SHRC SHELTERS FALL REPORT

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Executive Summary

A-1 Blasting, Inc. of Broken Arrow, Oklahoma, successfully fabricates oil field screens with seven to nine employees depending on demand. They plan to diversify by manufacturing above ground storm shelters designed to meet FEMA P-361 and NSSA standards. A second revenue driver will allow A-1 Blasting, Inc. to more efficiently use staff and capital assets as demand fluctuates for screens.

The storm shelter industry in the Tulsa area is highly fragmented. Almost all direct competitors have drastically overdesigned shelters and are using more steel then necessary to protect occupants from wind and projectiles in accordance with FEMA standards. A-1 Blasting, Inc. will easily gain a price advantage on these competitors due to a more efficient design that minimizes material and labor while providing as much or more protection than competitors.

A-1 Blasting, Inc. will differentiate from competitors by framing the interior of each shelter to resemble standard residential framing allowing the customer to finish the interior of the shelter to his or her tastes with sheetrock, plumbing, electrical, and insulation. Therefore, SHRC Shelters can be integrated seamlessly and serve as a functional room in a newly constructed home. The firm will offer three standard-sized shelters but can provide custom sizes, as the wall structure is standard across all models.

A-1 Blasting, Inc. will use homebuilders who operate in the Tulsa area as distributors to reduce operating risk associated with leverage. Homebuilders can incorporate SHRC Shelters into stock homes or sell them to clients building custom homes. Distributors allow A-1 Blasting, Inc. to minimize fixed costs associated with sales, installation and marketing, which decreases the number of units A-1 Blasting, Inc. must sell to break even. Using homebuilders as distributors also creates a competitive advantage by allowing customers the option to purchase an A-1 Blasting, Inc. shelter before they even purchase a home, instead of only marketing as a garage-mounted unit.

Homebuilders in the Tulsa area are expected to build about 4,800 homes in 2013, and the number of new homes is projected to have an average annual growth rate of about 7.0% over the next five years. A-1 Blasting, Inc. will likely acquire a 0.25% - 0.5% market share during the first year of operation and 1.5% - 3.0% during the third year of operation. Revenues in 2013 are projected at about $57,000 with an average annual growth rate of 186% over the first five years of operation.

Contents

Mission Statement

The mission of SHRC Shelters is to create safe, economical shelter designs with outstanding features to satisfy clients and market demands.

Problem Statement

A-1 Blasting, Inc. of Broken Arrow, Oklahoma, desires to expand manufacturing operations by adding an above ground storm shelters to their production. A market analysis must be conducted to determine what the market will accept in new products and what competitive edges can be attained. From the analyzed data, a market acceptable engineering design must be completed and the costs and sales must be projected.

Statement of Work

SHRC Shelters will perform market analysis to determine possible competitive advantages for a new storm shelter that A-1 Blasting, Inc. can produce. After the determination of the market concept engineering design, the storm shelter will be drawn and production costs will be analyzed. The storm shelter will be designed to protect occupants from damaging winds, hail, and flying debris. The storm shelter will have potential to function as a closet, pantry or garage storage unit.

The following are the tasks to be performed:

- Research Patents
- Research Testing/Certification
- Market Analysis
- Design Basic Shelter
- Consider and Design Multiple Usages for Shelter
- Determine Construction Materials
- Perform Detailed Engineering Analysis of Forces
- Draw Detailed Design in SolidWorks
- Estimate Costs
- Write Fall Report
- Present Design Concepts for Fall Presentation

- Build Prototype Chosen by A-1 Blasting, Inc.
- Test Prototype
- Market Concept
- Write Final Spring Report
- Present Final Design for Spring Presentation

Period and Location of Performance:

The work will be performed at the Oklahoma State University campus and/or A-1 Blasting, Inc. The market concept and engineering design will be completed by the end of the fall semester. SHRC Shelters will construct and test a prototype by the end of the spring semester.

Acceptance Criteria and Applicable Standards:

The acceptance criteria consist of economic feasibility of the storm shelter and compliance to applicable standards. The National Storm Shelter Association (NSSA) dictates requirements necessary for storm shelter design. FEMA P-361 also controls the design and concept of a concrete and steel storm shelter. Texas Tech University has provided testing parameters which will guide SHRC Shelters in the testing and certification processes.

Deliverables Schedule:

A-1 Blasting, Inc. will receive a marketable concept and engineering designs at the end of the fall semester 2012. By the end of spring semester, SHRC Shelters expects to have a tested a prototype for A-1 Blasting, Inc.

Work Breakdown Structure

1) Storm Shelter
    a) Research
        i) Investigate testing/certification
            (1) Look into NSSA approved designs
            (2) Research 3rd party approval
    b) Design Shelter
        i) Brainstorm initial size and designs
        ii) Determine construction materials
        iii) Perform detailed engineering analysis of forces and projectile impacts

iv) Draw detailed 3D model in SolidWorks

(1) Draw model

(2) Draw construction drawings

(a) Write instructions on construction and installation

v) Estimate prototype costs from models

c) Fall Presentations

i) Establish pertinent talking points

ii) Gather information from research and project

iii) Assemble PowerPoint presentation

iv) Practice presentation

(1) Rehearse slides and parts

(2) Anticipate and plan responses for possible audience questions

v) Give presentation on December 4, 2012, at 10:00am

d) Build Prototype

i) Contact BAE Lab or A-1 Blasting, Inc. for construction location and timeline

ii) Get construction schedule/timeline

iii) Build structure

e) Test Prototype

i) Schedule time at Texas Tech Wind Research

(1) Pending approval from Dr. Weckler and A-1 Blasting, Inc.

f) Market Shelter

i) Use cost estimate from design phase as well as actual prototype cost to estimate

ii) Contact Ag Econ group for further analysis

g) Spring Presentation

i) Establish presentation content

ii) Gather information from research and project

iii) Assemble PowerPoint presentation

iv) Practice presentation

v) Give final presentation

Market Analysis

Market and Trends

Storm shelter manufacturing and sales is a highly fragmented industry. Most firms operating in the industry are small private businesses that often have revenue streams in addition to storm shelter manufacturing, which causes a lack of dependable data regarding operations. The market is estimated at about $21 million based on thirteen firms reporting sales data[1]. Most firms have between one and four employees and hold on average a 7.7% market share[2].

Over the last five years the average price of storm shelters has remained the same due to a lack of demand in construction and decreasing material costs. Most residential shelter manufacturers relied on a high-volume low-margin strategy during the housing and construction boom of 2007-2008, but volume decreased significantly during the recession of 2008-2011. The drop in volume paired with depressed input costs allowed the price of most shelters to stay relatively constant.

Mid and Southwestern housing statistics in late 2011 and 2012 indicate that the economy in these regions is improving. As the economy gains steam, the price of inputs will rise, and demand will slowly pick up. Due to tax and operating uncertainty, manufacturers will likely maintain margin causing an increase in price.

Competitors

The direct competitors for A-1 Blasting, Inc. in the Tulsa area include Tornado Alley Armor, New Day Tornado Shelters, OKStormShelters, and Ground Zero Storm Shelters.

Tornado Alley Armor provides above ground storm shelters that are constructed of pre-manufactured steel panels and approved by NSSA. The panels are of standard sizes thus allowing the user to expand the size of the shelter by adding panels. Tornado Alley Armor sells complete shelters starting at $2900 for a 30” x 56” x 80” shelter, shown in Figure 1. The shelters can be customized to add more impact resistance, a stronger door, a panic room lock, lighting or customer-defined colors for additional cost.

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[2] Bizminer, 2012.*Micro Market Industry Report: Tulsa County*. June 2012. Available at: http://reports.bizminer.com/temp/pdf/683413148_1127174125.pdf. Accessed 11 November 2012.

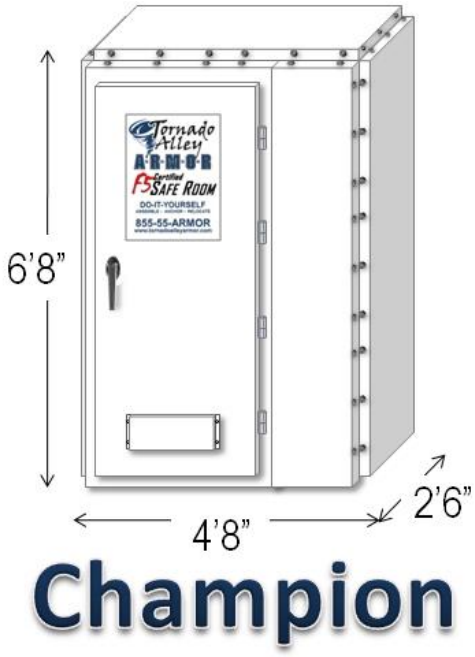


Figure 1. Tornado Alley Storm Shelter.

http://www.tornadoalleyarmor.com/models

New Day Tornado Shelters offers an ultra-small shelter for one to two people that is NSSA certified. The shelter is constructed from a reused propane tank turned on its end with an attractive paint job and an outward opening door. The unit retails for $3200 including installation, shown in Figure 2.

Figure 2. New Day storm shelter.

http://www.newdaytornadoshelters.com/Work.php

OKStormShelters offers steel safe rooms sized between 4' x 4' for two to four people to 6' x 8' for 10-12 people, these shelters are not NSSA certified. A 3' x 5' shelter is shown in Figure 3. OKStormShelters pricing ranges from $3200 to $5000 and all prices include installation. The

shelter is constructed with 3/16” steel walls with a 2”x2”x1/4” steel tube frame; this design greatly exceeds recommended wall section designs outlined in FEMA P361.

Figure 3. OKStormShelter 3' x 5' safe room.

http://okstormshelters.com/latest-work/3-x-5-safe-room-installation-in-skiatook/

Ground Zero Storm Shelters offers custom designed shelter sizes. All Ground Zero shelters are constructed from ¼” steel plate, with no sub frame, and are then anchored to concrete with Hilti 10k-lb bolts. These shelters are not NSSA approved; however a shelter that survived a tornado is shown in Figure 4.

Figure 4. Ground Zero Shelter.

http://www.groundzeroshelters.com/saferooms.html

Indirect competitors include various precast companies and local construction contractors who install underground storm shelters. These shelters vary wildly in price but are typically more expensive than above ground shelters due to excavation costs. Underground shelters do however offer additional protection from dangerous weather since they use the earth as layer of impact protection.

Concept, Value Proposition, Differentiation

A-1 Blasting, Inc. will provide concrete or steel above ground storm shelters that exceed FEMA P-361 standards designed for installation as a functional room in a newly constructed home. Shelters will be offered in several standard sizes, which include a 3'x4', a 5'x6', and a 6'x8'. The wall sections and door assembly are standard across all models allowing A-1 Blasting, Inc. to construct shelters of any size on order. The shelters will have a total height not to exceed 8' so that no roof truss modification is necessary in a new home. Standard 2"x4" lumber will be installed in the shelter to allow the installing contractor to include electrical junction boxes or plumbing and then finish the walls and ceiling to match the rest of the house. SHRC Shelters can be installed by simply bolting the shelter to a concrete slab or to concrete piers.

By providing storm shelters that integrate seamlessly into newly constructed homes as a functional room, A-1 Blasting, Inc. can focus marketing efforts on homebuilders. There are currently no known competitors that specifically target new construction while offering seamless product integration into the home and the daily lives of occupants.

Not only will A-1 Blasting, Inc. offer a product that integrates seamlessly into a home and does not occupy valuable garage space, but each shelter will be sold to or through building contractors. This allows the A-1 Blasting, Inc. to eliminate the fixed costs associated with installation equipment. Most building contractors already own the necessary equipment for storm shelter installation. A-1 Blasting, Inc.'s shelters will be priced well below competitors' averages, representing a significant value to customers in addition to allowing a contractor a generous markup.

Design Requirements

A tornado is a violently rotating column of air that stretches from the ground up to a cumulonimbus cloud bank. Tornadoes are found on every continent and vary in strength from small dust devils to large destructive multi-vortices. The strength of a tornado is based upon the enhanced Fujita scale, which can be seen in Table 1. The Enhanced Fujita Scale was researched and developed at Texas Tech University. A direct comparison of the old and new scale is found in Appendix A. The estimated wind speeds shown in the scale are based on three second gusts of wind (FEMA P-361 6.1.1). Appendix A also shows the typical damage patterns for differing storm intensities. The most common type of storm that produces tornadoes is called a super cell thunderstorm, which typically travels in a southwest to northeast direction.

Table 1. Enhanced Fujita Scale (FEMA 361).

Enhanced Fujita Scale		
Scale	Wind Speed	
	MPH	Km/H
EF0	65-85	105-137
EF1	86-110	138-178
EF2	111-135	179-218
EF3	136-165	219-266
EF4	166-200	267-322
EF5	>200	>322

Intense tornados are extremely rare; the probability of a structure being impacted by an EF4-EF5 event in the Midwestern states is 0.00002, which was calculated at a 50,000 MRI (FEMA P-361 6.1.5). Mean Recurrence Interval (MRI) is an estimate of the interval of time between occurrences of an event happening, which is valuable for risk analysis[3]. To calculate the MRI, the following equation is used:

$$MRI = \frac{n}{m}$$

where, n=the number of years on record

[3] Baer, E. M., 2008. Recurrence Interval. Carleton College. Available at: http://serc.carleton.edu/quantskills/methods/quantlit/RInt.html. Accessed 26 November 2012.

m=number of recorded occurrences of the event being considered

According to FEMA P-361, storm shelter designs must be used to meet wind loads in extreme events with MRI's up to 20,000-100,000 years (FEMA P-361, 6.2.1). Table 2 shows the frequency of tornadoes in the United States.

Table 2. Tornado frequency and size based on FEMA P-361 in the United States.

Fujita Scale	Number of Tornadoes	Percentage	Cumulative Percentage
F0	20,728	43.68	43.68
F1	16,145	34.03	77.71
F2	7,944	16.74	94.45
F3	2,091	4.41	98.86
F4	491	1.03	99.89
F5	50	0.11	100
Totals	47,449	100	

Residential safe rooms are intended to save lives in the event of dangerous winds; therefore, there are many strict criteria that must be met. According to FEMA P- 361, safe rooms should be designed for wind gusts of up to 250 mph (FEMA P-361, 3.1). The following formula is used to estimate the loading on a wall due to the force of wind:

$$Wind\ pressure\ \left[\frac{lb}{feet^2}\right] = 0.00256 * \left(Wind\ speed\ \left[\frac{miles}{hour}\right]\right)^2$$

Another aspect storm shelter design consideration includes impact forces due to flying debris. The most dangerous characteristic of a tornado is not so much the wind but injury from flying debris. Table 3 shows the characteristics of windborne missiles.

Table 3. Possible airborne debris in a high wind event (FEMA).

Missile Size	Typical Debris	Associated Damage Observed
Small (Light Weight)	Aggregate roof surfacing, pieces of trees, pieces of wood framing members, bricks	Broken doors, windows, and other glazing; some light roof covering damage
Medium (Medium Weight)	Appliances, HVAC units, long wood framing members, steel decking, trash containers, furniture	Considerable damage to walls, roof coverings, and roof structures
Large (Heavy Weight)	Structural columns, beams, joists, roof trusses, large tanks, automobiles, trees	Damage to wall and roof framing members and structural systems

FEMA P-361 states that in order for a shelter to be certified, it must meet and exceed an impact debris test (FEMA P-361, 3.1). These tests are currently being performed at the Texas Tech University Wind Science and Research Center. The test consists of shooting a 15-lb 2"x4" traveling horizontally at 100 mph at different parts of the shelter, which creates a momentum force of 68 lb_f/s on the cross-sectional area and an energy on impact of 5017 ft-lb (FEMA P-361, Table 7-2).

The door and door frame structure are also strictly regulated. FEMA P-361 has researched and tested many door types. According to FEMA P-361, a steel door composed of 14-gauge or stronger steel is appropriate for storm shelters. These doors, with widths of up to three feet, are found to withstand wind loading of gusts of up to 250 mph (FEMA P-361, 7.1). Each door needs to be attached to a solid frame at six different locals, with three points on the latch side and three points on the hinge side (FEMA P-361, 7.4.4). The door frame construction needs to consist of five 3/8" lag screws in the door jamb and three 3/8" lag screws in the door head. Three points of locking mechanisms are recommended in all cases.

Building standards for tornado shelters may be found in FEMA 320 and FEMA P-361. In homes, safe rooms need to be designed to last impact from large forces and strong winds, using a 250 mph wind speed, as well as impact from a 15-lb 2"x4" at 100 mph moving horizontally and at 67 mph moving vertically throughout a time period of two hours (FEMA P-361). Figure 5 indicates wind speeds which are particularly high across northeastern Oklahoma and increase the need for shelters. A-1 Blasting Inc.'s market will be in Oklahoma, and potentially in the surrounding states, all which are listed to be protected from the maximum wind speed of 250 mph.

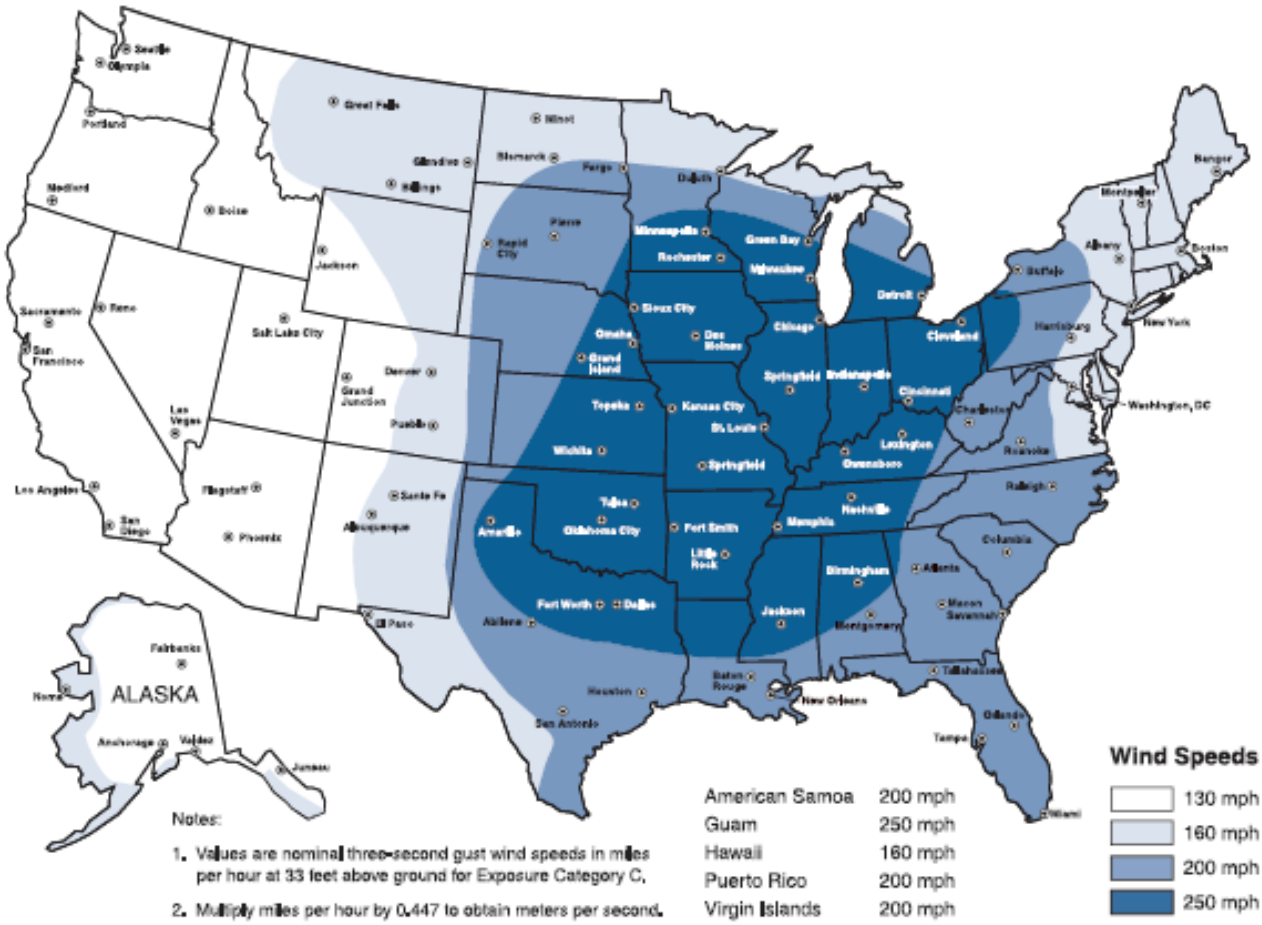


Figure 5. Wind speeds used in design of tornado shelters (FEMA361).

Detailed Work

Occupancy

Shelter occupancy is based on the area in square feet required per person, which is dependent upon the mobility of the occupants as well as the estimated amount of time they will remain in the shelter. FEMA P-361 establishes some basic guidelines to follow. For a residential one- or two-family dwelling, a minimum of two square feet per person is recommended (FEMA P-361, Table 3-5). For a community tornado shelter, a minimum of five square feet per person is recommended (FEMA P-361, Table 3-1).

Wind Force/Blow Away

Protecting the structure from failure due to wind loads is dependent on a solid anchoring system to resist sliding and uplift forces. A solid anchoring system prevents the shelter from blowing away.

From FEMA P-361 Table 3-6, the tornado safe room design speed is 250 mph. The maximum three second gust wind speed for an EF5 tornado is 234 mph, meaning that the design speed is sufficient. The total horizontal pressure due to wind loading is approximately 160 psf. Assuming the shelter is 8' tall, the shelter experiences 1280 pounds per foot of wall width. For an 8' wall, the horizontal force is 10,240 pounds.

$$Wind\ pressure\ \left[\frac{lb}{feet^2}\right] = 0.00256 * \left(Wind\ speed\ \left[\frac{miles}{hour}\right]\right)^2 = 0.00256 * (250mph)^2$$
$$= 160\ psf$$

The anchor bolts securing the shelter to the foundation should be of a sufficient tensile strength to resist uplift and shear strength to resist sliding. As a rule of thumb, the shear strength of a bolt is 60% of the ultimate tensile strength. Utilizing a grade 2 bolt with a tensile strength of 74ksi (Shigley's Table 8-9), the maximum allowable shear stress on the anchor bolts is 44.4ksi. To maintain a factor of safety of 2, the design requires 3/8" diameter bolts spaced every 12", which is enough to resist the shear forces due to one wall and is supplemented by the bolts holding down the other three walls.

$$Bolt\ Shear\ Strength = 0.60 * Tensile\ Strength = 0.6 * 74\ ksi$$
$$= 44.4\ ksi\ for\ a\ Grade\ 2\ bolt$$

$$Miniumum\ Bolt\ Area = \frac{Safety\ Factor * Force}{Stress} = \frac{2 * 1280lb}{44400\ \frac{lb}{in^2}}$$
$$= 0.0577\ in^2\ per\ foot\ of\ wall$$

$$Minimum\ Bolt\ diameter = \sqrt{0.0577 * \frac{4}{\pi}} = 0.271\ inches$$

Uplift

From FEMA P-361 section 4.3.2, uplift forces are dependent on the size of the roof. Uplift forces are also dependent on the roof geometry as seen in Appendix B. For a flat roof, corner uplift forces are 396 psf. Edge geometry experiences 238 psf, and the remaining roof area experiences 209 psf. The maximum uplift forces will occur on the largest shelter design. Calculations of uplift forces can be seen below for the 6'x8' shelter. Because the shelter is a small structure, it can be assumed that there are only edge and corner uplift forces. Assuming a total corner area of four square feet and a remaining roof edge area of 44 square feet, the uplift forces are calculated as the following:

$$Edge\ Uplift\ Force = Edge\ Area * Edge\ Uplift\ Pressure = 238\ psf * 44\ ft^2 = 10472\ lb$$

$$Corner\ Uplift\ Force = Corner\ Area * Corner\ Uplift\ Pressure = 396\ psf * 4\ ft^2 = 1584\ lb$$

$$Uplift\ Force = Corner + Edge\ Uplift\ Forces = \ 10472\ lb + 1584\ lb = 12056\ lb$$

In order to find the hold down force required, combine the uplift forces and the weight of the shelter, which is assumed to be 2000 lbs. To check bolt tension, divide the hold down force by the total bolt area, resulting in the average tensile forces in the bolts to be 402 lb per bolt.

$$Hold\ Down\ Force = Uplift\ Force - Shelter\ Weight = 12056\ lb - 2000\ lb = 10056\ lb$$

$$Bolt\ Stress = \frac{Force}{Area} = \frac{Total\ Force}{Total\ Bolt\ Area} = \frac{10056\ lb}{25 * \frac{\pi}{4} * \left(\frac{3}{8} in\right)^2} = 3642\ psi\ in\ tension$$

The bolt anchors must also be checked to ensure they will not pull out of the concrete. All of these procedures ensure the shelter will not blow away during an intense tornado event.

