW online library archive. All data online, and much more, is also available on CD-ROM. Information is available at the website on how to obtain it. Thanks for your support, and enjoy the information contained on the following pages. Share them with those who will learn from them and teach what they know to others.

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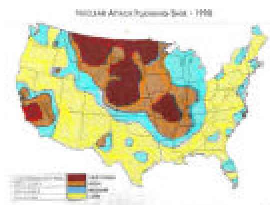
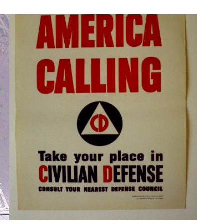
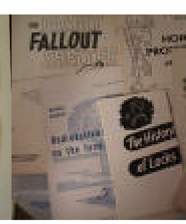
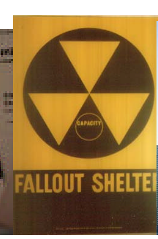








Appendix D
Case Study II – School Shelter Design (Kansas)

Overview

On May 3, 1999, an outbreak of tornadoes tore through parts of Oklahoma and Kansas leveling entire neighborhoods and killing 49 people; 6 in Kansas. Chisholm Life Skills Center in Wichita, Kansas sustained heavy damage from these storm systems. A double portable classroom was demolished and the roof system for the southwest classroom section of the school was destroyed. A mechanical room chimney collapsed onto an adjacent roof causing roof and wall failure. The roof membrane was damaged at several locations over the entire building.

PBA, an A/E firm in Wichita, was commissioned by the Unified School District No. 259 to assess damages and provide retrofit options including proposed locations for safe areas at Chisholm Center. Advantages and disadvantages for each proposal were listed, along with a recommendation and a cost estimate.

PBA recommended a centrally located classroom addition to replace the portable classrooms. The new addition would replace the lost facilities and also function as a tornado shelter. It would provide 840 square feet of usable floor space and be constructed with pre-cast concrete wall panels, a pre-cast double tee concrete roof structure, and roof mounted mechanical equipment. The design would meet the requirements of the newest local building codes for normal building use and technical guidelines in FEMA documents for tornado shelter use, including a design wind speed of 250 mph.

A major advantage of the design plan is that it could be implemented without disrupting school activity. Design plans for the new addition at the Chisholm Life Skills Center are provided in this appendix. The plans are preceded by the wind load analysis on which the design is based.

ASCE 7-98 Wind Load Analysis for Chisholm Life Skills Center Shop Addition

Using Exposure C

General Data

$K_z = 0.85$	Velocity Pressure Exposure Coefficient (Table 6-5 of ASCE 7-98)
$I = 1.00$	Importance Factor (see Chapter 5 of this manual)
$V = 250$	Wind Speed (mph) from FEMA Wind Zone Map (Figure 2-2 in this manual)
$K_{zt} = 1$	Topographic Factor (Figure 6-2 of ASCE 7-98)
$K_d = 1.00$	Wind Directionality Factor (Table 6-6 of ASCE 7-98)
$h = 14$	Building Height (ft)
$L = 56$	Building Length (ft)
$B = 35$	Building Width (ft)

Velocity Pressure (Section 6.5.10 of ASCE 7-98)

$q_z = (0.00256)(K_z)(K_{zt})(K_d)(V^2 I)$ $q_z = 136.00$ psf

$q_h = qz$

$q_h = 136.00$ psf

External Pressure Coefficients for Walls (Figure 6-3 in ASCE 7-98)

$L/B = 1.60$	$C_{p1} = 0.8$	windward wall	$B/L = 0.63$	$C_{p1} = 0.8$	windward wall
	$C_{p2a} = -0.38$	leeward wall		$C_{p2b} = -0.5$	leeward wall
	$C_{p3} = -0.7$	side wall		$C_{p3} = -0.7$	side wall

Roof Pressure Coefficients (Figure 6-3 in ASCE 7-98)

$h/L = 0.25$	$C_{p4a} = -0.9$	from 0–7 ft from windward edge
	$C_{p4b} = -0.9$	from 7–14 ft from windward edge
	$C_{p5} = -0.5$	from 14–28 ft from windward edge
	$C_{p6} = -0.3$	more than 28 ft from windward edge

(**Note:** Let $C_{p4} = C_{p4a} = C_{p4b}$ due to roof geometry)

Gust Factor

G = 0.85

Internal Pressure Coefficients for Buildings (Table 6-7 in ASCE 7-98)

GC_{pipos} = 0.55 for partially enclosed buildings

GC_{pineg} = -0.55for partially enclosed buildings

Design Wind Pressure for Rigid Buildings of All Heights (Section 6.5.12.2.1 of ASCE 7-98)

