

# Loss Avoidance Study: SWCC Safe Rooms

## Summary

Over the last decade, local governments and the State of Iowa with support of FEMA through Hazard Mitigation Assistance (HMA) Programs have invested millions of dollars in funding to construct tornado safe rooms across Iowa. The goal of this study was to evaluate the losses avoided as a result of implementation of tornado safe room mitigation measures completed in Iowa prior to a tornado or high wind event. These measures provide life safety protection during tornado and high wind events.

In this study of the City of Creston, a total of \$16,108,000 in losses were avoided due to past mitigation measures through the construction of two tornado safe rooms for protection of the at risk population at Southwestern Community College (SWCC). Comparing the cost of constructing these safe rooms which was an estimated total of \$242,700, to the total losses avoided (\$ 16,108,000) results in a Loss Avoidance Ratio ( $L_R$ ) of 66.37. These safe rooms were completed independent of HMA program funding but do basically meet the FEMA 361 requirements regulating the construction of tornado safe rooms.

## Project Data

Between August 2007 and August of 2010, the Southwestern Community College (SWCC) located in Creston, Union County, Iowa constructed two student dormitories. Both Spartan Suites and Spartan Hall dormitories were constructed with the inclusion of tornado safe rooms on the first floor of each of the two buildings as a portion of the hallways.



Figure 1: SWCC Campus (SWCC)



Figure 2: Spartan Suites Safe Room (Laugerman + Architects)

The first of the two constructed was Spartan Suites, a 48 person dormitory completed in August of 2007 located at Latitude: 41.072355 and Longitude: -94.378282. This two-story building contained a 503 square foot tornado safe room built to the FEMA 361, First Edition 2003 standard as a portion of the first floor hallway. With a safe room occupancy of 99 people, the safe room consisted of 8 inch reinforced concrete masonry unit walls, and a 12 inch thick concrete ceiling.<sup>1</sup> The safe room in Spartan Suites was estimated to have cost \$106,500.<sup>2</sup>

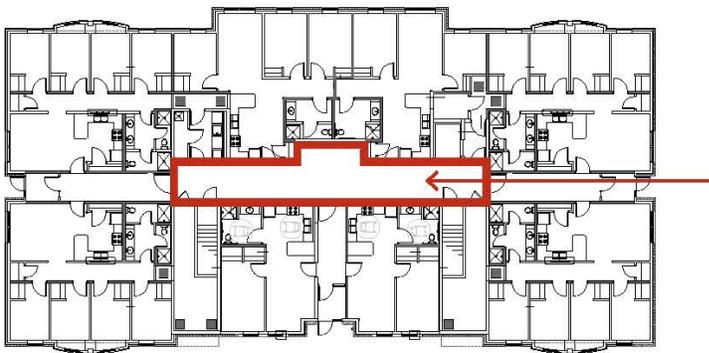


Figure 3: Spartan Hall Safe Room (Laugerman + Architects)

The second safe room was constructed in Spartan Hall, a 75 person dormitory completed in August of 2010 located at Latitude: 41.071651 and Longitude: -94.379071. This three-story building contained a 605 square foot tornado safe room designed and built to the FEMA 361, Second Edition 2008 as a portion of the first floor hallway. With a safe room occupancy of 119, the safe room consisted of 8 inch reinforced concrete masonry units with a 12 inch reinforced concrete ceiling.<sup>3</sup> The estimated cost for the construction of the safe room in Spartan Hall was \$136,200.<sup>4</sup>

On Saturday, April 14, 2012, at approximately 7:00 pm, an EF2 tornado struck the SWCC campus.<sup>5</sup>

<sup>1</sup> Laugerman + Architects summary sheet

<sup>2</sup> Phone conversation with Dave Laugerman, AIA; Laugerman + Architects 4/19/12.

<sup>3</sup> Laugerman + Architects summary sheet

<sup>4</sup> Ibid.