Penetration

A sufficient thickness of material must be utilized to prevent the sheet metal skin from being pierced from projectiles in a tornado. Evaluating the energy stored in the usual projectile is important. The usual projectile, which is used in the projectile tests at the Texas Tech Wind Science and Research Center, is a 2"x4" nominal piece of lumber weighing 15 lb fired at 100 mph for wall profiles and 67 mph for roof profiles. Because 12-gauge sheet metal has never been punctured during testing, this design will utilize 10-gauge sheet metal to ensure the safety of the occupants.

Deflection

Deflections must be calculated for both the sheet metal and the frame. The deflection of the sheet metal between the frame is calculated at the center of the material. Although Texas Tech University research shows 12-gauge steel is sufficient to stop incoming missiles as stated in FEMA P-361 section 7.3.2, further calculations are shown for the quality of this report. The kinetic energy of this projectile is given by the following equation:[4]

$$Kinetic\ Energy = \ 0.5 * mass * velocity^2 = 0.5 * 15\ lbm * (100\ mph)^2$$
$$= 75000\ lbm\ miles^2\ hour^{-2}$$

$$Energy = 75000\ lbm\ mph^2 * \frac{5280ft}{mile} * \frac{5280ft}{mile} * \frac{hour}{3600s} * \frac{hour}{3600s} * \frac{lbf * s^2}{32.2\ lbm * ft}$$
$$= 5015\ ft\ lb$$

To perform the deflection calculation, it is necessary to know the force imparted by the projectile over a certain distance. The energy is known from the previous calculations. The maximum allowable deflection in a storm shelter is 3" as set by FEMA P-361 section 7.3.2. Note the safety factor of 2 has already been accounted for in the energy value below. The force exerted on the compound beam and sheet metal is calculated to be 40,120 lb.

[4] http://www2b.abc.net.au/science/k2/stn/archives/archive100/newposts/2014/topic2014539.shtm

$$Force = \frac{Safety\ Factor * Energy}{Distance} = \frac{120360\ in\ lb}{3\ in} = 40120\ lb$$

Deflection of the frame is calculated by combining the sheet metal skin with the angle iron frame. Modulus of elasticity is unaffected because both materials are steel; however, the moment of inertia must be recalculated for the compound beam which can be seen in Figure 6 below.

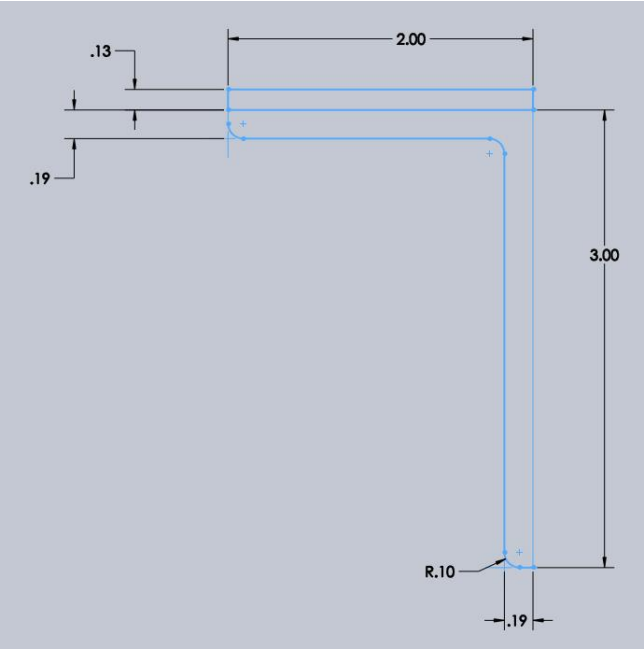


Figure 6. Moment of Inertia for the compound beam.

From this profile, the moment of inertia for the compound beam is calculated. Table 4 includes the values and calculations used. The moment of inertia for the composite beam is 0.65 in^4.

Table 4. Moment of Inertia calculations.

Segment	a (in^2)	y (in)	ay (in^3)	d (in)	ad^2 (in^4)	$I=bh^3/12$
Sheet	0.2690	0.0673	0.0181	0.8072	0.1753	0.0004
Angle	0.9380	1.1060	1.0374	0.2315	0.0503	0.4240
Total	1.2070		1.0555		0.2256	0.4244
Total I (in^4)	0.6500					

Each angle iron "stud" is spaced every 12" on center to support the sheet metal skin. Previous tests show that a double 2"x4" stud spaced 16" on center passed the projectile test according to FEMA P-361, Appendix C. The variables that change in the deflection equation are E, the modulus of elasticity, and I, the moment of inertia. Calculating for a double 2"x4" wooden stud, EI is approximately $17.15*10^6$, whereas EI for the angle iron and sheet metal is approximately $19.5*10^6$. The angle iron is approximately 14% stronger than the lumber double stud wall and is sufficient to pass the impact test.

$$Double\ Stud\ E*I = 1.6*10^6\ psi * \frac{3in*(3.5\ in)^3}{12} = 17.15*10^6\ in^2\ lb$$

$$Angle\ Iron\ E*I = 30*10^6\ psi * 0.650\ in^4 = 19.5*10^6\ in^2\ lb$$

If the projectile impacts directly between the angle iron frame, the sheet metal is forced to absorb the entire force. Although the sheet metal that will be examined is rectangular in shape, the deflection will follow a circular pattern surrounding the point of impact. The diameter of the circular pattern will be less than the spacing between the frame beyond which the energy and deflection is taken up by the frame itself. The maximum diameter used was 12" because the angle iron frame is spaced every 12". The actual value will be slightly smaller due to the width of the angle iron. This calculation should be sufficient for any size frame set on a 12" spacing.[5] Note that v, Poisson's ratio, is assumed to be 0.3 for plate steel. The maximum deflection can be calculated as follows:

$$D = \frac{E*t^3}{12*(1-v)^2} = \frac{30*10^6\ psi*(0.1345in)^3}{12*(1-0.3)^2} = 12414\ in\ lb$$

$$Maximum\ Deflection = \frac{Force*maximum\ radius^2}{16*\pi*D} = \frac{40120\ lb*(6\ in)^2}{16*\pi*12414\ in\ lb} = 2.315\ in$$

The sheet metal is of sufficient strength and thickness to resist puncture. The deflection due to projectile impact in both the sheet metal and the frame is small enough to meet the criteria set

[5] http://www.physicsforums.com/showthread.php?t=260145

forth by FEMA P-361. The bolts are sufficient in number and strength to resist uplift forces and horizontal wind forces. This shelter design meets all design requirements and presently awaits approval from Professor Dr. Weckler, industry specialist Win Adams, and A-1 Blasting, Inc. owner Bob Smith.

Construction

The shelter was constructed by the Oklahoma State University Biosystems and Agricultural Engineering fabrication shop. Construction drawings used during fabrication are located in Appendix C. Construction images are located in Appendix D.

Test Results

The constructed shelter was tested at the Texas Tech Wind Science center for adherence to FEMA standards. The test verified that the shelter would withstand the impact of a 15lb projectile at 100mph. Texas Tech tested the shelter by firing 15lb 2x4 lumbers at several different components of the shelter.

The shelter passed on contingency of the door. The shelter's wall sections experienced maximum deformation of about 1" which is well within the 3" maximum. The installed door failed the test with permanent deformations of over 5 inches near the dead bolts, shearing the screws on the hinge plate and causing the door panels to separate.

A prefabricated door that meets FEMA guidelines is priced between $2500 and $3500. Such an expensive door significantly increases the price of the shelter and makes it uncompetitive with the products offered by other firms. Therefore the design team is proposing a custom door that should cost about $300 to produce. Drawings for the custom door can be found in Appendix E, the new door design was also incorporated into shelter construction drawings located in Appendix C.

Pricing

A-1 Blasting, Inc.'s pricing model is displayed in Table 5 below including the cost of the new custom door.

Table 5. Pricing model.

	Steel	Steel
	4'x6'	6'x8'
Costs:		
Material	$1,378.98	$1,852.57
Labor	$827.39	$1,111.54
Variable Costs	$2,206.37	$2,964.12
CM at 60%	$1,323.82	$1,778.47
Price	$3,530.19	$4,742.58
Price per foot:	$147.09	$197.61

1- Interstate Steel & Metals, Inc. Tulsa, OK 74110

Distribution and Target Customers

Since A-1 Blasting, Inc. does not have a large and devoted sales staff, so the firm will use building contractors as distributors. As of 2011 fourth quarter there were 301 homebuilding firms in Tulsa, with total sales of $1.02 billion[6]. Homebuilder's revenue in the Tulsa area is expected to increase at an average rate of 7.5% over the next three years[7], which means that new home construction is increasing. A-1 Blasting, Inc. will initially build relationships with the five largest homebuilders in the Tulsa area to ensure rapid acceptance of the new storm shelters without extensive marketing overhead. These homebuilders will then either use A-1 Blasting, Inc.'s shelters in their stock homes or will sell the shelters to customers building custom homes.

All of A-1 Blasting, Inc.'s direct competitors are manufacturers, retailers, and installers; therefore, they require significant fixed costs in equipment and marketing. By using homebuilders as distributors, A-1 Blasting, Inc. is able reduce marketing costs which substantially reduces operational risks by minimizing fixed costs. It is necessary for A-1 Blasting,

[6] Bizminer, 2012.*Micro Market Industry Report: Tulsa County*. June 2012. Available at: http://reports.bizminer.com/temp/pdf/683413148_1127174125.pdf. Accessed 11 November 2012.

[7] *Ibis residential construction report*. (11, November 12). Retrieved from ibisworld.com

Inc. to price its shelters below its competitors so that distributing SHRC Shelters is attractive to homebuilders.

A major factor in the homebuilder's decision to distribute A-1's shelters may be A-1'a ability to finance the shelters for a short term. Often homebuilders build homes on short term credit and then either sell or refinance to a longer term credit instrument. A-1 will offer net 60, 90, or 120 day financing on shelters it sells through a homebuilder at a nominal 1.9% monthly interest rate (25.3% annual APR).

By distributing through homebuilders, A-1 Blasting, Inc. holds a sales advantage over its competitors who market shelters to homeowners as garage additions. A-1 Blasting, Inc. instead will reach homeowners through the homebuilders before homes are ever constructed.

Marketing Plan

A-1 Blasting, Inc. will create marketing materials that will be provided to distributors and customers. These items will include a series of brochures on the advantages of the SHRC Shelter, a video showing the installation and the final product, as well as a design guide.

Building and maintaining relationships with local homebuilders will be critical for A-1 Blasting, Inc. By establishing a presence at local home trade shows and regional residential construction trade shows, the firm will build brand recognition with potential buyers and homebuilders. A-1 Blasting, Inc. will participate in direct mail marketing to potential customers by obtaining building permit records of new houses that will soon be under construction and sending solicitations.

Volume and Market Share

Since A-1 Blasting, Inc. will primarily sell storm shelters for new construction, it is acceptable to estimate market ceiling as the total new homes per year in Tulsa. According to census estimates and homebuilder activity, an estimated 4,800 new homes will be constructed in 2013, and about 6,000 will be constructed in 2016 (Appendix F).

A-1 Blasting, Inc. can expect a market share of about 0.25% – 0.5% during the first year of operation as production challenges are met and relationships are built distributors. During years two and three, A-1 Blasting, Inc. can expect to increase market share to 1.5% - 3% once the product is accepted.

Financial Analysis and Valuation

A-1 Blasting, Inc. is expected to generate sales of about $57,000 and earnings of $6,700 from storm shelter manufacturing in the first year. Sales are expected to increase at an average of 186% annually over the first five years, with sales in 2017 expected to be about $580,000 as shown in Appendix G. The financial projections in Appendix G make several conservative assumptions such as disregarding economies of scale, price inflation, and competitive environment changes.

In 2017 A-1 Blasting is expected to be valued at about $2.1 million assuming a P/E ratio 23.9[8] which is the industry average ratio for metal fabricators in 2012q4.

Risks and Assumptions

The financial and sales volume projections are based on a series of assumptions including new home construction, median home price, homebuilder activity, marketing effectiveness and production efficiency. All assumptions are based partially or entirely on industry or census data, but as the operating environment and market changes over the next five years assumptions could be proven incorrect. All critical assumptions are listed in Table 6.

Table 6. Critical Assumptions for A-1 Blasting, Inc.

Assumptions	Description	Impacts
Competition Analysis	Used to make price and quality comparisons to determine competitive edges. Data based on competitors websites and price schedules.	Differentiation Plan
Costs Analysis	Used to project sales and assess competition. Based on prices provided by Tulsa material retailers and industry labor data.	Pricing/Contribution Margin

[8] *Yahoo Industry Financial Ratios*. (27, November 12). Retrieved from http://biz.yahoo.com/p/industries.html

Tulsa Housing Market Growth	Used in sales volume projections. Is based on homebuilder activity data from an industry reporting agency, median home price from census data, and the number of homes in the area according to census data.	Market Demand
Marketing Plan/Effectiveness	Used to determine marketing budget and market share. Based on industry trends, competitors' positioning, and buying characteristics of decisions makers.	Revenue/Sales, Marketing Budget
Distribution Plan	Used to differentiate from competition, set pricing, determine market volume, and project fixed costs. Based upon product positioning and buying process of customers.	Product Positioning, Competitive Advantage, Pricing
Production Capacity	Assumed to have capacity to produce the number of shelters sold.	Sales, Variable Costs

Risk is inherent in business operations, but A-1 will assess risks regularly and employ risk reduction techniques. Major foreseen risks are outlined below in Table 7. Risks will be present that are unforeseen at the time of planning.

Table 7. Critical Operational Risks for A-1 Blasting, Inc.

Risks	Implication	Mitigation
Inability to obtain distributors	No/Low sales	Hire sales staff or reposition product
Home starts slow	No market for product	Reposition to garage unit and beat competitors on price
Unpredictable demand	Difficult to predict costs/pricing and production time	Sub-contract sub-assemblies, increase inventory
Liquidity	Difficult to cover short term variable costs	Short term financing of variable costs
Marketing not generating sales	Low sales	Increase marketing activity or target more effectively through guerilla tactics
Distributor's Credit	Distributors can't pay off shelters after installation	Insure account payable
Interest Rate	Rate changes affect cost financing and price financing	Price adjustment/rate adjustment

References

ABC, 2006. Steel Plate and Bullet. ABC.net. Available at: http://www2b.abc.net.au/science/k2/stn/archives/archive100/newposts/2014/topic2014539.shtm. Accessed 13 November 2012.

Baer, E. M., 2008. Recurrence Interval. Carleton College. Available at: http://serc.carleton.edu/quantskills/methods/quantlit/RInt.html. Accessed 26 November 2012.

Bizminer, 2012.*Micro Market Industry Report: Tulsa County*. June 2012. Available at: http://reports.bizminer.com/temp/pdf/683413148_1127174125.pdf. Accessed 11 November 2012.

Budynas, R. G., and J. K. Nisbett. 2011. Chapter 8: Screws, Fasteners, and Design of Nonpermanent Joints. In Shigley's: Mecanical Engineering Design. 9th ed. New York, NY.:McGraw-Hill.

FEMA. 2008. Design and Construction Guidance for Community Safe Rooms. Federal Emergency Management Agency. Available at: http://www.fema.gov/library/viewRecord.do?id=1657. Accessed 14 November 2012.

Ibis Residential Construction Report. (11, November 12). Retrieved from ibisworld.com

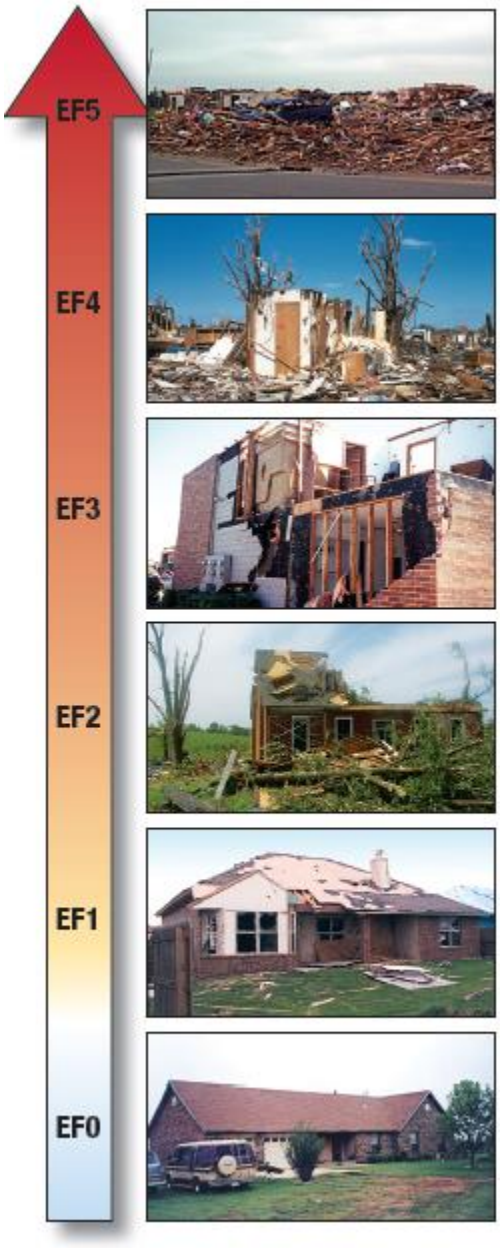
SAPN, 2010. Physics Forums. Jelsoft Enterprises Ltd. 2012. Available at: http://www.physicsforums.com/showthread.php?t=260145. Accessed 13 November 2012.

Yahoo Industry Financial Ratios. (27, November 12). Retrieved from http://biz.yahoo.com/p/industries.html

Appendix

Appendix A

Fujita Scale		EF Scale	
Fujita Scale	3-Second Gust Speed (mph)	EF Scale	3-Second Gust Speed (mph)
F0	45-78	EF0	65-85
F1	79-117	EF1	86-109
F2	118-161	EF2	110-137
F3	162-209	EF3	138-167
F4	210-261	EF4	168-199
F5	262-317	EF5	200-234



Incredible: Strong frame houses are lifted from foundations, reinforced concrete structures are damaged, automobile-sized missiles become airborne, trees are completely debarked.

Devastating: Well-constructed houses are destroyed, some structures are lifted from foundations and blown some distance, cars are blown some distance, large debris becomes airborne.

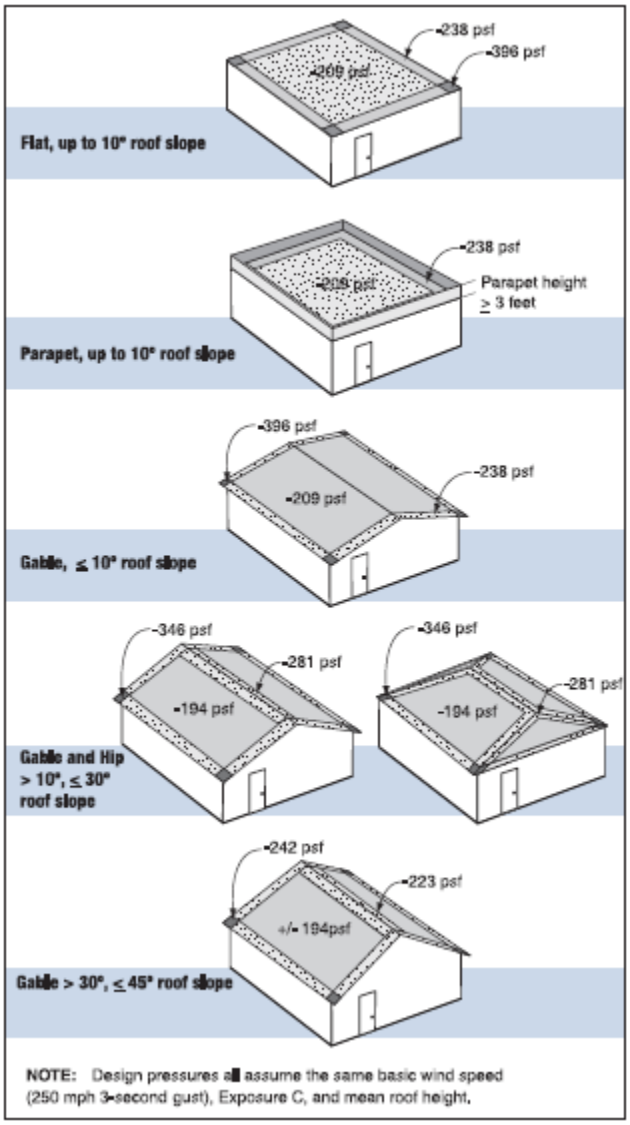
Severe: Roofs and some walls are torn from structures, some small buildings are destroyed, non-reinforced masonry buildings are destroyed, most trees in forest are uprooted.

Considerable: Roof structures are damaged, mobile homes are destroyed, debris becomes airborne (missiles are generated), large trees are snapped or uprooted.

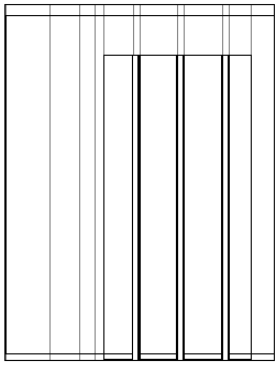
Moderate: Roof surfaces are peeled off, windows are broken, some tree trunks are snapped, unanchored mobile homes are overturned, attached garages may be destroyed.

Light: Chimneys are damaged, tree branches are broken, shallow-rooted trees are toppled.