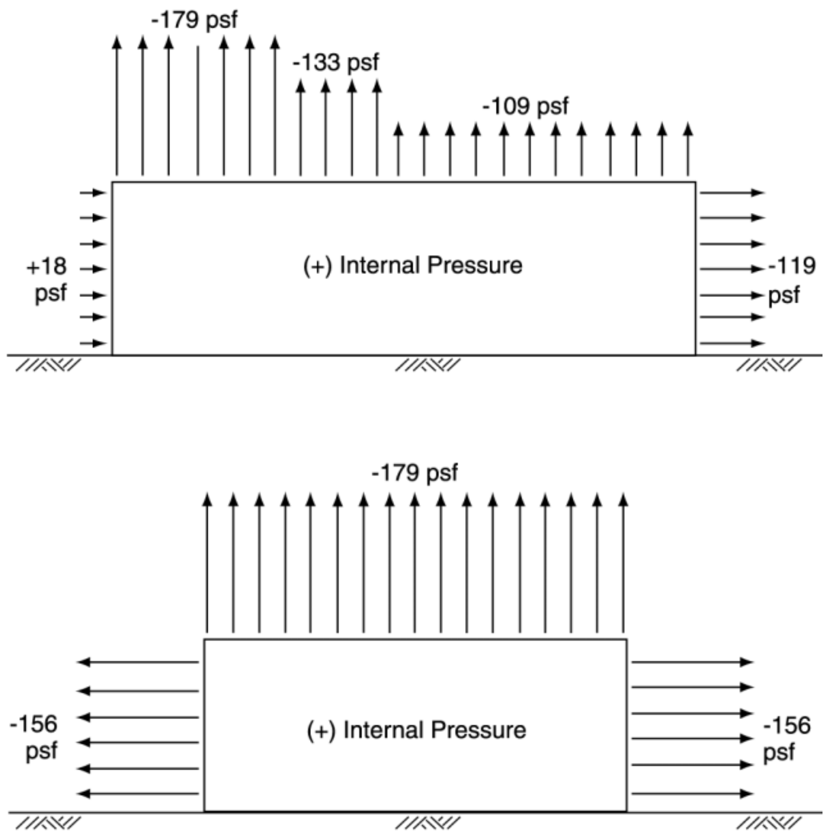
(for positive internal pressures)

$p_{wi} = (q_z)(G)(C_{p1} - q_h)(GC_{pipos})$	$p_{wi} = 17.68$	windward wall
$p_{lee2a} = (q_z)(G)(C_{p2a} - q_h)(GC_{pipos})$	$p_{lee2a} = -118.73$	leeward wall (wind parallel to ridge)
$p_{lee2b} = (q_z)(G)(C_{p2b} - q_h)(GC_{pipos})$	$p_{lee2b} = -132.60$	leeward wall (perpendicular to ridge)
$p_{side} = (q_z)(G)(C_{p3} - q_h)(GC_{pipos})$	$p_{side} = -155.72$	side wall
$p_{roof1} = (q_z)(G)(C_{p4} - q_h)(GC_{pipos})$	$p_{roof1} = -178.84$	roof pressures (0–14 ft from windward edge)
$p_{roof2} = (q_z)(G)(C_{p5} - q_h)(GC_{pipos})$	$p_{roof2} = -132.60$	roof pressures (14–28 ft from windward edge)
$p_{roof3} = (q_z)(G)(C_{p6} - q_h)(GC_{pipos})$	$p_{roof3} = -109.48$	roof pressures (more than 28 ft from windward edge)

(for negative internal pressures)

$p_{wi} = (q_z)(G)(C_{p1} - q_h)(GC_{pineg})$	$p_{wi} = 167.28$	windward wall
$p_{lee2a} = (q_z)(G)(C_{p2a} - q_h)(GC_{pineg})$	$p_{lee2a} = 30.87$	leeward wall (wind parallel to ridge)
$p_{lee2b} = (q_z)(G)(C_{p2b} - q_h)(GC_{pineg})$	$p_{lee2b} = 17.00$	leeward wall (perpendicular to ridge)
$p_{side} = (q_z)(G)(C_{p3} - q_h)(GC_{pineg})$	$p_{side} = -6.12$	side wall
$p_{roof1} = (q_z)(G)(C_{p4} - q_h)(GC_{pineg})$	$p_{roof1} = -29.24$	roof pressures (0–14 ft from windward edge)
$p_{roof2} = (q_z)(G)(C_{p5} - q_h)(GC_{pineg})$	$p_{roof2} = 17.00$	roof pressures (14–28 ft from windward edge)
$p_{roof3} = (q_z)(G)(C_{p6} - q_h)(GC_{pineg})$	$p_{roof3} = 40.12$	roof pressures (more than 28 ft from

Figure D-1
Design wind pressures when wind is parallel to ridge with positive internal pressures (Chisholm Life Skills Center Shop Addition)



Notes:
1. Positive pressure values act against the building surface.
2. Negative pressure values act away from the building surface.
3. Wind direction is from left to right on the top figure and going into the page on the lower figure.

BUDGETARY COST ESTIMATE FOR THE WICHITA, KANSAS, SHELTER

ESTIMATED CONSTRUCTION COSTS (+/- 20%)
(SHELTER AREA = 2,133 Square Feet)

CONSTRUCTION ITEM	COST
• Site work and general requirements	$ 16,200
• Utilities	$2,100
• Cast-in-place concrete	$22,900
• Pre-cast concrete structure	$ 57,700
• Metals	$ 8,700
• Woods and plastics	$ 21,000
• Thermal and moisture protection	$ 16,000
• Doors and hardware	$ 6,000
• Finishes	$ 6,000
• Specialties	$ 6,000
• Special equipment/technology	$6,000
• Electrical	$22,600
• Mechanical	$ 44,100
TOTAL CONSTRUCTION COSTS	$249,100
Profit and Fees	$ 24,900
TOTAL ESTIMATED CONSTRUCTION COSTS	**$274,000**
UNIT COST (PER SQUARE FOOT [SF])	**$128.00/SF**

NOTE: Currently, in this area of Kansas, school projects consisting of exterior loadbearing walls of CMU with brick veneer, interior non-loadbearing CMU walls, and open-web steel joist roof systems with metal decks are budgeted at $95.00–$100.00/ft^2.