<sup>5</sup> National Weather Service Des Moines: Storm Survey Results from Union County/Creston on April 14, 2012. Updated April 17, 2012. Accessed online on 4/18/12 from: [www.crh.noaa.gov/images/dmx/.../2012-04-14\\_Creston\\_Writeup.pdf](http://www.crh.noaa.gov/images/dmx/.../2012-04-14_Creston_Writeup.pdf)

## Tornado Event Analysis

According to the National Weather Service, the EF2 tornado touched ground at 6:55 pm on April 14, 2012 approximately 1.5 miles east of Cromwell, Union County, Iowa, and then tracked northeast through the northwestern portion of Creston, Union County, Iowa before dissipating 10 miles northeast of Creston. During this event, the tornado reached a peak wind speed of 130 mph, with an average path width of 600 yards.<sup>6</sup>

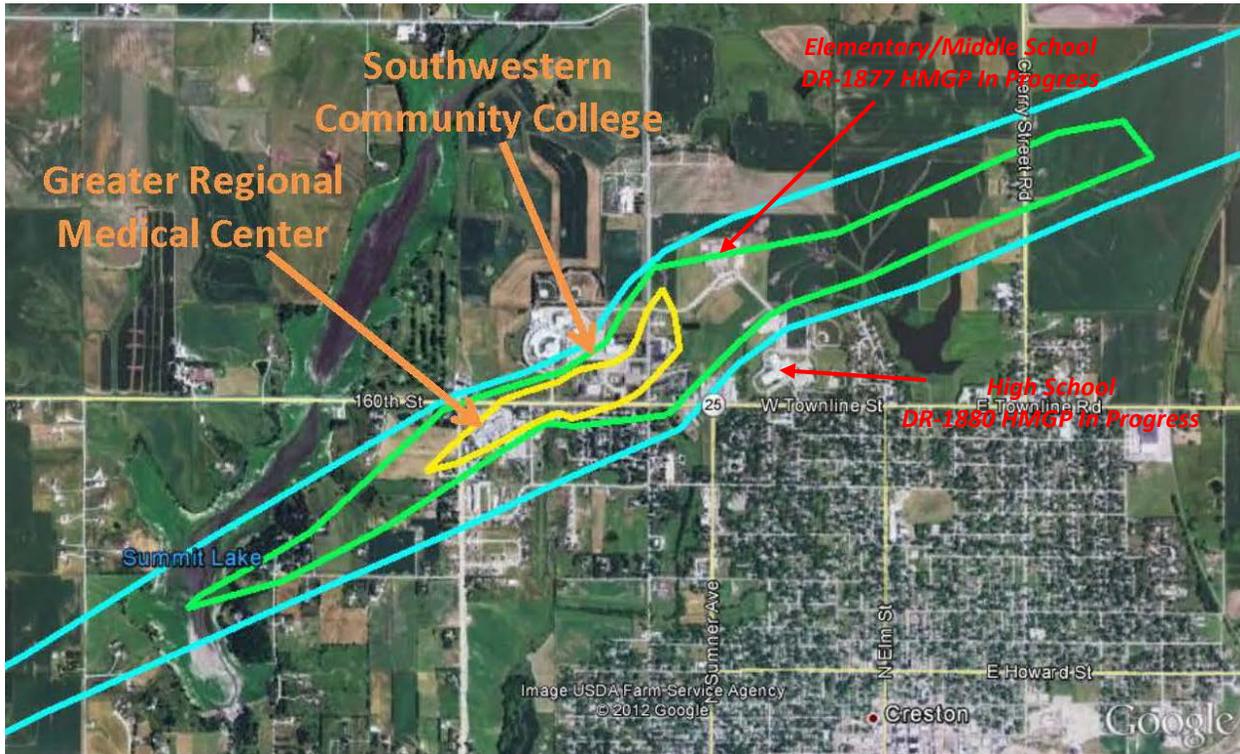


Figure 4: Tornado Path (National Weather Service)

*The light blue contour denotes EF0 damage, green denotes EF1 damage, and yellow represents EF2 damage. In addition, in red are two safe rooms are currently being funded through the HMGP at two of Creston's schools and are in progress.*

Due to the sudden onset of the event, a tornado warning was not issued by the National Weather Service until 7:11 pm, approximately ten minutes after the tornado had already passed.<sup>7</sup> With minimal time to respond, approximately 70 students were able to seek refuge in the safe rooms.<sup>8</sup> No injuries or deaths were reported from those that utilized the safe rooms. However, there were three students that were injured, one student required six stitches and suffered a broken finger, and two students suffered minor scrapes and bruises. None of the injured students were able to utilize the safe rooms.<sup>9</sup>

<sup>6</sup> Ibid.