Appendix B


-238 psf
-396 psf
-209 psf
Flat, up to 10° roof slope
-238 psf
-209 psf
Parapet height
≥ 3 feet
Parapet, up to 10° roof slope
-396 psf
-238 psf
-209 psf
Gable, ≤ 10° roof slope
-346 psf
-281 psf
-194 psf
-346 psf
-281 psf
-194 psf
Gable and Hip
> 10°, ≤ 30°
roof slope
-242 psf
-223 psf
+/- 194psf
Gable > 30°, ≤ 45° roof slope
NOTE: Design pressures all assume the same basic wind speed
(250 mph 3-second gust), Exposure C, and mean roof height.

Appendix C



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	entry modified		1
2	roof frame		1
3	Base		1
4	4ft wall		2
5	6ft wall		1
6	95 angle	Corner "stud," not included on wall drawings	4
7	entry skin		1
8	4ft skin		2
9	6ft skin		1
10	Roof skin		1
11	Door Assembly		1

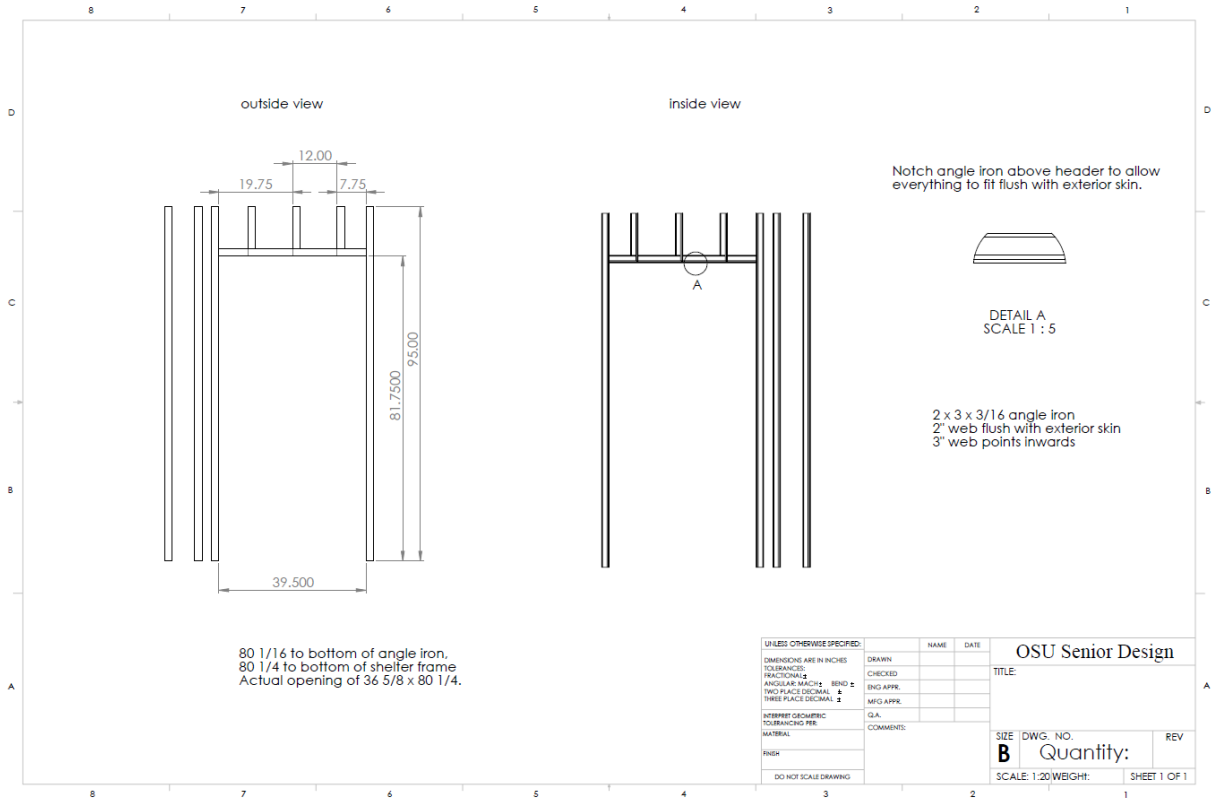
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

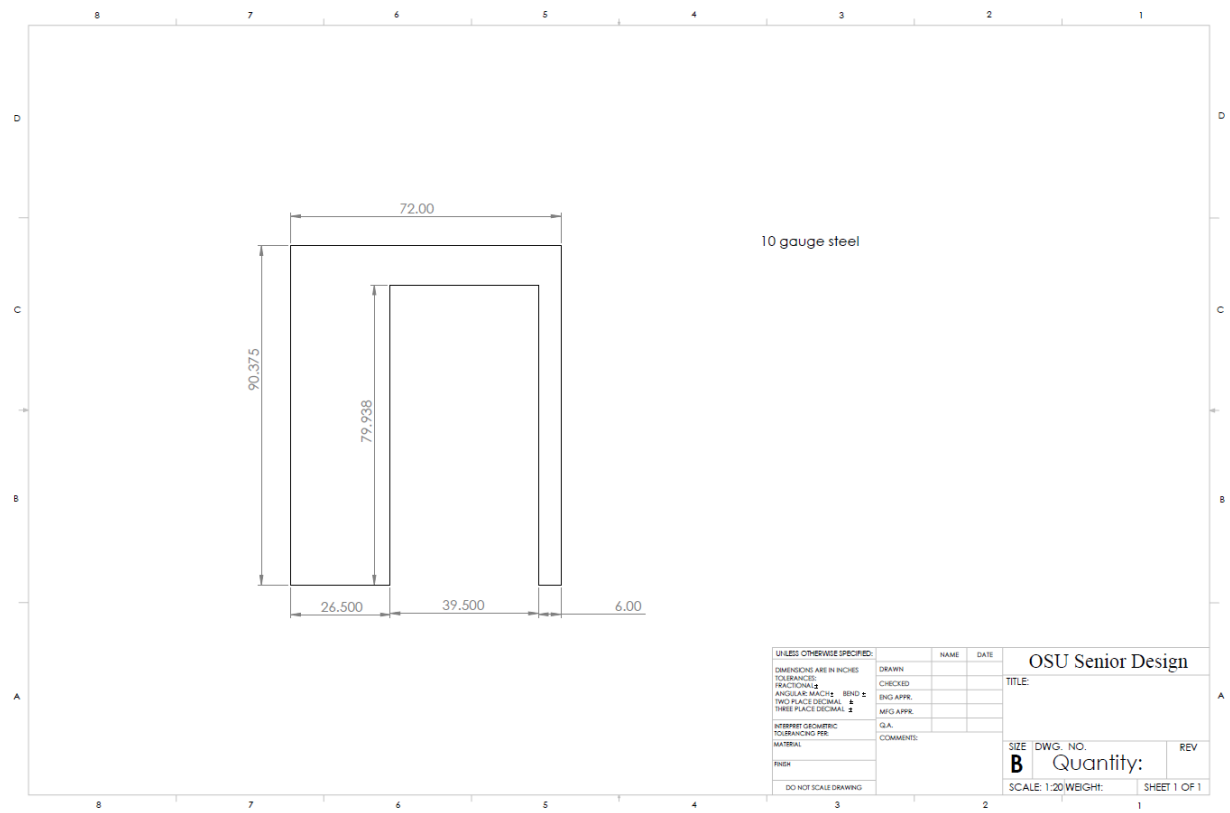
TITLE:

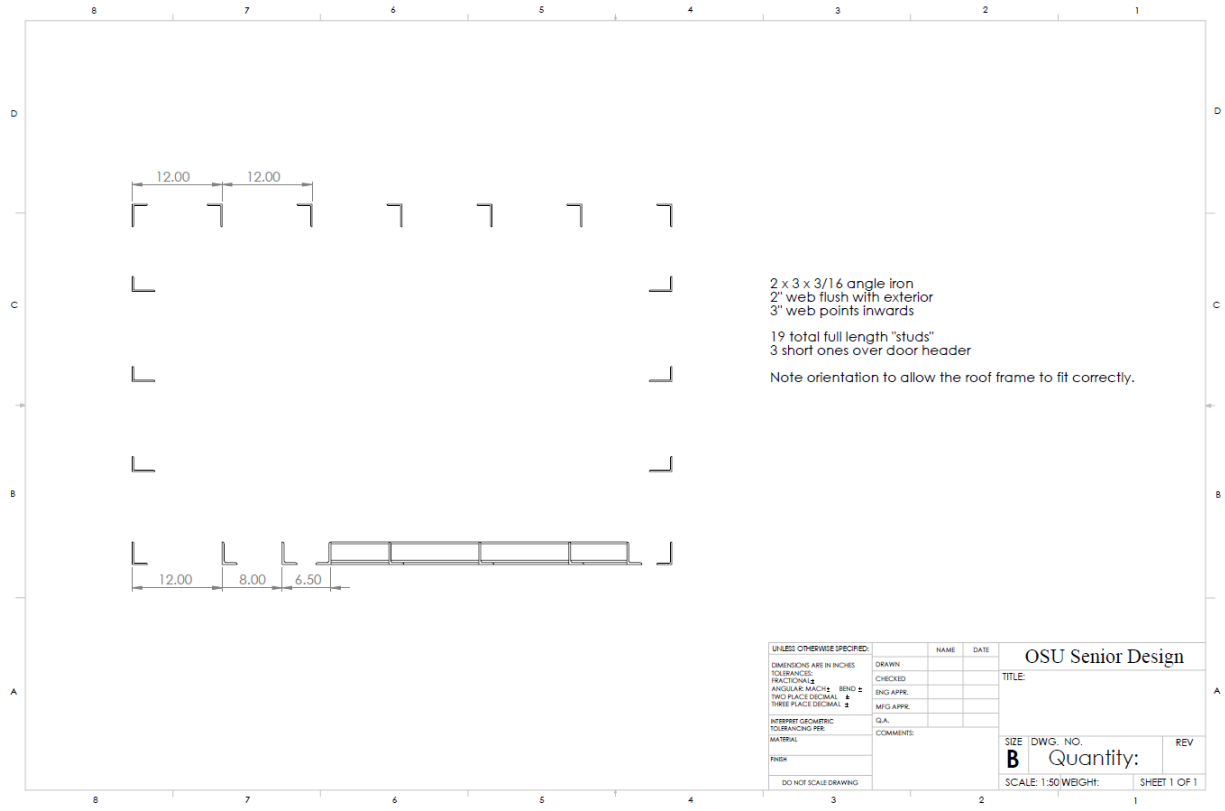
SIZE A | DWG. NO. BOM | REV

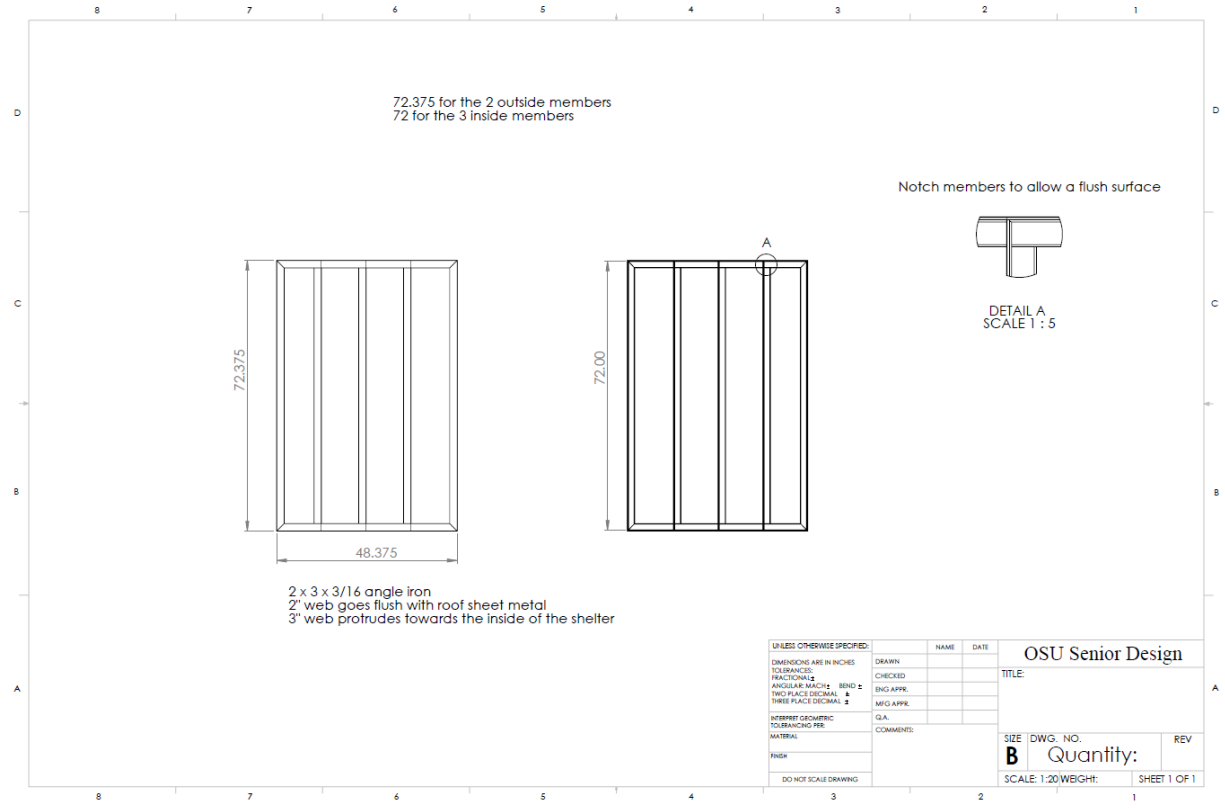
SCALE: 1:32 | WEIGHT: | SHEET 1 OF 1

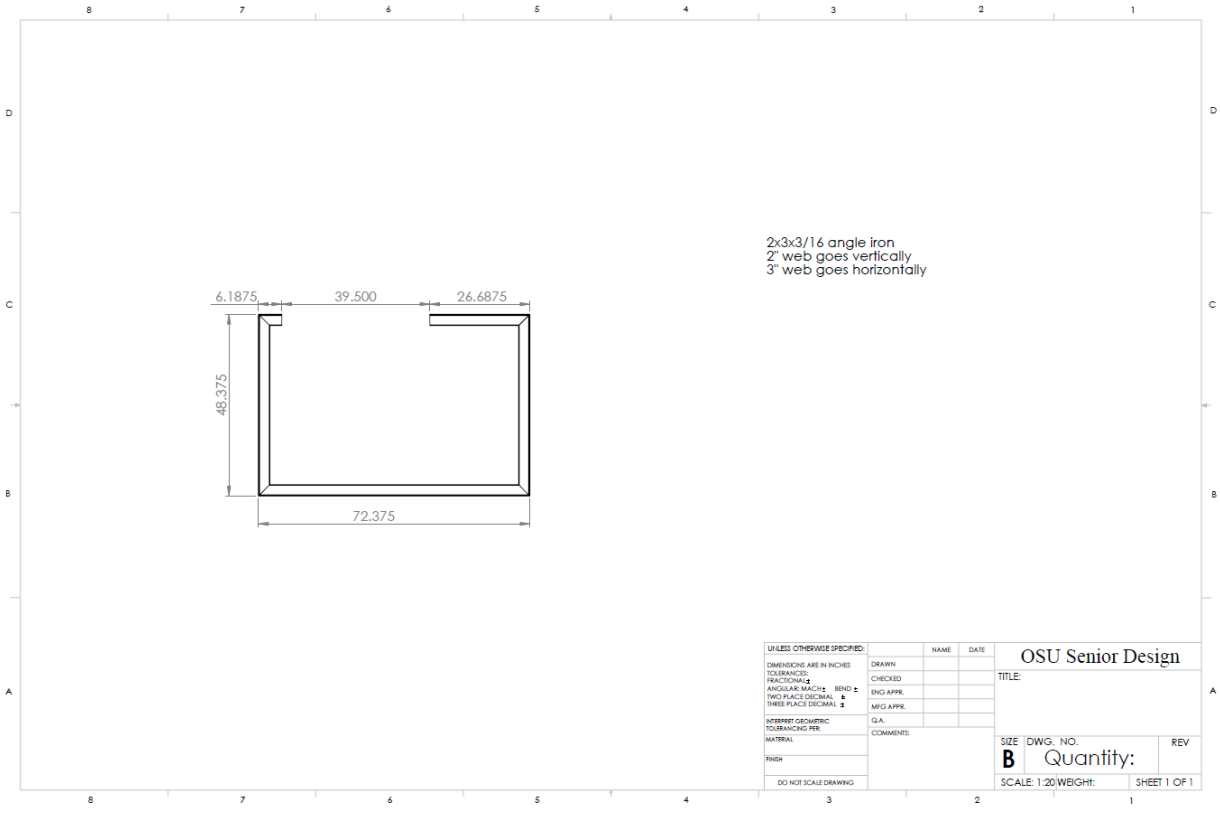
5 4 3 2 1

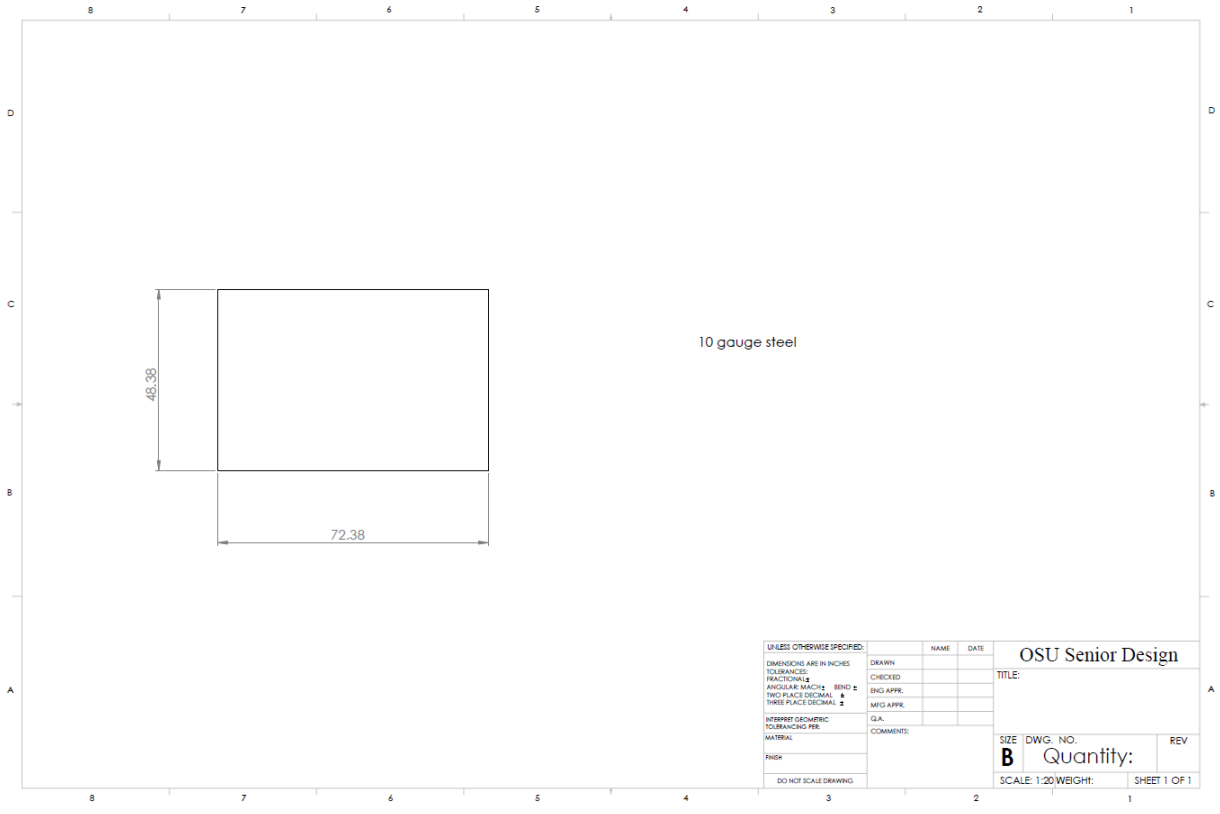

outside view
inside view
12.00
19.75
7.75
95.00
81.7500
39.500
A
Notch angle iron above header to allow everything to fit flush with exterior skin.
DETAIL A
SCALE 1 : 5
2 x 3 x 3/16 angle iron
2" web flush with exterior skin
3" web points inwards
80 1/16 to bottom of angle iron,
80 1/4 to bottom of shelter frame
Actual opening of 36 5/8 x 80 1/4.
OSU Senior Design
TITLE:
SIZE B
DWG. NO.
REV
Quantity:
SCALE: 1:20 WEIGHT:
SHEET 1 OF 1


72.00
90.375
79.938
26.500
39.500
6.00
10 gauge steel
OSU Senior Design
TITLE:
SIZE B
DWG. NO.
REV
Quantity:
SCALE: 1:20 WEIGHT:
SHEET 1 OF 1


12.00
12.00
12.00
8.00
6.50
2 x 3 x 3/16 angle iron
2" web flush with exterior
3" web points inwards
19 total full length "studs"
3 short ones over door header
Note orientation to allow the roof frame to fit correctly.
OSU Senior Design
Quantity:


72.375 for the 2 outside members
72 for the 3 inside members
Notch members to allow a flush surface
DETAIL A
SCALE 1 : 5
72.375
72.00
48.375
2 x 3 x 3/16 angle iron
2" web goes flush with roof sheet metal
3" web protrudes towards the inside of the shelter
OSU Senior Design
Quantity:


2x3x3/16 angle iron
2" web goes vertically
3" web goes horizontally
6.1875
39.500
26.6875
48.375
72.375
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
OSU Senior Design
TITLE:
SIZE
B
DWG. NO.
Quantity:
REV
SCALE: 1:20 WEIGHT:
SHEET 1 OF 1


48.38
72.38
10 gauge steel
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
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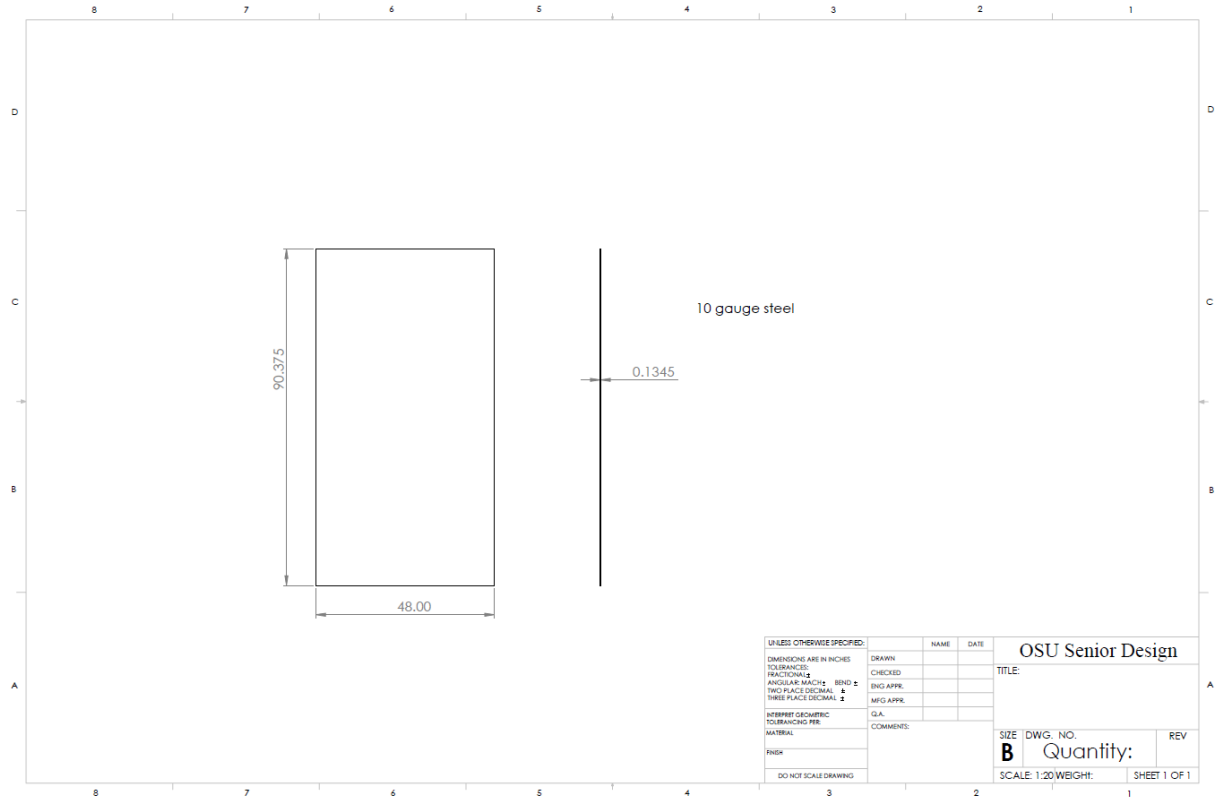
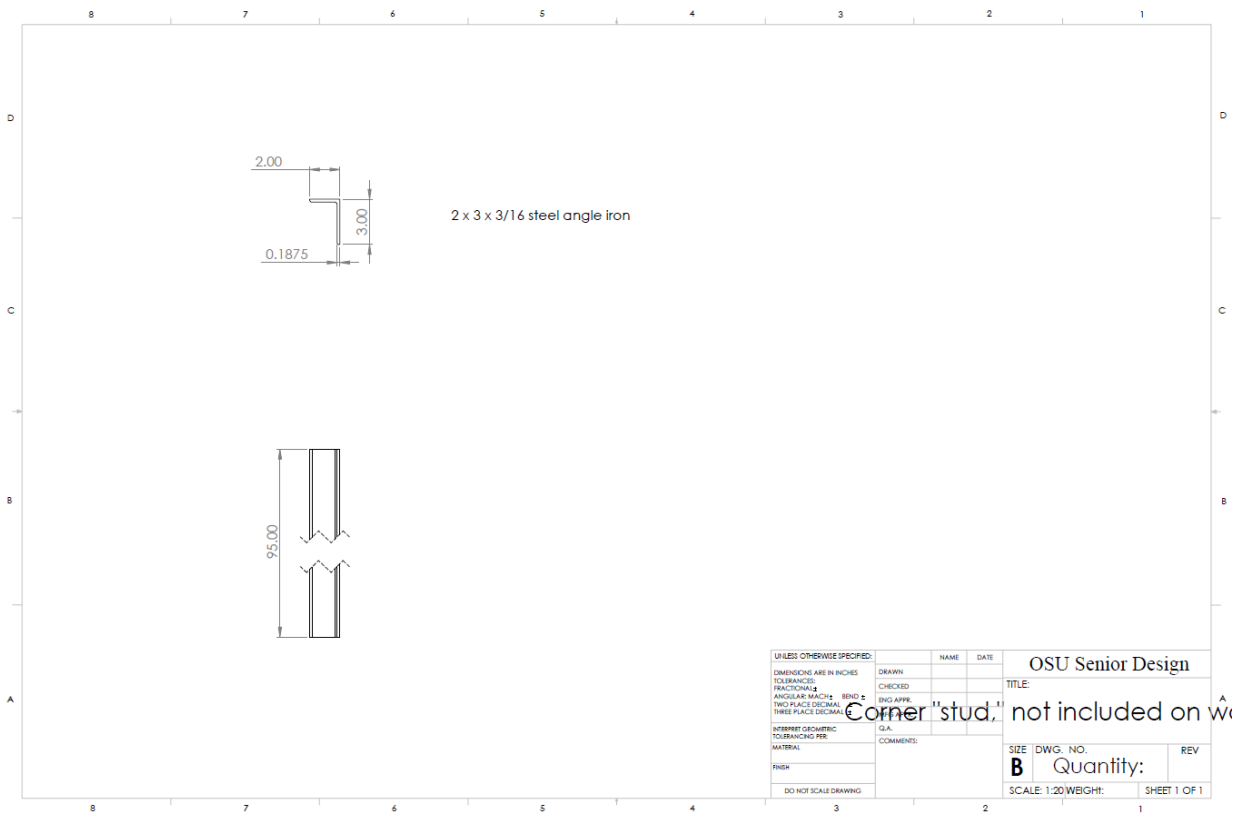
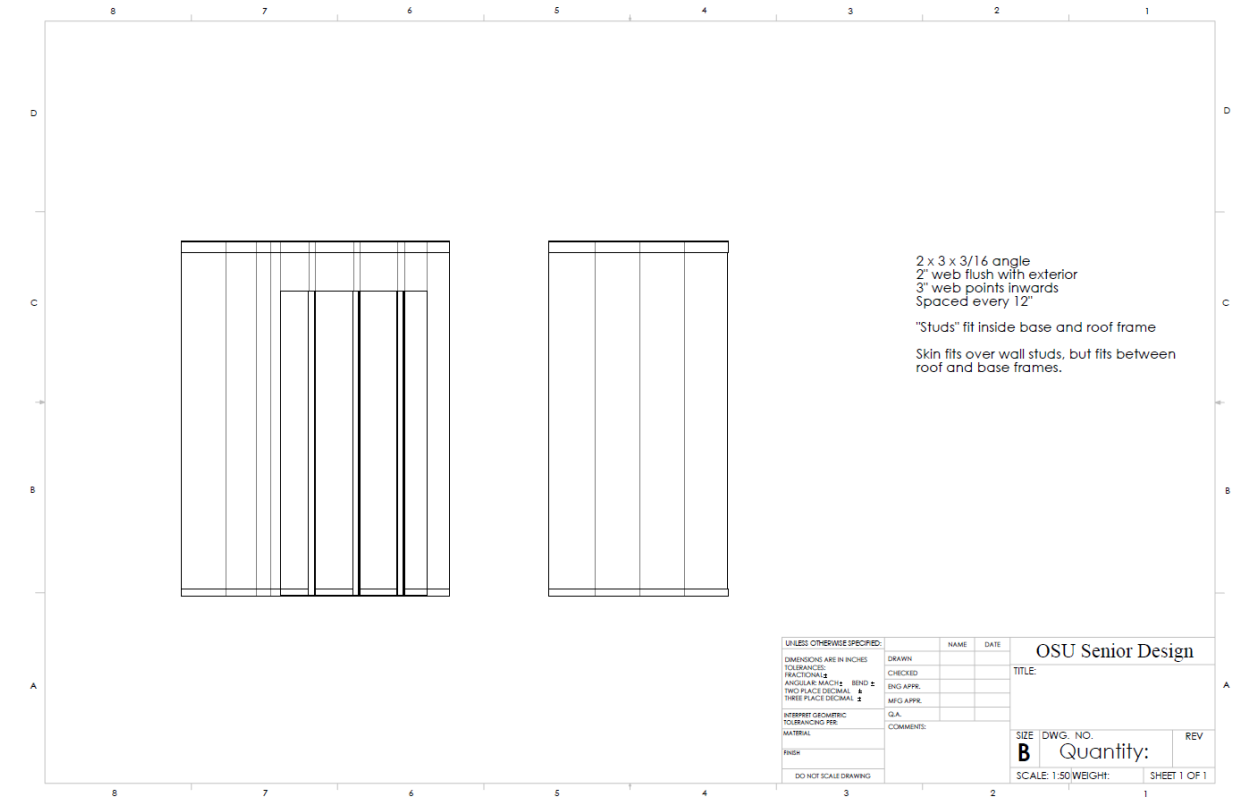
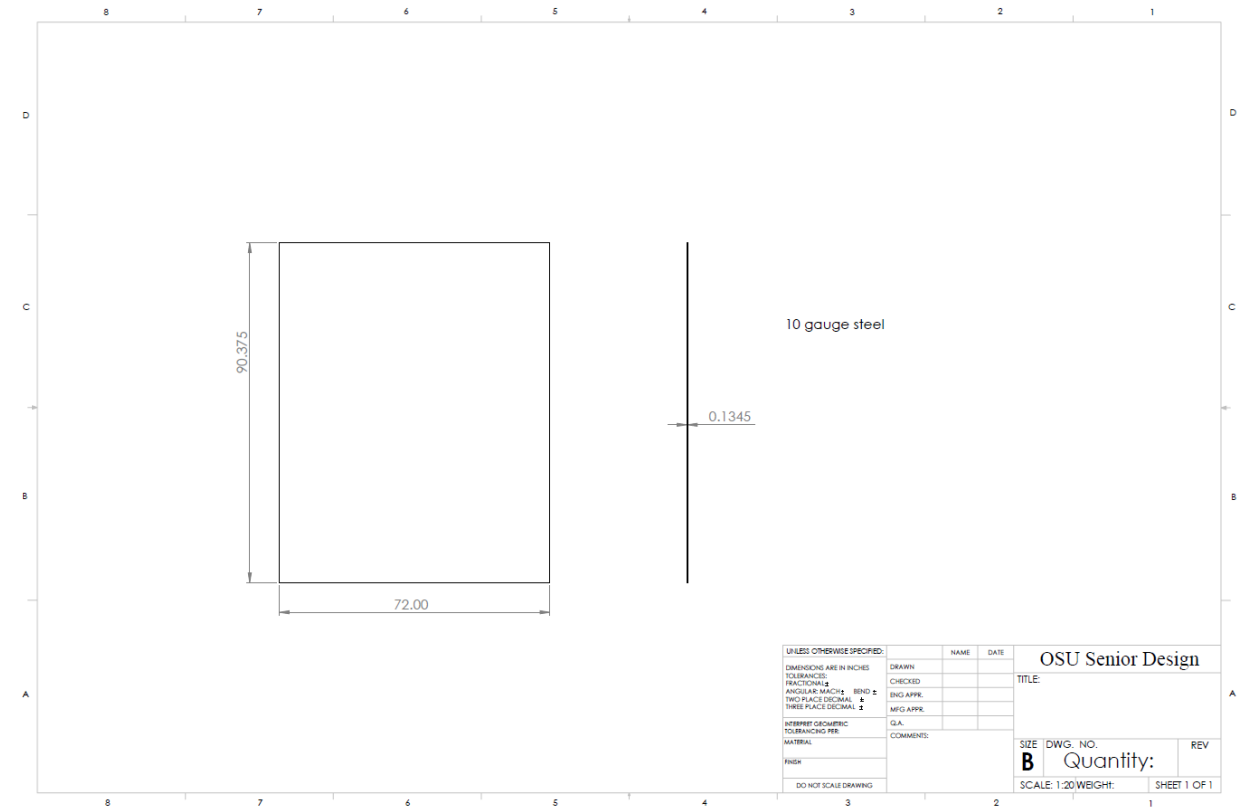
TITLE:
SIZE
B
DWG. NO.
Quantity:
REV
SCALE: 1:20 WEIGHT:
SHEET 1 OF 1


90.375
48.00
0.1345
10 gauge steel
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
OSU Senior Design
TITLE:
SIZE
DWG. NO.
REV
B
Quantity:
SCALE: 1:20 WEIGHT:
SHEET 1 OF 1


2.00
3.00
0.1875
2 x 3 x 3/16 steel angle iron
95.00
Corner "stud," not included on w
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
Q.A.
COMMENTS:
OSU Senior Design
TITLE:
SIZE
DWG. NO.
REV
B
Quantity:
SCALE: 1:20 WEIGHT:
SHEET 1 OF 1

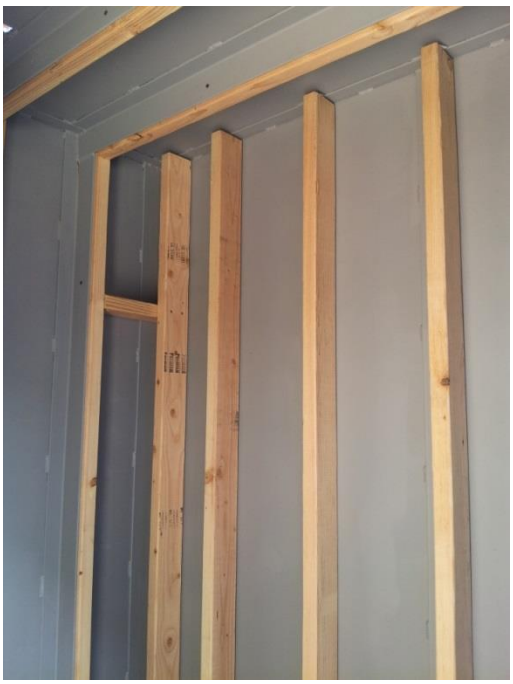

2 x 3 x 3/16 angle
2" web flush with exterior
3" web points inwards
Spaced every 12"
"Studs" fit inside base and roof frame
Skin fits over wall studs, but fits between roof and base frames.
OSU Senior Design
Quantity:
SCALE: 1:50 WEIGHT:
SHEET 1 OF 1

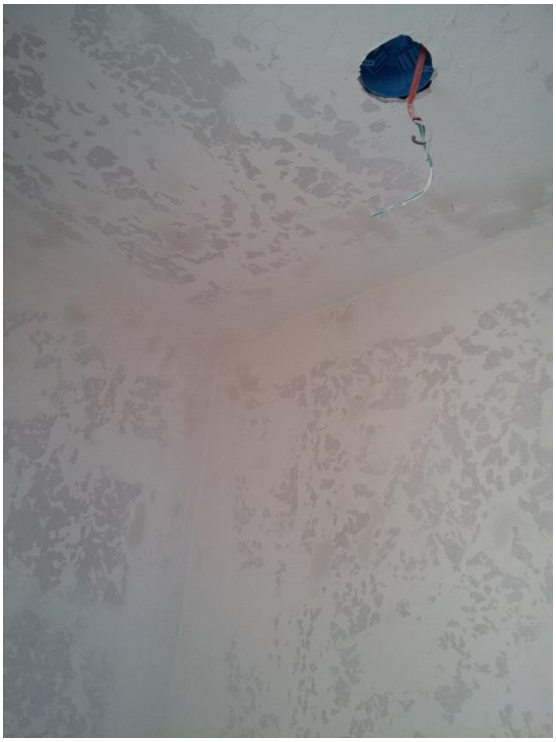

90.375
72.00
0.1345
10 gauge steel
OSU Senior Design
Quantity:
SCALE: 1:20 WEIGHT:
SHEET 1 OF 1

Appendix D


DANGER
DANGER
CAUTION

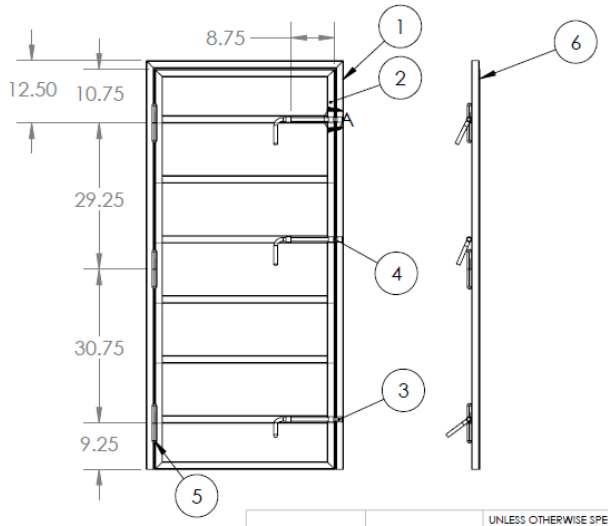
.

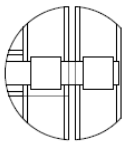




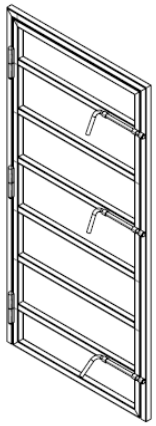
Appendix E

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Door Frame		1
2	Door		1
3	Lock Pipe		9
4	Lock Handle		3
5	1071A38		3
6	Door Skin		1





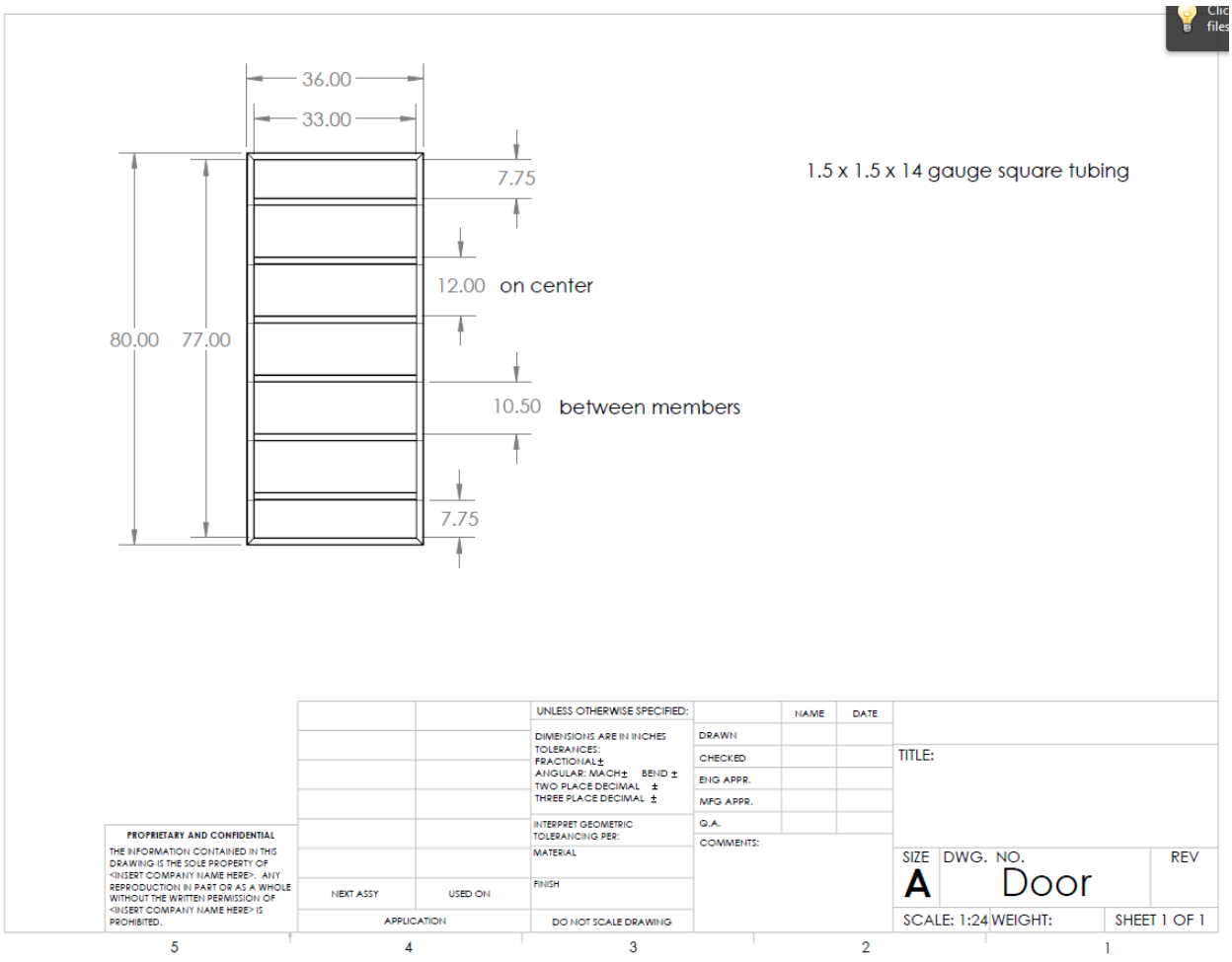
DETAIL A
SCALE 1 : 4

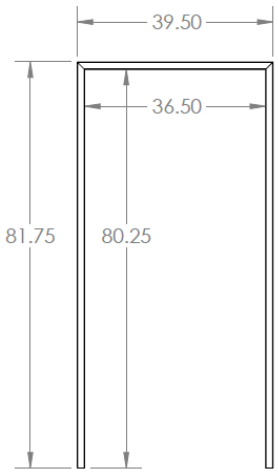


Center pipe on square tube
Weld both sides
1/4" Gap on top and sides of door

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN			TITLE:
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	G.A.			
		MATERIAL	COMMENTS:			SIZE: A — DWG. NO.: Door Assembly — REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:24 — WEIGHT: — SHEET 1 OF 1

5 4 3 2 1


36.00
33.00
7.75
12.00 on center
80.00
77.00
10.50 between members
7.75
1.5 x 1.5 x 14 gauge square tubing
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE
A
DWG. NO.
Door
REV
SCALE: 1:24
WEIGHT:
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
5
4
3
2
1



1.5 x 1.5 x 14 gauge Steel Square Tube

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
		FINISH			
NEXT ASSY	USED ON				
APPLICATION		DO NOT SCALE DRAWING			