<sup>7</sup> Des Moines Register, "Here's why the tornado sirens didn't sound in Creston" accessed 4/18/12: <http://blogs.desmoinesregister.com/dmr/index.php/2012/04/16/heres-why-the-tornado-sirens-didnt-blare-in-creston/>

<sup>8</sup> Email from Tom Lesan, Vice President of Economic Development SWCC, 4/17/12

<sup>9</sup> Email from Tom Lesan, Vice President of Economic Development SWCC, 4/19/12

SWCC administrators credited the relative success of the safe rooms to the tornado drill that was performed ten days prior to the tornado actually occurring.<sup>10</sup>

As a result of the tornado, both Spartan Suites and Spartan Hall suffered severe damage, although it is expected that they will be repaired, and reopened in August of 2012.<sup>11</sup>

## Damage Analysis Overview

There have been two tornado events recorded in the area of Spartan Suites since their completion in August of 2007:

- June 5, 2008 8:24 pm: EF1 resulting in 0 injuries, 0 deaths, \$25,000 in property damage, \$2,000 in crop damage.<sup>12</sup> (Figure 6)
- April 14, 2012 7:00 pm: EF2 resulting in 10 injuries, 0 deaths, preliminary property damage estimated at \$24,250,000; crop damage not yet determined.<sup>13</sup> (Figure 4)

## Methodology for Loss Avoidance Study

In the aftermath of the event, HSEMD learned that tornado safe rooms had been integrated into the construction of Spartan Suites and Spartan Hall. HSEMD then gathered data related to the performance of the safe rooms from various sources, including:

- SWCC administration
- Laugerman Architects, who designed both structures
- National Weather Service
- HSEMD damage assessment teams
- Media (newspaper, television, etc.)
- Tornadohistoryproject.com
- FEMA

Potential losses without the safe rooms in place (Mitigation Project Absent or MP<sub>A</sub>) were determined utilizing data gathered, and tools provided by FEMA. The values utilized in estimating the MP<sub>A</sub> dollar amount are based on the BCA 5.0 software, and are known



Figure 5: Spartan Suites (HSEMD)

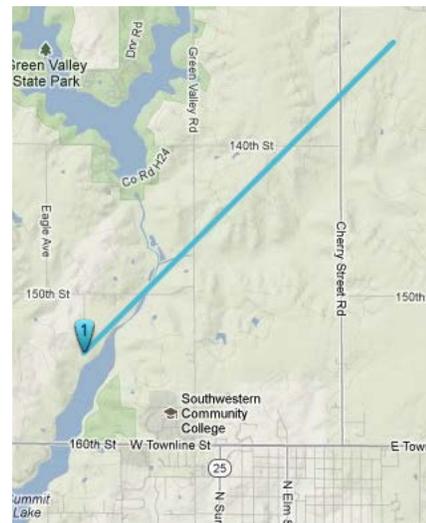


Figure 6: June 5, 2008 EF1 Tornado Path (tornadohistoryproject.com)

<sup>10</sup> Telephone conversation with Tom Lesan, Vice President of Economic Development SWCC, 4/17/12

<sup>11</sup> Ibid.

<sup>12</sup> <http://www.tornadohistoryproject.com>; accessed 4/18/12.

<sup>13</sup> April 14 Tornado- PA Damage Assessment Summary; HSEMD.

as the Willingness To Pay (WTP) values developed by FEMA. The WTP values are based on actuarial estimates for the costs related to varying types of injuries and fatalities. These WTP values are listed below:

Self-Treat Injuries	\$ 13,000
Treat and Release Injuries	\$ 102,000
Hospitalization Injuries	\$ 1,237,000
Fatalities	\$ 5,800,000

The method of determining the number of people that may possibly be killed or injured by a tornado is based on the number of occupants of the safe room, taking into account the probability of the types of potential fatalities, injures, and those that are not injured. This probability was determined by FEMA in a draft Loss Avoidance Study tool<sup>14</sup>, and is shown below for an EF2 tornado:

Self-Treat Injuries	24%
Treat and Release Injuries	20%
Hospitalization Injuries	10%
Fatalities	2%

With the estimated costs for the construction of the safe rooms, and the estimated costs related to injuries included, the Mitigation in Place ( $MP_C$ ) was determined. The actual number of fatalities and injuries from the event were then taken into account, and the same dollar figures as above were applied. The actual construction costs were then taken into consideration.