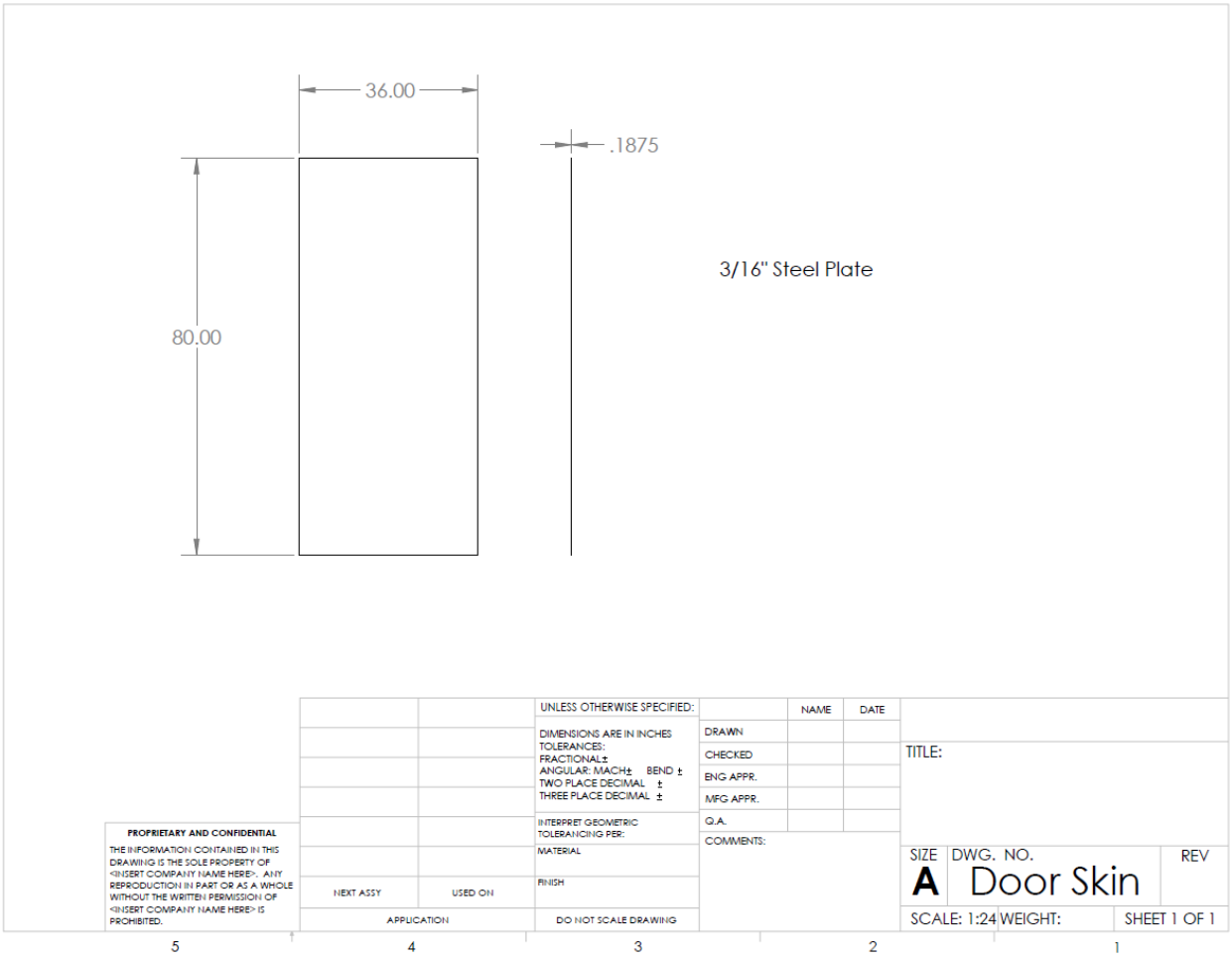
PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

TITLE:

SIZE	DWG. NO.	REV
A	Door Frame	
SCALE: 1:24	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1


36.00
.1875
80.00
3/16" Steel Plate
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE
A
DWG. NO.
Door Skin
REV
SCALE: 1:24
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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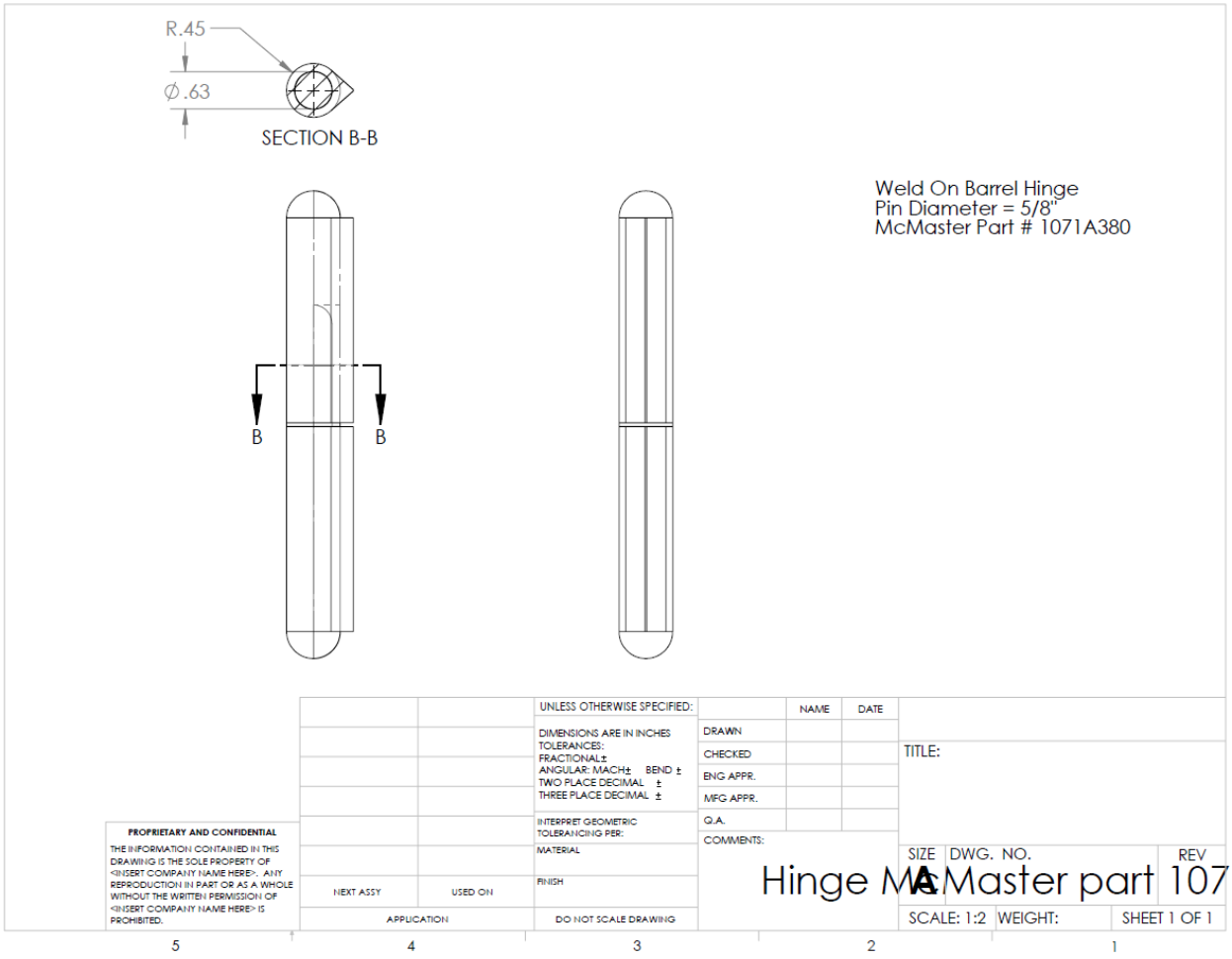
5
4
3
2
1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Weld On Barrel Hinge
Pin Diameter = 5/8"
McMaster Part # 1071A380
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TOLERANCES:
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ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
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THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
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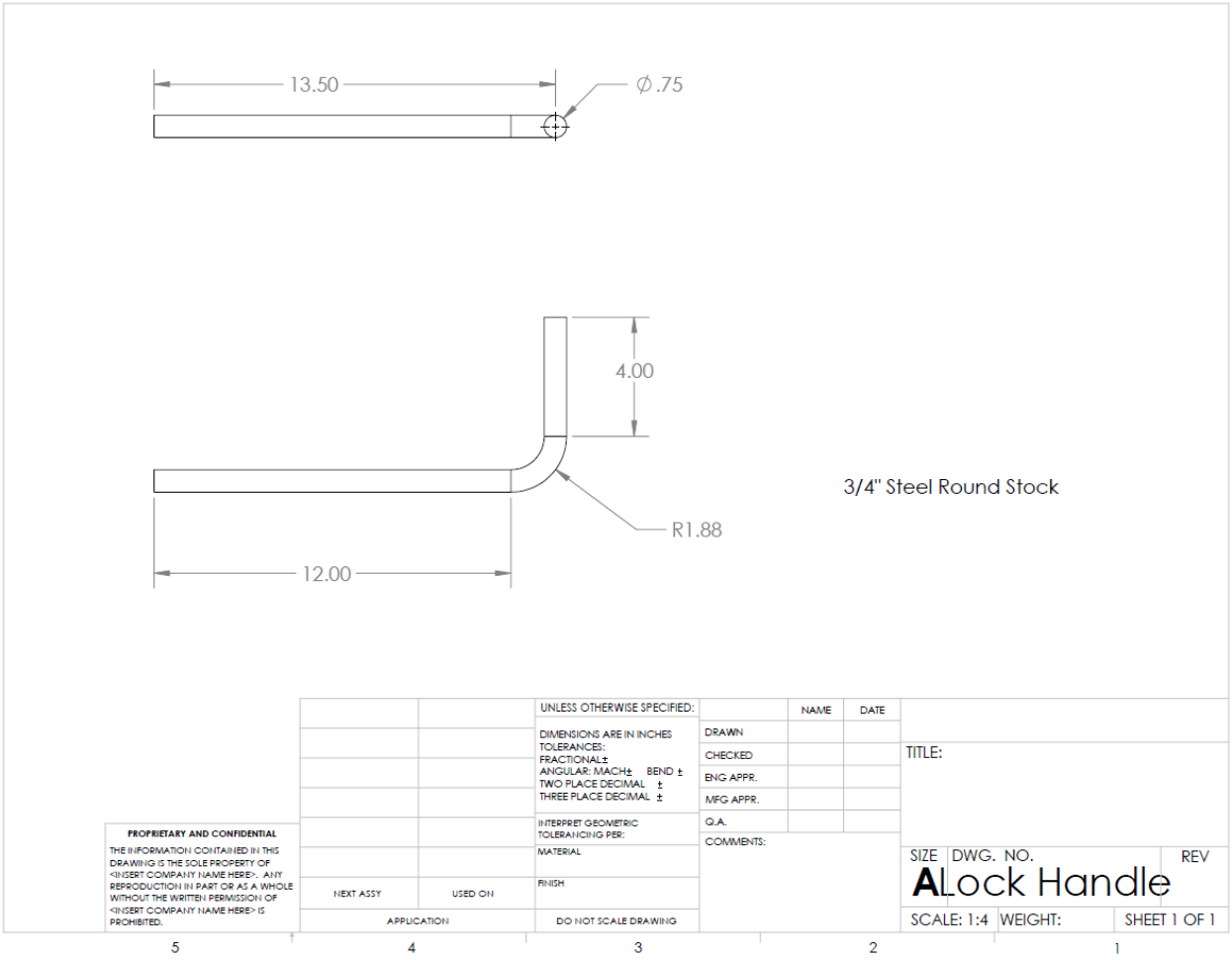
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R1.88
12.00
3/4" Steel Round Stock
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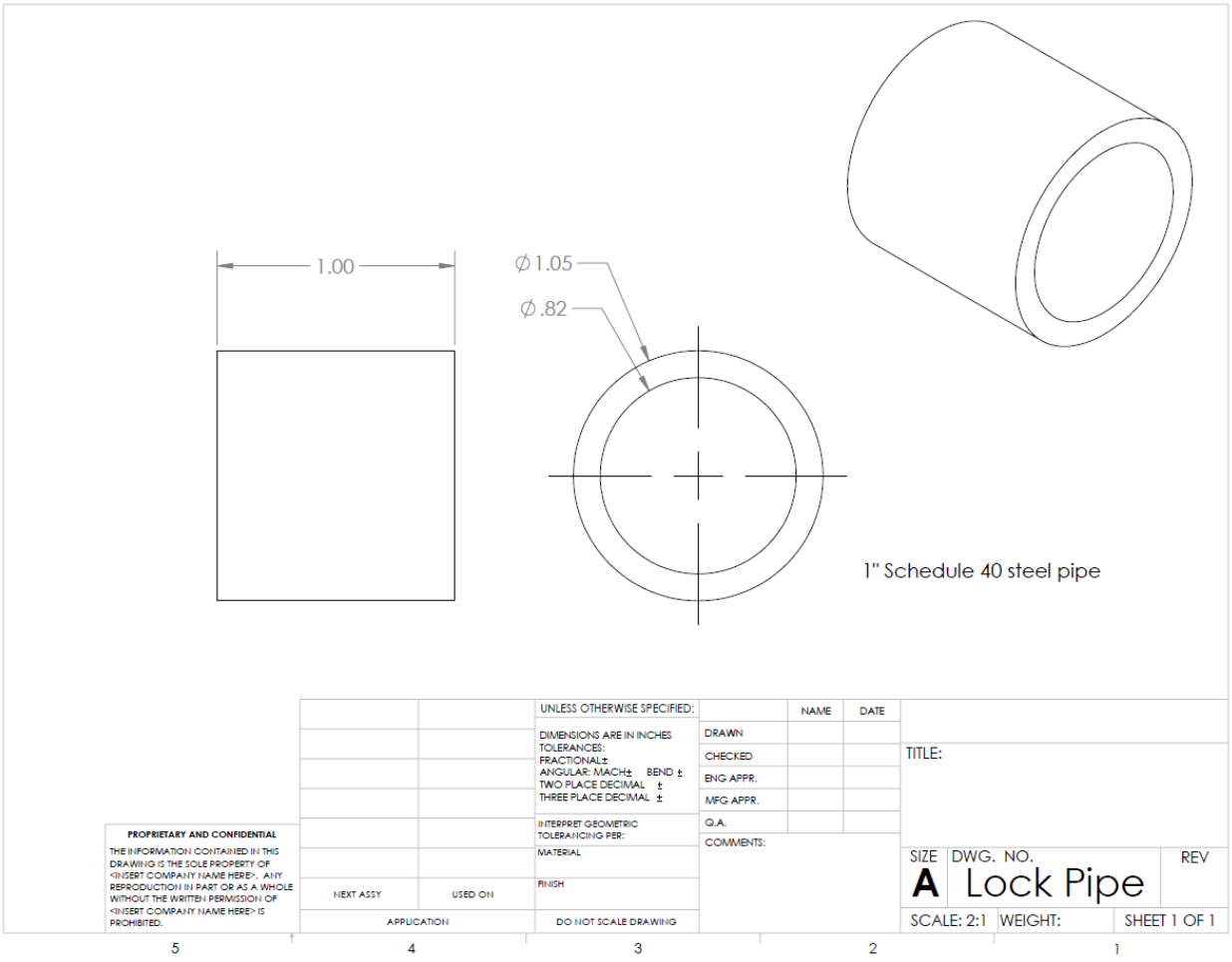


Appendix F

					Projected				
	2008	2009	2010	2011	2012	2013	2014	2015	2016
# of Homes[1]	401,734	405,821	410,553	413,357	417,739	422,485	427,612	433,138	439,079
Δ %		1.02%	1.17%	0.68%	1.06%	1.14%	1.21%	1.29%	1.37%
Median Value ($)[1]	$124,200	$126,600	$128,400	$126,800	$125,532	$124,591	$123,968	$123,658	$123,658
Δ %		1.93%	1.42%	-1.25%	-1.00%	-0.75%	-0.50%	-0.25%	0.00%
Homebuilder Revenue ($)[2]		$935,384,321	$931,638,135	$1,023,353,622	$1,100,105,144	$1,182,613,029	$1,271,309,007	$1,366,657,182	$1,469,156,471
Δ %			-0.40%	9.84%	7.50%	7.50%	7.50%	7.50%	7.50%
# of New Homes		**4,087**	**4,732**	**2,804**	4,382	4,746	5,128	5,526	5,940

1: US Census Data
2: Bizminer Industry Report

Appendix G

Pro-Forma Balance Sheet

A-1 Blasting Storm Shelter Division

ASSETS	2013	2014	2015	2016	2017
Current Assets					
Cash	$7,857	$32,140	$73,116	$139,424	$238,131
Net accounts receivable	$0	$0	$0	$0	$0
Inventory	$0	$0	$0	$0	$0
Total Current Assets	$7,857	$32,140	$73,116	$139,424	$238,131
Fixed Assets					
Long-term investments	$0	$0	$0	$0	$0
Land	$0	$0	$0	$0	$0
Buildings (net of depreciation)	$0	$0	$0	$0	$0
Plant & equipment (net)	$0	$0	$0	$0	$0
Furniture & fixtures (net)	$0	$0	$0	$0	$0
Total Net Fixed Assets	$0	$0	$0	$0	$0
TOTAL ASSETS	$7,857	$32,140	$73,116	$139,424	$238,131
LIABILITIES					
Current Liabilities					
Accounts payable	$0	$0	$0	$0	$0
Short-term notes	$0	$0	$0	$0	$0
Current portion of long-term notes	$0	$0	$0	$0	$0
Accruals & other payables	$0	$0	$0	$0	$0
Total Current Liabilities	$0	$0	$0	$0	$0
SHAREHOLDERS' EQUITY					
Capital stock	$0	$0	$0	$0	$0
SHAREHOLDERS' EQUITY	$7,857	$32,140	$73,116	$139,424	$238,131
Total Shareholders' Equity	$7,857	$32,140	$73,116	$139,424	$238,131
TOTAL LIABILITIES & EQUITY	$7,857	$32,140	$73,116	$139,424	$238,131

Pro-Forma Cash Flow Statement

A-1 Blasting Storm Shelter Division

Cash flows from operating activities	2013	2014	2015	2016	2017
Cash received from customers	$28,470	$77,092	$124,935	$197,474	$289,480
Cash paid for merchandise	(28,257)	(76,514)	(123,999)	(195,995)	(287,310)
Cash paid for wages and other operating exp	(18,260)	(44,819)	(70,135)	(108,486)	(156,715)
Cash paid for interest	0	0	0	0	0
Cash paid for taxes	(3,648)	(11,498)	(19,508)	(31,664)	(47,227)
Other	0	0	0	0	0
Net cash provided (used) by operating activit	($21,695)	($55,739)	($88,706)	($138,670)	($201,773)
Cash flows from financing activities					
Cash received from issuing stock	0	0	0	0	0
Cash received from long-term borrowings	0	0	0	0	0
Cash paid to repurchase stock	0	0	0	0	0
Cash paid to retire long-term debt	0	0	0	0	0
Cash received from accounts receivable	29,552	80,021	129,683	204,979	300,480
Cash paid to accounts payable	0	0	0	0	0
Net cash provided (used) in financing activiti	$29,552	$80,021	$129,683	$204,979	$300,480
Increase (decrease) in cash during the perio	$7,857	$24,282	$40,976	$66,308	$98,707
Cash balance at the beginning of the period		$7,857	$32,140	$73,116	$139,424
Cash balance at the end of the period	$7,857	$32,140	$73,116	$139,424	$238,131

Pro-Forma Income Statement

A-1 Blasting Storm Shelter Division

REVENUE	2013	2014	2015	2016	2017
Net Sales	$56,940	$154,183	$249,870	$394,949	$578,959
COST OF SALES					
Beginning inventory	$0	$0	$0	$0	$0
Plus goods purchased	$28,256.79	$76,513.98	$123,998.78	$195,994.73	$287,310.46
Total Goods Available	$28,257	$76,514	$123,999	$195,995	$287,310
Less ending inventory	0	0	0	0	0
Total Cost of Goods Sold	$28,257	$76,514	$123,999	$195,995	$287,310
Gross Profit (Loss)	$28,683	$77,669	$125,871	$198,954	$291,649
OPERATING EXPENSES					
General/Administrative					
Salaries and wages	$11,412	$30,900	$50,077	$79,153	$116,031
Employee benefits	2,282	6,180	10,015	15,831	23,206
Payroll taxes	913	2,472	4,006	6,332	9,282
Insurance[1]	0	0	0	0	0
Rent[2]	0	0	0	0	0
Utilities	140	380	615	973	1,426
Depreciation & amortiz	53	142	231	365	535
Office supplies	18	47	77	122	178
Postage	26	71	115	182	267
Advertising	569	1,542	2,499	3,949	5,790
Total Operating Expenses	$15,413	$41,735	$67,636	$106,907	$156,715
Net Income Before Taxes	$13,271	$35,934	$58,235	$92,048	$134,933
Taxes on income	4,645	12,577	20,382	32,217	47,227
Net Income After Taxes	$8,626	$23,357	$37,853	$59,831	$87,707
Extraordinary gain or loss	$0	$0	$0	$0	$0
Income tax on extraordinary gain	0	0	0	0	0
NET INCOME (LOSS)	$8,626	$23,357	$37,853	$59,831	$87,707
CUM. INCOME (LOSS)	$8,626	$31,983	$69,836	$129,667	$217,374

1: Business is conducted in A-1 Blasting facility, insurance costs are reflected on A-1 financial Statements

2: Business is conducted in A-1 Blasting facility, location costs are reflected on A-1 financial Statements

SHRC SHELTERS

STACI CUCCIO, FLINT HOLBROOK, KEVIN ROEWE & JARED SWART

Mission

- A-1 Blasting, Inc. of Broken Arrow, Oklahoma
- Develop storm shelter
  - Market analysis
    - Competitive advantages
  - Engineering design
  - Satisfy client & market demands
  - Texas Tech certification

Market Trends

- Highly fragmented industry
- Small private businesses with alternative revenue streams
- $21 million per year, 13 firms reporting
- Moves with housing starts
- Average price same over last 5 years, due to recession and depressed material prices
- Housing starts expected to increase over next 5 years

Competitors

- Direct competitors: Above ground shelters
  - Mostly above ground steel
  - Most tremendously over designed
  - Varying prices and sizes
    - 4.5’ x 2.5’ ⟶ $2900
    - Propane tank ⟶ $3200
    - 6’ x 8’ ⟶ $5000
  - Most marketed as garage drop in
- Indirect competitors

http://www.newdaytornadoshelters.com/Work.php

Concept and Value Proposition

- Meet FEMA P-361
- Multiple sizes
  - 4’ x 6’ x 8’
  - 6’ x 8’ x 8’
- Finished interior
- Seamless integration
- Easy build in
- Target new homes
- Priced less then competitors

Distribution

- Homebuilders as distributors
- Homebuilders pick up shelters from A-1, install and finish
- Homebuilder can include shelter in price of home
- A-1 does not need installation equipment or sales staff
  - Leverage risk reduction

Target Customers

- Homebuilders (Primary)
  - New spec home
  - New custom home
- Homeowners (Secondary)
  - Garage unit

Design Specifications

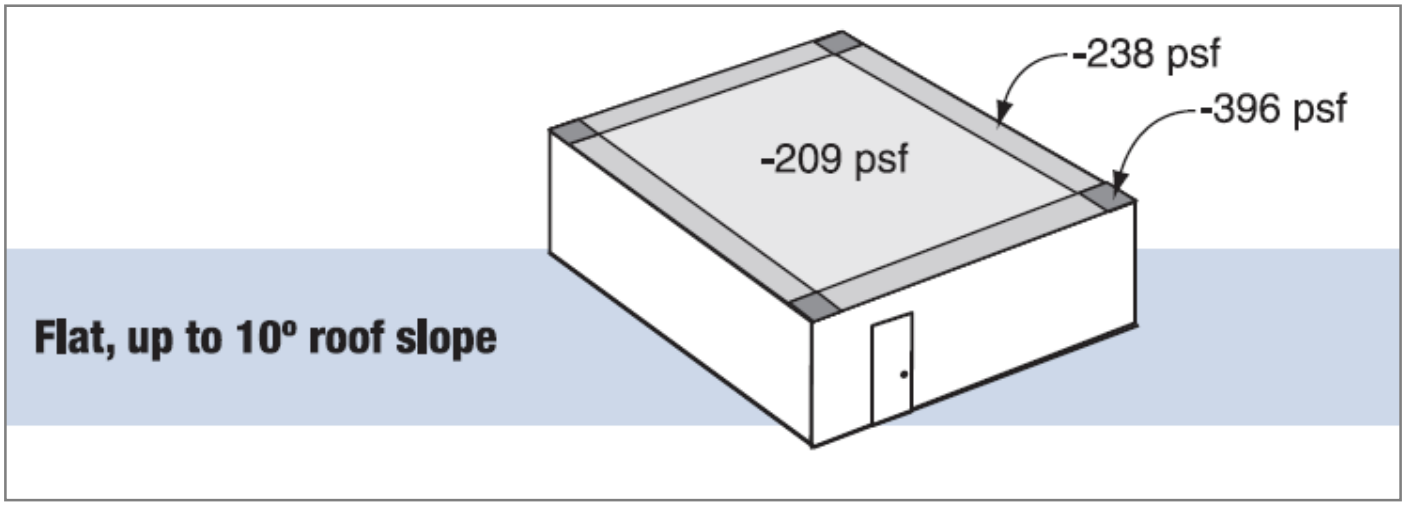
- Designed to meet FEMA P-361
  - Maximum wind gust of 250 mph
  - Maximum impact deflection of 3 inches
- Space: 2 square feet per occupant
- Ventilation: 2 square inches per occupant

Engineering

- Sheet metal deformation
- Angle iron deformation
- Horizontal wind force
- Uplift force

Forces

- Debris Impact = 40,120 lb
- Horizontal Force = 2,560 lb per ft wall width
- Vertical Force = Dependent upon roof size



Sheet Metal Deformation

- Deflection = Force $*$ Max Radius^2 / (16 $*$ π $*$ D)
  - $D = \frac{E*t^3}{12*(1-v)^2} = \frac{30*10^6\ psi*0.1345\ in^3}{12*(1-0.3)^2} = 12414$ in lb
- $\text{Deflection} = \frac{40120\ lb*(6\ in)^2}{16*\pi*12414\ in\ lb} = 2.315$ in

Beam Deformation

- $\text{Deformation} = \text{Force} * \text{Length}^3 / (48 * \text{E} * \text{I})$
- $\text{Deformation} = \frac{40{,}120\ lb * (96\ in)^3}{48 * 30 * 10^6 psi * 0.439 in} = 1.872$ in
- Within allowable deformation limit

Bolt Wind Resistance

- Grade 2 Bolt, Ultimate Tensile Strength = 74ksi
- Shear Strength = 0.60 * Tensile Strength
- Shear Strength = 0.60 * 74 ksi = 44.4 ksi
- Bolt area = Force / Stress
- Bolt area = $\frac{2560\ \text{lb}}{44400\ \text{psi}} = 0.0577\ \frac{\text{in}^2}{\text{ft wall width}}$
- Bolt diameter = $\sqrt{0.0577 * \frac{4}{\pi}} = 0.271$ inches

Bolt Uplift Resistance

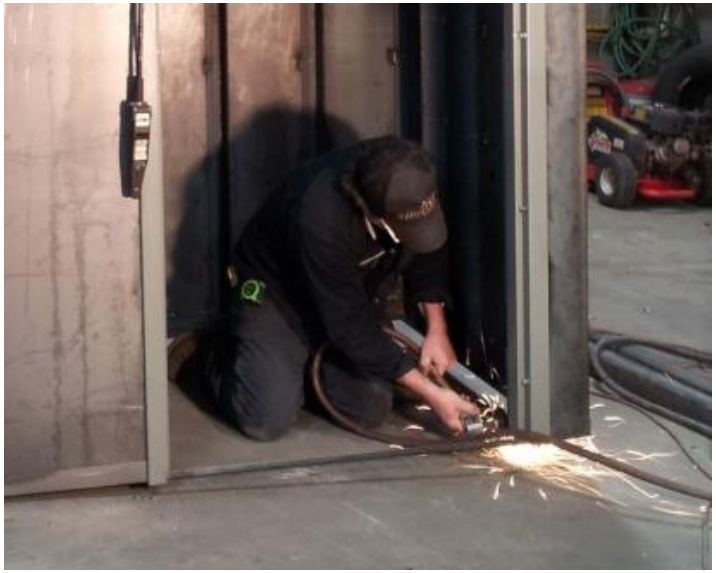
- $Hold\ Down\ Force = Uplift\ Force - Shelter\ Weight = 12056\ lb - 2000\ lb = 10056\ lb$
- $Bolt\ Stress = \frac{Force}{Area} = \frac{Total\ Force}{Total\ Bolt\ Area} = \frac{10056\ lb}{28 * \frac{\pi}{4} * \left(\frac{3}{8} in\right)^2} = 3251\ psi\ in\ tension$
- Approximately 359 lbs per bolt

Final Design

- 2”x3”x3/16” angle iron 12” o.c.
- 10 gauge sheet metal skin
- 3/8” min. anchor bolts 12” o.c. around perimeter
- Steel door

Construction

- General fabrication
- Reorient roof
- Install door and frame
- Add roof vents



Construction

- Primed and painted steel
- Attached wooden studs
- Installed drywall
- Sanded, textured and painted

About the Test

- Air Cannon
  - Projectile
    - 15 lb 2x4
    - 100 mph
- Setup

Impacts

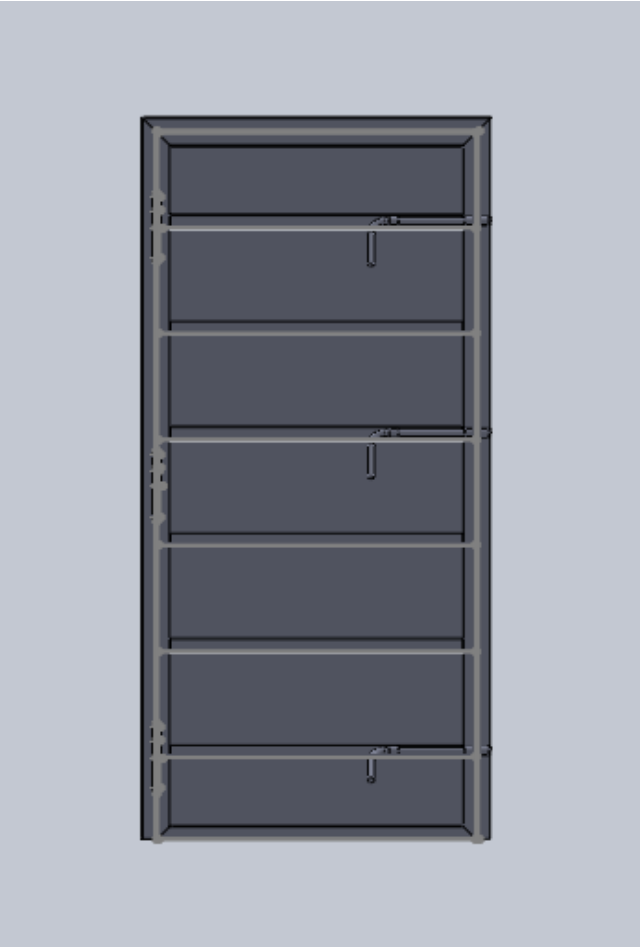
- Three shots to door
  - Deadbolts
  - Hinges
- Three shots to strategic locations on shelter
  - Front wall
  - Side wall

Results

- Shelter passed
  - On a contingency
- Deflection
  - Well within constraints
- Drywall
  - Passed
- Door
  - Design or purchase

New Door

- New design
  - 1.5” square tubing
  - 3/16” steel plate
  - 3 sliding locks made with 5/8”round stock
  - 3 hinges
- Premade steel door
  - Dean



Pricing

	Steel	Steel
	4'x6'	6'x8'
Costs:		
Material	$1,378.98	$1,852.57
Labor	$827.39	$1,111.54
Variable Costs	$2,206.37	$2,964.12
CM at 60%	$1,323.82	$1,778.47
Price	$3,530.19	$4,742.58
Price per foot:	$147.09	$197.61

Marketing Plan

- Marketing Materials
  - Brochures
  - Mailings
  - Video
- Relationship Building
  - 5 largest homebuilders initially
- Local Tradeshows

Tulsa Volume Projections

	Projected				
	2012	2013	2014	2015	2016
# of New Homes	4,382	4,746	5,128	5,526	5,940
Market Share		0.40%	1%	1.50%	2.20%

Financial Highlights

- $57k in sales and $8k profit in 2013
- 5 year average revenue growth of 186%
- $580k in sales and $87k profit in 2017

Acknowledgements

- Bob Smith & A-1 Blasting, Inc.
- Dr. Weckler
- Wayne Kiner & the BAE shop
- Larry Tanner at Texas Tech University

Questions

SHRC SHELTERS FALL REPORT

STACI CUCCIO

FLINT HOLBROOK

KEVIN ROEWE

JARED SWART

Executive Summary

A-1 Blasting, Inc. of Broken Arrow, Oklahoma, successfully fabricates oil field screens with seven to nine employees depending on demand. They plan to diversify by manufacturing above ground storm shelters designed to meet FEMA P-361 and NSSA standards. A second revenue driver will allow A-1 Blasting, Inc. to more efficiently use staff and capital assets as demand fluctuates for screens.

The storm shelter industry in the Tulsa area is highly fragmented. Almost all direct competitors have drastically overdesigned shelters and are using more steel then necessary to protect occupants from wind and projectiles in accordance with FEMA standards. A-1 Blasting, Inc. will easily gain a price advantage on these competitors due to a more efficient design that minimizes material and labor while providing as much or more protection than competitors.

A-1 Blasting, Inc. will differentiate from competitors by framing the interior of each shelter to resemble standard residential framing allowing the customer to finish the interior of the shelter to his or her tastes with sheetrock, plumbing, electrical, and insulation. Therefore, SHRC Shelters can be integrated seamlessly and serve as a functional room in a newly constructed home. The firm will offer three standard-sized shelters but can provide custom sizes, as the wall structure is standard across all models.

A-1 Blasting, Inc. will use homebuilders who operate in the Tulsa area as distributors to reduce operating risk associated with leverage. Homebuilders can incorporate SHRC Shelters into stock homes or sell them to clients building custom homes. Distributors allow A-1 Blasting, Inc. to minimize fixed costs associated with sales, installation and marketing, which decreases the number of units A-1 Blasting, Inc. must sell to break even. Using homebuilders as distributors also creates a competitive advantage by allowing customers the option to purchase an A-1 Blasting, Inc. shelter before they even purchase a home, instead of only marketing as a garage-mounted unit.

Homebuilders in the Tulsa area are expected to build about 4,800 homes in 2013, and the number of new homes is projected to have an average annual growth rate of about 7.0% over the next five years. A-1 Blasting, Inc. will likely acquire a 0.25% - 0.5% market share during the first year of operation and 1.5% - 3.0% during the third year of operation. Revenues in 2013 are projected at about $57,000 with an average annual growth rate of 186% over the first five years of operation.

The SHRC Shelters division of A-1 Blasting, Inc. is expected to generate earnings of about $88,000 in 2017. The metal fabricators industry average price to earnings (P/E) ratio is 23.9. Therefore, it is estimated that the A-1 Shelters division will have a valuation in 2017 of about $2 million.

Contents

Mission Statement

The mission of SHRC Shelters is to create safe, economical shelter designs with outstanding features to satisfy clients and market demands.

Problem Statement

A-1 Blasting, Inc. of Broken Arrow, Oklahoma, desires to expand manufacturing operations by adding an above ground storm shelters to their production. A market analysis must be conducted to determine what the market will accept in new products and what competitive edges can be attained. From the analyzed data, a market acceptable engineering design must be completed and the costs and sales must be projected.

Statement of Work

SHRC Shelters will perform market analysis to determine possible competitive advantages for a new storm shelter that A-1 Blasting, Inc. can produce. After the determination of the market concept engineering design, the storm shelter will be drawn and production costs will be analyzed. The storm shelter will be designed to protect occupants from damaging winds, hail, and flying debris. The storm shelter will have potential to function as a closet, pantry or garage storage unit.

The following are the tasks to be performed:

- Research Patents
- Research Testing/Certification
- Market Analysis
- Design Basic Shelter
- Consider and Design Multiple Usages for Shelter
- Determine Construction Materials
- Perform Detailed Engineering Analysis of Forces
- Draw Detailed Design in SolidWorks
- Estimate Costs

- Write Fall Report
- Present Design Concepts for Fall Presentation
- Build Prototype Chosen by A-1 Blasting, Inc.
- Test Prototype
- Market Concept
- Write Final Spring Report
- Present Final Design for Spring Presentation

Period and Location of Performance:

The work will be performed at the Oklahoma State University campus and/or A-1 Blasting, Inc. The market concept and engineering design will be completed by the end of the fall semester. SHRC Shelters will construct and test a prototype by the end of the spring semester.

Acceptance Criteria and Applicable Standards:

The acceptance criteria consist of economic feasibility of the storm shelter and compliance to applicable standards. The National Storm Shelter Association (NSSA) dictates requirements necessary for storm shelter design. FEMA P-361 also controls the design and concept of a concrete and steel storm shelter. Texas Tech University has provided testing parameters which will guide SHRC Shelters in the testing and certification processes.

Deliverables Schedule:

A-1 Blasting, Inc. will receive a marketable concept and engineering designs at the end of the fall semester 2012. By the end of spring semester, SHRC Shelters expects to have a tested a prototype for A-1 Blasting, Inc.

Work Breakdown Structure

1) Storm Shelter
    a) Research
        i) Investigate testing/certification
            (1) Look into NSSA approved designs
            (2) Research 3rd party approval
    b) Design Shelter
        i) Brainstorm initial size and designs
        ii) Determine construction materials
        iii) Perform detailed engineering analysis of forces and projectile impacts
        iv) Draw detailed 3D model in SolidWorks
            (1) Draw model
            (2) Draw construction drawings
                (a) Write instructions on construction and installation
        v) Estimate prototype costs from models
    c) Fall Presentations
        i) Establish pertinent talking points
        ii) Gather information from research and project
        iii) Assemble PowerPoint presentation
        iv) Practice presentation
            (1) Rehearse slides and parts
            (2) Anticipate and plan responses for possible audience questions
        v) Give presentation on December 4, 2012, at 10:00am
    d) Build Prototype
        i) Contact BAE Lab or A-1 Blasting, Inc. for construction location and timeline
        ii) Get construction schedule/timeline
        iii) Build structure
    e) Test Prototype
        i) Schedule time at Texas Tech Wind Research

(1) Pending approval from Dr. Weckler and A-1 Blasting, Inc.

f) Market Shelter
   i) Use cost estimate from design phase as well as actual prototype cost to estimate
   ii) Contact Ag Econ group for further analysis

g) Spring Presentation
   i) Establish presentation content
   ii) Gather information from research and project
   iii) Assemble PowerPoint presentation
   iv) Practice presentation
   v) Give final presentation

Market

Market and Trends

Storm shelter manufacturing and sales is a highly fragmented industry. Most firms operating in the industry are small private businesses that often have revenue streams in addition to storm shelter manufacturing, which causes a lack of dependable data regarding operations. The market is estimated at about $21 million based on thirteen firms reporting sales data[1]. Most firms have between one and four employees and hold on average a 7.7% market share[2].

Over the last five years the average price of storm shelters has remained the same due to a lack of demand in construction and decreasing material costs. Most residential shelter manufacturers relied on a high-volume low-margin strategy during the housing and construction boom of 2007-2008, but volume decreased significantly during the recession of 2008-2011. The drop in volume paired with depressed input costs allowed the price of most shelters to stay relatively constant.

[2] Bizminer, 2012.*Micro Market Industry Report: Tulsa County*. June 2012. Available at: http://reports.bizminer.com/temp/pdf/683413148_1127174125.pdf. Accessed 11 November 2012.

Mid and Southwestern housing statistics in late 2011 and 2012 indicate that the economy in these regions is improving. As the economy gains steam, the price of inputs will rise, and demand will slowly pick up. Due to tax and operating uncertainty, manufacturers will likely maintain margin causing an increase in price.

Competitors

The direct competitors for A-1 Blasting, Inc. in the Tulsa area include Tornado Alley Armor, New Day Tornado Shelters, OKStormShelters, and Ground Zero Storm Shelters.

Tornado Alley Armor provides above ground storm shelters that are constructed of pre-manufactured steel panels and approved by NSSA. The panels are of standard sizes thus allowing the user to expand the size of the shelter by adding panels. Tornado Alley Armor sells complete shelters starting at $2900 for a 30” x 56” x 80” shelter, shown in Figure 1. The shelters can be customized to add more impact resistance, a stronger door, a panic room lock, lighting or customer-defined colors for additional cost.

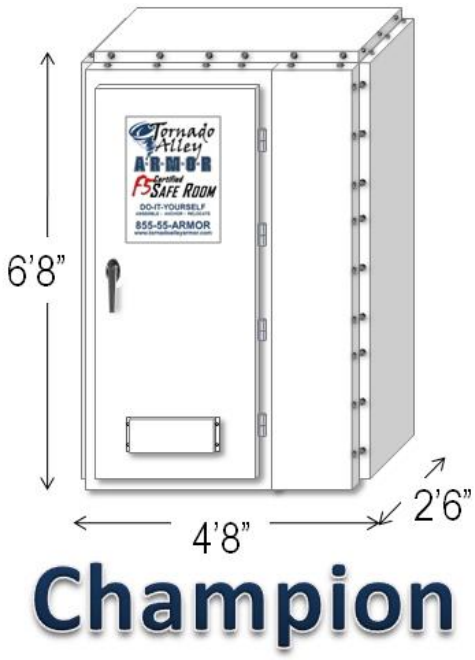


Figure 1. Tornado Alley Storm Shelter.

http://www.tornadoalleyarmor.com/models

New Day Tornado Shelters offers an ultra-small shelter for one to two people that is NSSA certified. The shelter is constructed from a reused propane tank turned on its end with an attractive paint job and an outward opening door. The unit retails for $3200 including installation, shown in Figure 2.

Figure 2. New Day storm shelter.

http://www.newdaytornadoshelters.com/Work.php

OKStormShelters offers steel safe rooms sized between 4’ x 4’ for two to four people to 6’ x 8’ for 10-12 people, these shelters are not NSSA certified. A 3’ x 5’ shelter is shown in Figure 3. OKStormShelters pricing ranges from $3200 to $5000 and all prices include installation. The shelter is constructed with 3/16” steel walls with a 2”x2”x1/4” steel tube frame; this design greatly exceeds recommended wall section designs outlined in FEMA P361.

Figure 3. OKStormShelter 3' x 5' safe room.

http://okstormshelters.com/latest-work/3-x-5-safe-room-installation-in-skiatook/

Ground Zero Storm Shelters offers custom designed shelter sizes. All Ground Zero shelters are constructed from ¼” steel plate, with no sub frame, and are then anchored to concrete with Hilti 10k-lb bolts. These shelters are not NSSA approved; however a shelter that survived a tornado is shown in Figure 4.

Figure 4. Ground Zero Shelter.

http://www.groundzeroshelters.com/saferooms.html

Indirect competitors include various precast companies and local construction contractors who install underground storm shelters. These shelters vary wildly in price but are typically more expensive than above ground shelters due to excavation costs. Underground shelters do however offer additional protection from dangerous weather since they use the earth as layer of impact protection.

Concept, Value Proposition, Differentiation

A-1 Blasting, Inc. will provide concrete or steel above ground storm shelters that exceed FEMA P-361 standards designed for installation as a functional room in a newly constructed home. Shelters will be offered in several standard sizes, which include a 3'x4', a 5'x6', and a 6'x8'. The wall sections and door assembly are standard across all models allowing A-1 Blasting, Inc. to construct shelters of any size on order. The shelters will have a total height not to exceed 8' so that no roof truss modification is necessary in a new home. Standard 2"x4" lumber will be installed in the shelter to allow the installing contractor to include electrical junction boxes or

plumbing and then finish the walls and ceiling to match the rest of the house. SHRC Shelters can be installed by simply bolting the shelter to a concrete slab or to concrete piers.

By providing storm shelters that integrate seamlessly into newly constructed homes as a functional room, A-1 Blasting, Inc. can focus marketing efforts on homebuilders. There are currently no known competitors that specifically target new construction while offering seamless product integration into the home and the daily lives of occupants.

Not only will A-1 Blasting, Inc. offer a product that integrates seamlessly into a home and does not occupy valuable garage space, but each shelter will be sold to or through building contractors. This allows the A-1 Blasting, Inc. to eliminate the fixed costs associated with installation equipment. Most building contractors already own the necessary equipment for storm shelter installation. A-1 Blasting, Inc.'s shelters will be priced well below competitors' averages, representing a significant value to customers in addition to allowing a contractor a generous markup.

Pricing

A-1 Blasting, Inc.'s pricing model is displayed in Table 1 below.

Table 1. Pricing model.

	Concrete	**Steel**	**Concrete**	**Steel**	**Concrete**	**Steel**
	3'x4'	3'x4'	4'x6'	4'x6'	6'x8'	6'x8'
Costs:						
Material	$1,188.50	$1,553.26	$1,312.22	$1,864.61	$1,477.00	$2,277.48
Labor	$713.10	$192.70	$787.33	$287.58	$886.20	$454.82
Variable Costs	$1,901.60	$1,745.96	$2,099.55	$2,152.19	$2,363.20	$2,732.30
CM at 50%	$950.80	$872.98	$1,049.78	$1,076.10	$1,181.60	$1,366.15
Price	$2,852.40	$2,618.94	$3,149.33	$3,228.29	$3,544.80	$4,098.45
Price per foot:	$237.70	$218.25	$131.22	$134.51	$73.85	$85.38

1- Interstate Steel & Metals, Inc. Tulsa, OK 74110

2- Cherokee Concrete Coweta, OK, 74429

Distribution and Target Customers

Since A-1 Blasting, Inc. does not have a large and devoted sales staff, so the firm will use building contractors as distributors. As of 2011 fourth quarter there were 301 homebuilding firms in Tulsa, with total sales of $1.02 billion[3]. Homebuilder's revenue in the Tulsa area is expected to increase at an average rate of 7.5% over the next three years[4], which means that new home construction is increasing. A-1 Blasting, Inc. will initially build relationships with the five largest homebuilders in the Tulsa area to ensure rapid acceptance of the new storm shelters without extensive marketing overhead. These homebuilders will then either use A-1 Blasting, Inc.'s shelters in their stock homes or will sell the shelters to customers building custom homes.

All of A-1 Blasting, Inc.'s direct competitors are manufacturers, retailers, and installers; therefore, they require significant fixed costs in equipment and marketing. By using homebuilders as distributors, A-1 Blasting, Inc. is able reduce marketing costs which substantially reduces operational risks by minimizing fixed costs. It is necessary for A-1 Blasting, Inc. to price its shelters below its competitors so that distributing SHRC Shelters is attractive to homebuilders.

A major factor in the homebuilder's decision to distribute A-1's shelters may be A-1'a ability to finance the shelters for a short term. Often homebuilders build homes on short term credit and then either sell or refinance to a longer term credit instrument. A-1 will offer net 60, 90, or 120 day financing on shelters it sells through a homebuilder at a nominal 1.9% monthly interest rate (25.3% annual APR).

By distributing through homebuilders, A-1 Blasting, Inc. holds a sales advantage over its competitors who market shelters to homeowners as garage additions. A-1 Blasting, Inc. instead will reach homeowners through the homebuilders before homes are ever constructed.

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[3] Bizminer, 2012.*Micro Market Industry Report: Tulsa County*. June 2012. Available at: http://reports.bizminer.com/temp/pdf/683413148_1127174125.pdf. Accessed 11 November 2012.