## Return on Investment

The estimated potential losses as a result of the April 14, 1012 tornado if the safe rooms did not exist were calculated as:

$MP_A$	#	WTP Value	Subtotal
Self-Treat Injuries	17	\$ 13,000	\$ 221,000
Treat and Release Injuries	14	\$ 102,000	\$ 1,428,000
Hospitalization Injuries	7	\$ 1,237,000	\$ 8,659,000
Fatalities	1	\$ 5,800,000	\$ 5,800,000
<b>Total Loss of Life and Injury Damages</b>	<b>39</b>		<b>\$ 16,108,000</b>

Although there were injuries on the SWCC campus, none of those who utilized the safe rooms sustained any injuries. The costs of constructing the safe rooms in Spartan Suites and Spartan Hall, and the WTP costs, if any, were estimated as:

<sup>14</sup> Loss Avoidance Study, FEMA Mitigation-Risk Reduction Division, 4/18/12

MP <sub>C</sub>	#	WTP Value	Subtotal
Self-Treat Injuries	0	\$ 13,000	\$ -
Treat and Release Injuries	0	\$ 102,000	\$ -
Hospitalization Injuries	0	\$ 1,237,000	\$ -
Fatalities	0	\$ 5,800,000	\$ -
<b>Total Loss of Life and Injury Damages</b>	<b>0</b>		<b>\$ -</b>
Spartan Suites			\$ 106,500
Spartan Hall			\$ 136,200
<b>Total Construction Costs</b>			<b>\$ 242,700</b>
<b>TOTAL</b>			<b>\$ 242,700</b>

Using the following formula, the Loss Avoidance Ratio (L<sub>R</sub>) was determined:  $MP_A/MP_C = L_R$   
 $\$16,108,000/\$242,700 = 66.37$

The Loss Avoidance Ratio (L<sub>R</sub>) is then: **66.37**

## Discussion

Since 1950, Iowa has been struck by over 2,200 tornados, killing over 80 people, and injuring almost one person per tornado.<sup>15</sup> These tornados range in intensity from EF0, causing minimal damage; to EF5, causing massive destruction, injuries, and often fatalities.

Tornado safe rooms are an effective mitigation action to prevent and reduce injuries and deaths caused by tornados. In Iowa, the safe rooms at SWCC are a great example of how tornado safe rooms have effectively prevented injuries and deaths of an actual tornado event. This study presents a testimony of the losses avoided through the construction of tornado safe rooms as a mitigation method in Iowa.



Figure 7: Spartan Hall Safe Room (HSEMD)

The tornado that struck both Spartan Suites and Spartan Hall caused severe damage to the buildings. However, the safe rooms remained intact, and largely undamaged.(Figure 7: Spartan Hall Safe Room (HSEMD)) This proved that the structural design and materials used in constructing the safe rooms were effective in withstanding EF2 tornado winds and associated debris. Due to the nature of the tornado that struck, and the lack of warning, it is creditable that 70 students made it into the safe rooms, and were protected.

<sup>15</sup> <http://www.tornadohistoryproject.com>; accessed 4/25/12.

Had the safe rooms not been in place, it can be estimated that roughly half of the students that sought refuge in the safe rooms would have been possibly injured and or killed by the tornado, with estimated potential losses in excess of \$16 million according to the FEMA BCA methodology utilized. The relatively low construction costs of the safe rooms, along with the few injuries that did occur on campus, when compared with the potential losses, result in an estimated benefit of over 43 times the actual costs.

Through the analysis of the SWCC safe rooms, it can be concluded that tornado safe rooms are effective in protecting lives from injuries and death during tornados. It can also be verified that tornado safe rooms are a cost effective method in mitigating losses from tornados and high wind events when compared with no protection being available.