[4] *Ibis residential construction report*. (11, November 12). Retrieved from ibisworld.com

Volume and Market Share

Since A-1 Blasting, Inc. will primarily sell storm shelters for new construction, it is acceptable to estimate market ceiling as the total new homes per year in Tulsa. According to census estimates and homebuilder activity, an estimated 4,800 new homes will be constructed in 2013, and about 6,000 will be constructed in 2016 (Appendix A).

A-1 Blasting, Inc. can expect a market share of about 0.25% – 0.5% during the first year of operation as production challenges are met and relationships are built distributors. During years two and three, A-1 Blasting, Inc. can expect to increase market share to 1.5% - 3% once the product is accepted.

Marketing Plan

A-1 Blasting, Inc. will create marketing materials that will be provided to distributors and customers. These items will include a series of brochures on the advantages of the SHRC Shelter, a video showing the installation and the final product, as well as a design guide. Building and maintaining relationships with local homebuilders will be critical for A-1 Blasting, Inc. By establishing a presence at local home trade shows and regional residential construction trade shows, the firm will build brand recognition with potential buyers and homebuilders. A-1 Blasting, Inc. will participate in direct mail marketing to potential customers by obtaining building permit records of new houses that will soon be under construction and sending solicitations.

Financial Analysis and Valuation

A-1 Blasting, Inc. is expected to generate sales of about $57,000 and earnings of $6,700 from storm shelter manufacturing in the first year. Sales are expected to increase at an average of 186% annually over the first five years, with sales in 2017 expected to be about $580,000 as shown in Appendix B. The financial projections in Appendix E make several conservative assumptions such as disregarding economies of scale, price inflation, and competitive environment changes.

In 2017 A-1 Blasting is expected to be valued at about $2.1 million assuming a P/E ratio 23.9[5] which is the industry average ratio for metal fabricators in 2012q4.

Risks and Assumptions

The financial and sales volume projections are based on a series of assumptions including new home construction, median home price, homebuilder activity, marketing effectiveness and production efficiency. All assumptions are based partially or entirely on industry or census data, but as the operating environment and market changes over the next five years assumptions could be proven incorrect. All critical assumptions are listed in Table 2.

Table 2. Critical Assumptions for A-1 Blasting, Inc.

Assumptions	Description	Impacts
Competition Analysis	Used to make price and quality comparisons to determine competitive edges. Data based on competitors websites and price schedules.	Differentiation Plan
Costs Analysis	Used to project sales and assess competition. Based on prices provided by Tulsa material retailers and industry labor data.	Pricing/Contribution Margin
Tulsa Housing Market Growth	Used in sales volume projections. Is based on homebuilder activity data from an industry reporting agency, median home price from census data, and the number of homes in the area according to census data.	Market Demand

[5] *Yahoo Industry Financial Ratios*. (27, November 12). Retrieved from http://biz.yahoo.com/p/industries.html

Marketing Plan/Effectiveness	Used to determine marketing budget and market share. Based on industry trends, competitors' positioning, and buying characteristics of decisions makers.	Revenue/Sales, Marketing Budget
Distribution Plan	Used to differentiate from competition, set pricing, determine market volume, and project fixed costs. Based upon product positioning and buying process of customers.	Product Positioning, Competitive Advantage, Pricing
Production Capacity	Assumed to have capacity to produce the number of shelters sold.	Sales, Variable Costs

Risk is inherent in business operations, but A-1 will assess risks regularly and employ risk reduction techniques. Major foreseen risks are outlined below in Table 3. Risks will be present that are unforeseen at the time of planning.

Table 3. Critical Operational Risks for A-1 Blasting, Inc.

Risks	Implication	Mitigation
Inability to obtain distributors	No/Low sales	Hire sales staff or reposition product
Home starts slow	No market for product	Reposition to garage unit and beat competitors on price
Unpredictable demand	Difficult to predict costs/pricing and production time	Sub-contract sub-assemblies, increase inventory
Liquidity	Difficult to cover short term variable costs	Short term financing of variable costs
Marketing not generating sales	Low sales	Increase marketing activity or target more effectively through guerilla tactics
Distributor's Credit	Distributors can't pay off shelters after installation	Insure account payable
Interest Rate	Rate changes affect cost financing and price financing	Price adjustment/rate adjustment

Design Requirements

A tornado is a violently rotating column of air that stretches from the ground up to a cumulonimbus cloud bank. Tornadoes are found on every continent and vary in strength from small dust devils to large destructive multi-vortices. The strength of a tornado is based upon the enhanced Fujita scale, which can be seen in Table 4. The Enhanced Fujita Scale was researched and developed at Texas Tech University. A direct comparison of the old and new scale is found in Appendix C. The estimated wind speeds shown in the scale are based on three-second gusts of wind (FEMA P-361 6.1.1). Appendix D shows the typical damage patterns for differing storm intensities. The most common type of storm that produces tornadoes is called a super cell thunderstorm, which typically travels in a southwest to northeast direction.

Table 4. Enhanced Fujita Scale (FEMA 361).

Enhanced Fujita Scale		
Scale	**Wind Speed**	
	MPH	***Km/H***
EF0	65-85	105-137
EF1	86-110	138-178
EF2	111-135	179-218
EF3	136-165	219-266
EF4	166-200	267-322
EF5	>200	>322

Intense tornados are extremely rare; the probability of a structure being impacted by an EF4-EF5 event in the Midwestern states is 0.00002, which was calculated at a 50,000 MRI (FEMA P-361 6.1.5). Mean Recurrence Interval (MRI) is an estimate of the interval of time between occurrences of an event happening, which is valuable for risk analysis[6]. To calculate the MRI, the following equation is used:

[6] Baer, E. M., 2008. Recurrence Interval. Carleton College. Available at: http://serc.carleton.edu/quantskills/methods/quantlit/RInt.html. Accessed 26 November 2012.

$$MRI = \frac{n}{m}$$

where, *n*=the number of years on record

m=number of recorded occurrences of the event being considered

According to FEMA P-361, storm shelter designs must be used to meet wind loads in extreme events with MRI's up to 20,000-100,000 years (FEMA P-361, 6.2.1). Table 5 shows the frequency of tornadoes in the United States.

Table 5. Tornado frequency and size based on FEMA P-361 in the United States.

Fujita Scale	Number of Tornadoes	Percentage	Cumulative Percentage
F0	20,728	43.68	43.68
F1	16,145	34.03	77.71
F2	7,944	16.74	94.45
F3	2,091	4.41	98.86
F4	491	1.03	99.89
F5	50	0.11	100
Totals	47,449	100	

Residential safe rooms are intended to save lives in the event of dangerous winds; therefore, there are many strict criteria that must be met. According to FEMA P- 361, safe rooms should be designed for wind gusts of up to 250 mph (FEMA P-361, 3.1). The following formula is used to estimate the loading on a wall due to the force of wind:

$$Wind\ pressure\ \left[\frac{lb}{feet^2}\right] = 0.00256 * \left(Wind\ speed\ \left[\frac{miles}{hour}\right]\right)^2$$

Another aspect storm shelter design consideration includes impact forces due to flying debris. The most dangerous characteristic of a tornado is not so much the wind but injury from flying debris. Table 6 shows the characteristics of windborne missiles.

Table 6. Possible airborne debris in a high wind event (FEMA).

Missile Size	Typical Debris	Associated Damage Observed
Small (Light Weight)	Aggregate roof surfacing, pieces of trees, pieces of wood framing members, bricks	Broken doors, windows, and other glazing; some light roof covering damage
Medium (Medium Weight)	Appliances, HVAC units, long wood framing members, steel decking, trash containers, furniture	Considerable damage to walls, roof coverings, and roof structures
Large (Heavy Weight)	Structural columns, beams, joists, roof trusses, large tanks, automobiles, trees	Damage to wall and roof framing members and structural systems

FEMA P-361 states that in order for a shelter to be certified, it must meet and exceed an impact debris test (FEMA P-361, 3.1). These tests are currently being performed at the Texas Tech University Wind Science and Research Center. The test consists of shooting a 15-lb 2"x4" traveling horizontally at 100 mph at different parts of the shelter, which creates a momentum force of 68 lb_f/s on the cross-sectional area and an energy on impact of 5017 ft-lb (FEMA P-361, Table 7-2).

The door and door frame structure are also strictly regulated. FEMA P-361 has researched and tested many door types. According to FEMA P-361, a steel door composed of 14-gauge or stronger steel is appropriate for storm shelters. These doors, with widths of up to three feet, are found to withstand wind loading of gusts of up to 250 mph (FEMA P-361, 7.1). Each door needs to be attached to a solid frame at six different locals, with three points on the latch side and three points on the hinge side (FEMA P-361, 7.4.4). The door frame construction needs to consist of five 3/8" lag screws in the door jamb and three 3/8" lag screws in the door head. Three points of locking mechanisms are recommended in all cases.

Building standards for tornado shelters may be found in FEMA 320 and FEMA P-361. In homes, safe rooms need to be designed to last impact from large forces and strong winds, using a 250 mph wind speed, as well as impact from a 15-lb 2"x4" at 100 mph moving horizontally and at 67 mph moving vertically throughout a time period of two hours (FEMA P-361). Figure 6 indicates wind speeds which are particularly high across northeastern Oklahoma and increase the need

for shelters. A-1 Blasting Inc.'s market will be in Oklahoma, and potentially in the surrounding states, all which are listed to be protected from the maximum wind speed of 250 mph.

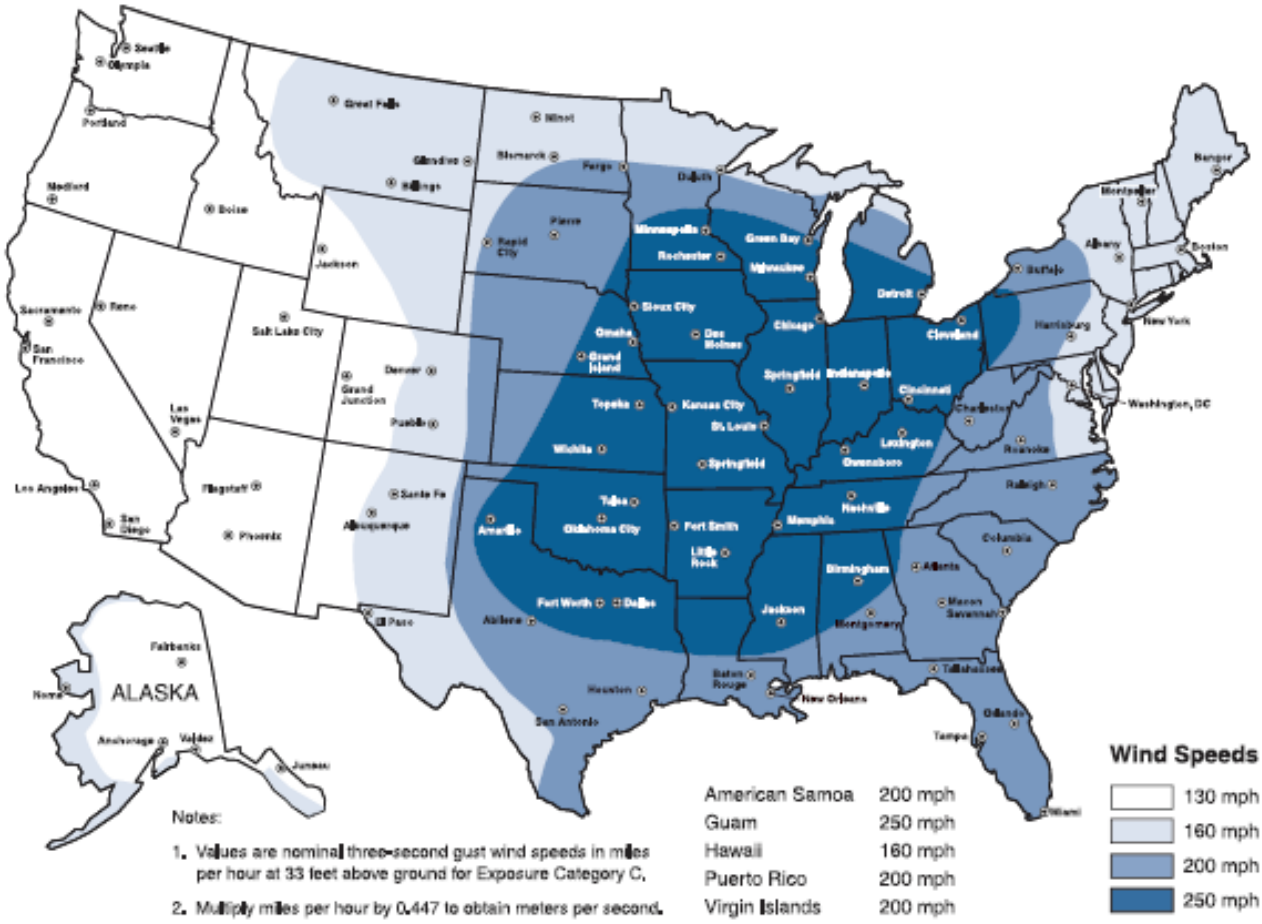

Figure 6. Wind speeds used in design of tornado shelters (FEMA361).

Detailed Work

Occupancy

Shelter occupancy is based on the area in square feet required per person, which is dependent upon the mobility of the occupants as well as the estimated amount of time they will remain in the shelter. FEMA P-361 establishes some basic guidelines to follow. For a residential one- or two-family dwelling, a minimum of two square feet per person is recommended (FEMA P-361,

Table 3-5). For a community tornado shelter, a minimum of five square feet per person is recommended (FEMA P-361, Table 3-1).

Wind Force/Blow Away

Protecting the structure from failure due to wind loads is dependent on a solid anchoring system to resist sliding and uplift forces. A solid anchoring system prevents the shelter from blowing away.

From FEMA P-361 Table 3-6, the tornado safe room design speed is 250 mph. The maximum three second gust wind speed for an EF5 tornado is 234 mph, meaning that the design speed is sufficient. The total horizontal pressure due to wind loading is approximately 160 psf. Assuming the shelter is 8' tall, the shelter experiences 1280 pounds per foot of wall width. For an 8' wall, the horizontal force is 10,240 pounds.

$$Wind\ pressure\ \left[\frac{lb}{feet^2}\right] = 0.00256 * \left(Wind\ speed\ \left[\frac{miles}{hour}\right]\right)^2 = 0.00256 * (250mph)^2$$
$$= 160\ psf$$

The anchor bolts securing the shelter to the foundation should be of a sufficient tensile strength to resist uplift and shear strength to resist sliding. As a rule of thumb, the shear strength of a bolt is 60% of the ultimate tensile strength. Utilizing a grade 2 bolt with a tensile strength of 74ksi (Shigley's Table 8-9), the maximum allowable shear stress on the anchor bolts is 44.4ksi. To maintain a factor of safety of 2, the design requires 3/8" diameter bolts spaced every 12", which is enough to resist the shear forces due to one wall and is supplemented by the bolts holding down the other three walls.

$$Bolt\ Shear\ Strength = 0.60 * Tensile\ Strength = 0.6 * 74\ ksi$$
$$= 44.4\ ksi\ for\ a\ Grade\ 2\ bolt$$

$$Miniumum\ Bolt\ Area = \frac{Safety\ Factor * Force}{Stress} = \frac{2 * 1280lb}{44400\ \frac{lb}{in^2}}$$

$$= 0.0577\ in^2\ per\ foot\ of\ wall$$

$$Minimum\ Bolt\ diameter = \sqrt{0.0577 * \frac{4}{\pi}} = 0.271\ inches$$

Uplift

From FEMA P-361 section 4.3.2, uplift forces are dependent on the size of the roof. Uplift forces are also dependent on the roof geometry as seen in Appendix E. For a flat roof, corner uplift forces are 396 psf. Edge geometry experiences 238 psf, and the remaining roof area experiences 209 psf. The maximum uplift forces will occur on the largest shelter design. Calculations of uplift forces can be seen below for the 6'x8' shelter. Because the shelter is a small structure, it can be assumed that there are only edge and corner uplift forces. Assuming a total corner area of four square feet and a remaining roof edge area of 44 square feet, the uplift forces are calculated as the following:

$$Edge\ Uplift\ Force = Edge\ Area * Edge\ Uplift\ Pressure = 238\ psf * 44\ ft^2 = 10472\ lb$$

$$Corner\ Uplift\ Force = Corner\ Area * Corner\ Uplift\ Pressure = 396\ psf * 4\ ft^2$$
$$= 1584\ lb$$

$$Uplift\ Force = Corner + Edge\ Uplift\ Forces = 10472\ lb + 1584\ lb = 12056\ lb$$

In order to find the hold down force required, combine the uplift forces and the weight of the shelter, which is assumed to be 2000 lbs. To check bolt tension, divide the hold down force by the total bolt area, resulting in the average tensile forces in the bolts to be 402 lb per bolt.

$$Hold\ Down\ Force = Uplift\ Force - Shelter\ Weight = 12056\ lb - 2000\ lb = 10056\ lb$$

$$Bolt\ Stress = \frac{Force}{Area} = \frac{Total\ Force}{Total\ Bolt\ Area} = \frac{10056\ lb}{25 * \frac{\pi}{4} * \left(\frac{3}{8} in\right)^2} = 3642\ psi\ in\ tension$$

The bolt anchors must also be checked to ensure they will not pull out of the concrete. All of these procedures ensure the shelter will not blow away during an intense tornado event.

Penetration

A sufficient thickness of material must be utilized to prevent the sheet metal skin from being pierced from projectiles in a tornado. Evaluating the energy stored in the usual projectile is important. The usual projectile, which is used in the projectile tests at the Texas Tech Wind Science and Research Center, is a 2"x4" nominal piece of lumber weighing 15 lb fired at 100 mph for wall profiles and 67 mph for roof profiles. Because 12-gauge sheet metal has never been punctured during testing, this design will utilize 10-gauge sheet metal to ensure the safety of the occupants.

Deflection

Deflections must be calculated for both the sheet metal and the frame. The deflection of the sheet metal between the frame is calculated at the center of the material. Although Texas Tech University research shows 12-gauge steel is sufficient to stop incoming missiles as stated in FEMA P-361 section 7.3.2, further calculations are shown for the quality of this report. The kinetic energy of this projectile is given by the following equation:[7]

$$Kinetic\ Energy = 0.5 * mass * velocity^2 = 0.5 * 15\ lbm * (100\ mph)^2$$
$$= 75000\ lbm\ miles^2\ hour^{-2}$$

[7] http://www2b.abc.net.au/science/k2/stn/archives/archive100/newposts/2014/topic2014539.shtm

$$Energy = 75000\ lbm\ mph^2 * \frac{5280ft}{mile} * \frac{5280ft}{mile} * \frac{hour}{3600s} * \frac{hour}{3600s} * \frac{lbf * s^2}{32.2\ lbm * ft}$$

$$= 5015\ ft\ lb$$

To perform the deflection calculation, it is necessary to know the force imparted by the projectile over a certain distance. The energy is known from the previous calculations. The maximum allowable deflection in a storm shelter is 3" as set by FEMA P-361 section 7.3.2. Note the safety factor of 2 has already been accounted for in the energy value below. The force exerted on the compound beam and sheet metal is calculated to be 40,120 lb.

$$Force = \frac{Safety\ Factor * Energy}{Distance} = \frac{120360\ in\ lb}{3\ in} = 40120\ lb$$

Deflection of the frame is calculated by combining the sheet metal skin with the angle iron frame. Modulus of elasticity is unaffected because both materials are steel; however, the moment of inertia must be recalculated for the compound beam which can be seen in Figure 7 below.

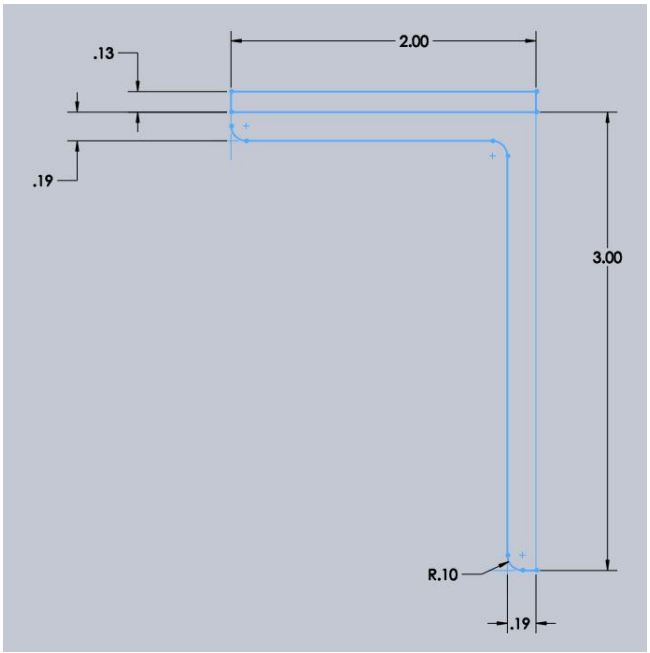

Figure 7. Moment of Inertia for the compound beam.

From this profile, the moment of inertia for the compound beam is calculated. Table 7 includes the values and calculations used. The moment of inertia for the composite beam is 0.65 in^4.

Table 7. Moment of Inertia calculations.

Segment	a (in^2)	y (in)	ay (in^3)	d (in)	ad^2 (in^4)	$I=bh^3/12$
Sheet	0.2690	0.0673	0.0181	0.8072	0.1753	0.0004
Angle	0.9380	1.1060	1.0374	0.2315	0.0503	0.4240
Total	1.2070		1.0555		0.2256	0.4244
Total I (in^4)	0.6500					

Each angle iron "stud" is spaced every 12" on center to support the sheet metal skin. Previous tests show that a double 2"x4" stud spaced 16" on center passed the projectile test according to FEMA P-361, Appendix E. The variables that change in the deflection equation are E, the modulus of elasticity, and I, the moment of inertia. Calculating for a double 2"x4" wooden stud, EI is approximately $17.15*10^6$, whereas EI for the angle iron and sheet metal is approximately $19.5*10^6$. The angle iron is approximately 14% stronger than the lumber double stud wall and is sufficient to pass the impact test.

$$Double\ Stud\ E*I = 1.6*10^6\ psi * \frac{3in*(3.5\ in)^3}{12} = 17.15*10^6\ in^2\ lb$$

$$Angle\ Iron\ E*I = 30*10^6\ psi * 0.650\ in^4 = 19.5*10^6\ in^2\ lb$$

If the projectile impacts directly between the angle iron frame, the sheet metal is forced to absorb the entire force. Although the sheet metal that will be examined is rectangular in shape, the deflection will follow a circular pattern surrounding the point of impact. The diameter of the circular pattern will be less than the spacing between the frame beyond which the energy and deflection is taken up by the frame itself. The maximum diameter used was 12" because the angle iron frame is spaced every 12". The actual value will be slightly smaller due

to the width of the angle iron. This calculation should be sufficient for any size frame set on a 12" spacing.[8] Note that v, Poisson's ratio, is assumed to be 0.3 for plate steel. The maximum deflection can be calculated as follows:

$$D = \frac{E * t^3}{12 * (1 - v)^2} = \frac{30 * 10^6\ psi * (0.1345in)^3}{12 * (1 - 0.3)^2} = 12414\ in\ lb$$

$$Maximum\ Deflection = \frac{Force * maximum\ radius^2}{16 * \pi * D} = \frac{40120\ lb * (6\ in)^2}{16 * \pi * 12414\ in\ lb} = 2.315\ in$$

The sheet metal is of sufficient strength and thickness to resist puncture. The deflection due to projectile impact in both the sheet metal and the frame is small enough to meet the criteria set forth by FEMA P-361. The bolts are sufficient in number and strength to resist uplift forces and horizontal wind forces. This shelter design meets all design requirements and presently awaits approval from Professor Dr. Weckler, industry specialist Win Adams, and A-1 Blasting, Inc. owner Bob Smith.

Concrete

Research has been conducted showing that a reinforced concrete structure 6" thick with #4 rebar 12" on center is sufficient to stop a 15 lb 2"x4" projectile at 100 mph without spalling on the interior. Further research shows that 4" thick concrete with #4 rebar 12" on center is sufficient to stop the same projectile at 67 mph. Refer to section 7.3.5 of FEMA document P-361, which is backed by research conducted by Twisdale and Dunn and Texas Tech University, for further detail.

Design Drawings

SHRC Shelters has designed two main structures for A-1 Blasting, Inc. One type of structure design is all steel, and the other is made up of concrete and rebar. The steel structure is

[8] http://www.physicsforums.com/showthread.php?t=260145

constructed with 10-gauge steel with 2”x3”x3/16” angle iron on 12” centers. The concrete structure is made of 6’ thick 3000 psi concrete with #4 rebar reinforcement spaced 12” horizontally and vertically. The steel structure can be seen in Figure 8, and the concrete structure is shown in Figure 9.

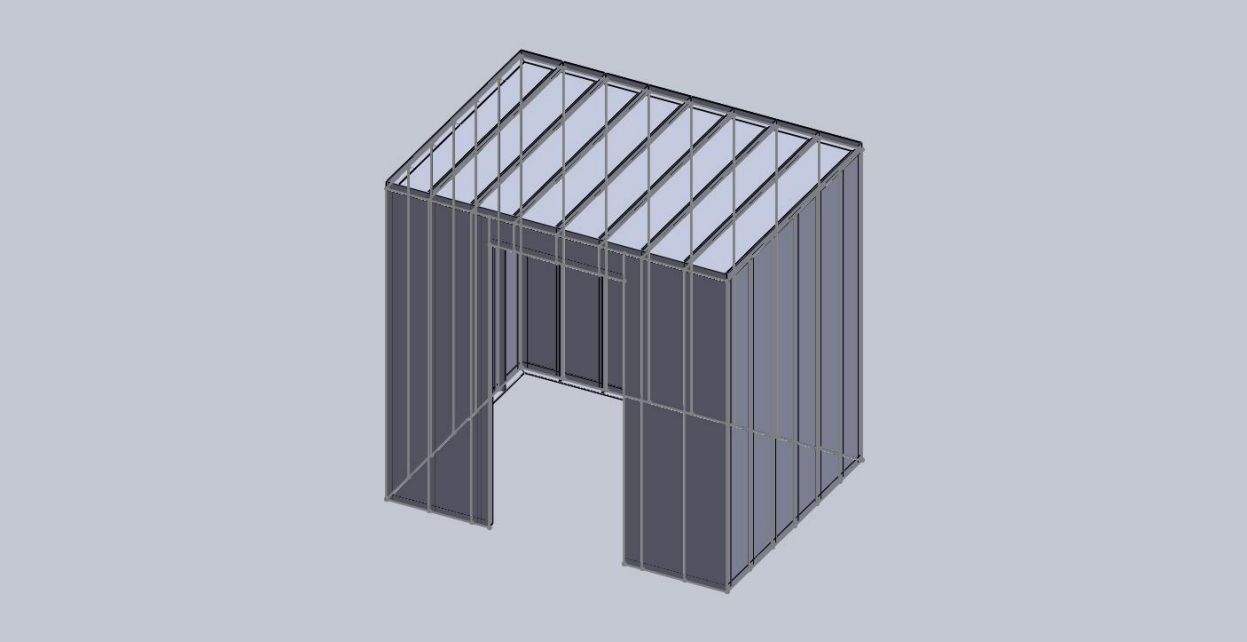

Figure 8. Steel structure storm shelter designed in SolidWorks.

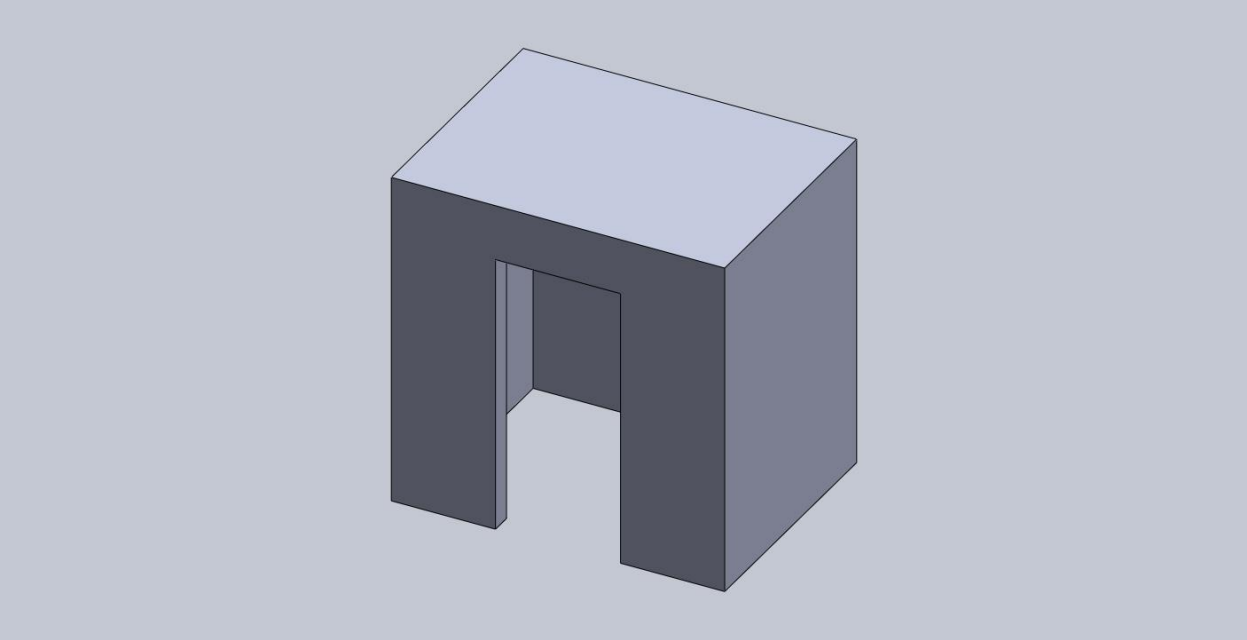

Figure 9. Concrete structure storm shelter designed in SolidWorks.

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Appendix

Appendix A

					Projected				
	2008	2009	2010	2011	2012	2013	2014	2015	2016
# of Homes[1]	401,734	405,821	410,553	413,357	417,739	422,485	427,612	433,138	439,079
Δ %		1.02%	1.17%	0.68%	1.06%	1.14%	1.21%	1.29%	1.37%
Median Value ($)[1]	$124,200	$126,600	$128,400	$126,800	$125,532	$124,591	$123,968	$123,658	$123,658
Δ %		1.93%	1.42%	-1.25%	-1.00%	-0.75%	-0.50%	-0.25%	0.00%
Homebuilder Revenue ($)[2]		$935,384,321	$931,638,135	$1,023,353,622	$1,100,105,144	$1,182,613,029	$1,271,309,007	$1,366,657,182	$1,469,156,471
Δ %			-0.40%	9.84%	7.50%	7.50%	7.50%	7.50%	7.50%
# of New Homes		**4,087**	**4,732**	**2,804**	4,382	4,746	5,128	5,526	5,940

1: US Census Data
2: Bizminer Industry Report

Appendix B (Projected Financial Statements)

Pro-Forma Balance Sheet

A-1 Blasting Storm Shelter Division

ASSETS	**2013**	**2014**	**2015**	**2016**	**2017**
Current Assets					
Cash	$7,857	$32,140	$73,116	$139,424	$238,131
Net accounts receivable	$0	$0	$0	$0	$0
Inventory	$0	$0	$0	$0	$0
Total Current Assets	$7,857	$32,140	$73,116	$139,424	$238,131
Fixed Assets					
Long-term investments	$0	$0	$0	$0	$0
Land	$0	$0	$0	$0	$0
Buildings (net of depreciation)	$0	$0	$0	$0	$0
Plant & equipment (net)	$0	$0	$0	$0	$0
Furniture & fixtures (net)	$0	$0	$0	$0	$0
Total Net Fixed Assets	$0	$0	$0	$0	$0
TOTAL ASSETS	$7,857	$32,140	$73,116	$139,424	$238,131
LIABILITIES					
Current Liabilities					
Accounts payable	$0	$0	$0	$0	$0
Short-term notes	$0	$0	$0	$0	$0
Current portion of long-term notes	$0	$0	$0	$0	$0
Accruals & other payables	$0	$0	$0	$0	$0
Total Current Liabilities	$0	$0	$0	$0	$0
SHAREHOLDERS' EQUITY					
Capital stock	$0	$0	$0	$0	$0
SHAREHOLDERS' EQUITY	$7,857	$32,140	$73,116	$139,424	$238,131
Total Shareholders' Equity	$7,857	$32,140	$73,116	$139,424	$238,131
TOTAL LIABILITIES & EQUITY	$7,857	$32,140	$73,116	$139,424	$238,131

Pro-Forma Income Statement

A-1 Blasting Storm Shelter Division

REVENUE	2013	2014	2015	2016	2017
Net Sales	$56,940	$154,183	$249,870	$394,949	$578,959
COST OF SALES					
Beginning inventory	$0	$0	$0	$0	$0
Plus goods purchased	$28,256.79	$76,513.98	$123,998.78	$195,994.73	$287,310.46
Total Goods Available	$28,257	$76,514	$123,999	$195,995	$287,310
Less ending inventory	0	0	0	0	0
Total Cost of Goods Sold	$28,257	$76,514	$123,999	$195,995	$287,310
Gross Profit (Loss)	$28,683	$77,669	$125,871	$198,954	$291,649
OPERATING EXPENSES					
General/Administrative					
Salaries and wages	$11,412	$30,900	$50,077	$79,153	$116,031
Employee benefits	2,282	6,180	10,015	15,831	23,206
Payroll taxes	913	2,472	4,006	6,332	9,282
Insurance[1]	0	0	0	0	0
Rent[2]	0	0	0	0	0
Utilities	140	380	615	973	1,426
Depreciation & amortiz	53	142	231	365	535
Office supplies	18	47	77	122	178
Postage	26	71	115	182	267
Advertising	569	1,542	2,499	3,949	5,790
Total Operating Expenses	$15,413	$41,735	$67,636	$106,907	$156,715
Net Income Before Taxes	$13,271	$35,934	$58,235	$92,048	$134,933
Taxes on income	4,645	12,577	20,382	32,217	47,227
Net Income After Taxes	$8,626	$23,357	$37,853	$59,831	$87,707
Extraordinary gain or loss	$0	$0	$0	$0	$0
Income tax on extraordinary gain	0	0	0	0	0
NET INCOME (LOSS)	$8,626	$23,357	$37,853	$59,831	$87,707
CUM. INCOME (LOSS)	$8,626	$31,983	$69,836	$129,667	$217,374

1: Business is conducted in A-1 Blasting facility, insurance costs are reflected on A-1 financial Statements

2: Business is conducted in A-1 Blasting facility, location costs are reflected on A-1 financial Statements

Pro-Forma Cash Flow Statement

A-1 Blasting Storm Shelter Division

Cash flows from operating activities	2013	2014	2015	2016	2017
Cash received from customers	$28,470	$77,092	$124,935	$197,474	$289,480
Cash paid for merchandise	(28,257)	(76,514)	(123,999)	(195,995)	(287,310)
Cash paid for wages and other operating exp	(18,260)	(44,819)	(70,135)	(108,486)	(156,715)
Cash paid for interest	0	0	0	0	0
Cash paid for taxes	(3,648)	(11,498)	(19,508)	(31,664)	(47,227)
Other	0	0	0	0	0
Net cash provided (used) by operating activit	($21,695)	($55,739)	($88,706)	($138,670)	($201,773)
Cash flows from financing activities					
Cash received from issuing stock	0	0	0	0	0
Cash received from long-term borrowings	0	0	0	0	0
Cash paid to repurchase stock	0	0	0	0	0
Cash paid to retire long-term debt	0	0	0	0	0
Cash received from accounts receivable	29,552	80,021	129,683	204,979	300,480
Cash paid to accounts payable	0	0	0	0	0
Net cash provided (used) in financing activiti	$29,552	$80,021	$129,683	$204,979	$300,480
Increase (decrease) in cash during the perio	$7,857	$24,282	$40,976	$66,308	$98,707
Cash balance at the beginning of the period		$7,857	$32,140	$73,116	$139,424
Cash balance at the end of the period	$7,857	$32,140	$73,116	$139,424	$238,131

Appendix C

Table 8. The original Fujita Scale and the Enhanced Fujita Scale

Fujita Scale		EF Scale	
Fujita Scale	**3-Second Gust Speed (mph)**	**EF Scale**	**3-Second Gust Speed (mph)**
F0	45-78	EF0	65-85
F1	79-117	EF1	86-109
F2	118-161	EF2	110-137
F3	162-209	EF3	138-167
F4	210-261	EF4	168-199
F5	262-317	EF5	200-234

Appendix D

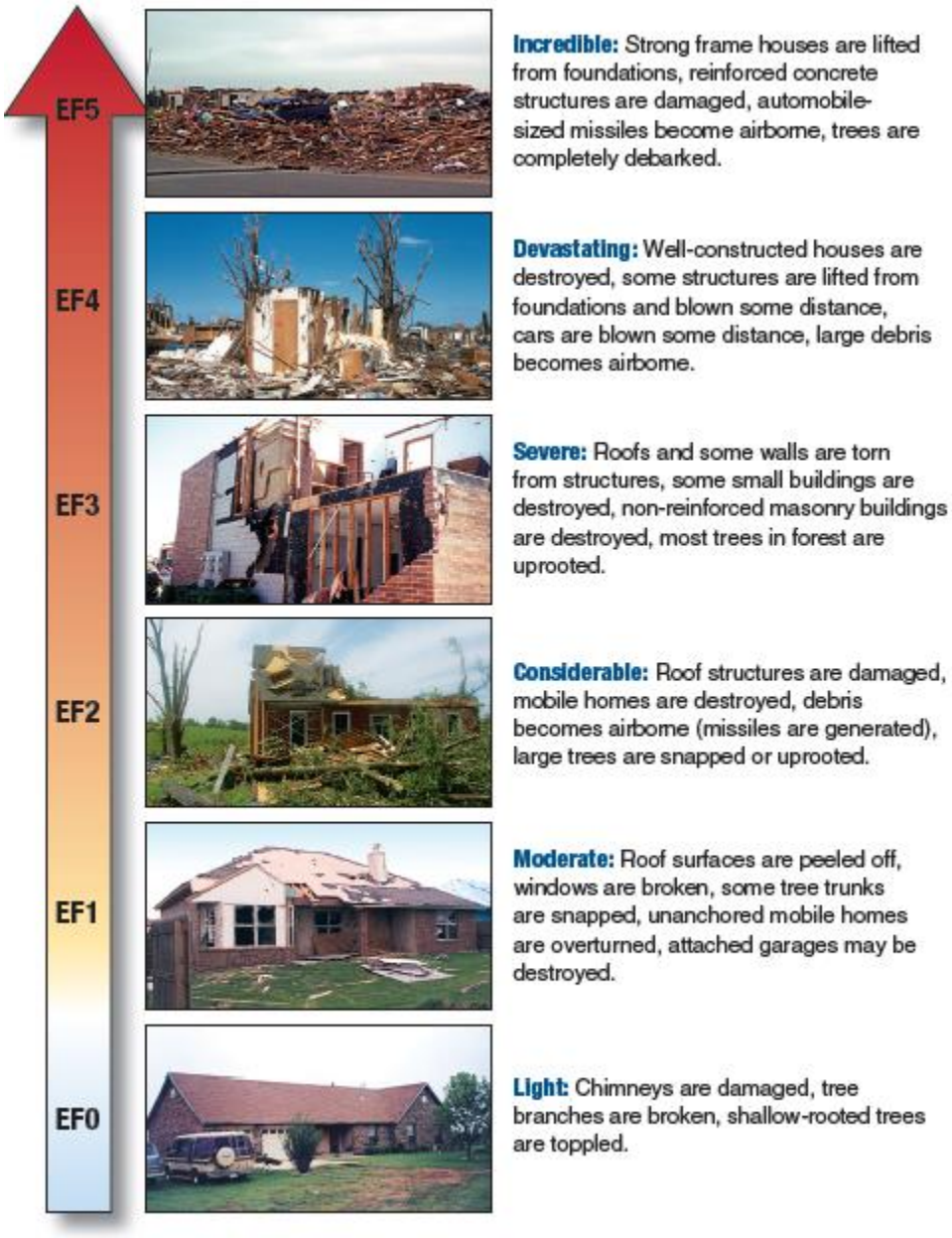


Figure 10. Effects of varying wind speeds on residential structures and the correlation of damage in direct relation to wind intensity.

Appendix E

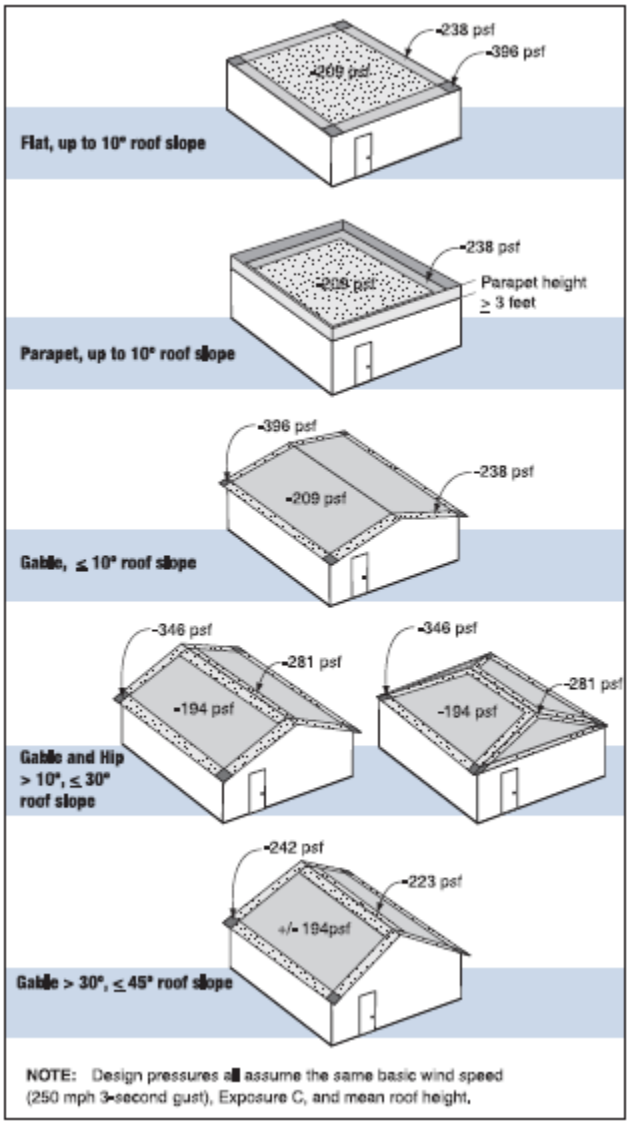


Figure 11. Pressures exhibited on a structure by high winds (FEMA P-361 Figure 4-3).

SHRC SHELTERS

STACI CUCCIO, FLINT HOLBROOK, KEVIN ROEWE, & JARED SWART

MISSION

- Create safe economical shelter designs
- Design outstanding features
- Satisfy client & market demands

PROBLEM STATEMENT

- Storm shelter production for A-1 Blasting, Inc. of Broken Arrow, Oklahoma
- Market analysis
- Engineering design
- Projected cost & sales

STATEMENT OF WORK

- Competitive advantages
- Standards & specifications research
- SolidWorks shelter designs
- Potential alternative functions
- Production costs

FALL SEMESTER TASKS LIST

- Research patents
- Research testing/certification
- Analyze market
- Design basic shelter
- Consider multiple usages of shelter
- Determine construction materials
- Perform detailed engineering analysis of forces
- Draw detailed design in SolidWorks
- Estimate costs

SPRING SEMESTER TASK LIST

- Prototype chosen by A-1 Blasting, Inc.
- Potential to build prototype
- Test prototype
- Create marketing materials

STANDARDS & SPECIFICATIONS

- National Storm Shelter Association
- ICC-500
- FEMA P-361
- Texas Tech University Certification

DESIGN REQUIREMENTS

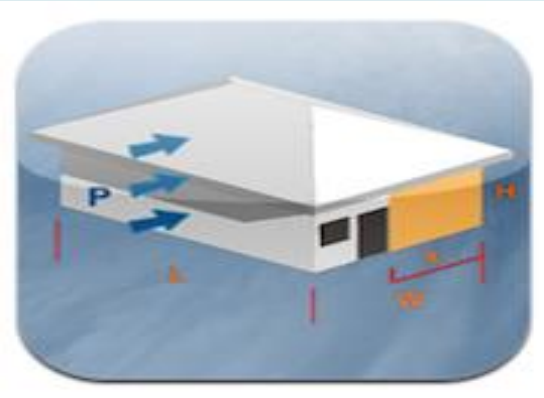
- Designed to meet FEMA P-361 requirements for intense wind event
- Multiple requirements

Enhanced Fujita Scale		
Scale	Wind Speed	
	MPH	***Km/H***
EF0	65-85	105-137
EF1	86-110	138-178
EF2	111-135	179-218
EF3	136-165	219-266
EF4	166-200	267-322
EF5	>200	>322

WIND LOADING - WALL SECTION

- Rated for winds perpendicular to the face of the wall
- Gusts last for three seconds
- Designed for max gust of 250 mph

$$Wind\ pressure\left[\frac{lb}{feet^2}\right] = 0.00256 * \left(Wind\ speed\left[\frac{miles}{hour}\right]\right)^2$$



http://www.bdcnetwork.com/appcenter/wind-load-shear-wall-design-calculator

FLYING DEBRIS

- Most dangerous characteristic of a tornado

Missile Size	Typical Debris	Associated Damage Observed
Small (Light Weight)	Aggregate roof surfacing, pieces of trees, pieces of wood framing members, bricks	Broken doors, windows, and other glazing; some light roof covering damage
Medium (Medium Weight)	Appliances, HVAC units, long wood framing members, steel decking, trash containers, furniture	Considerable damage to walls, roof coverings, and roof structures
Large (Heavy Weight)	Structural columns, beams, joists, roof trusses, large tanks, automobiles, trees	Damage to wall and roof framing members and structural systems

TEXAS TECH UNIVERSITY WIND SCIENCE & ENGINEERING RESEARCH CENTER

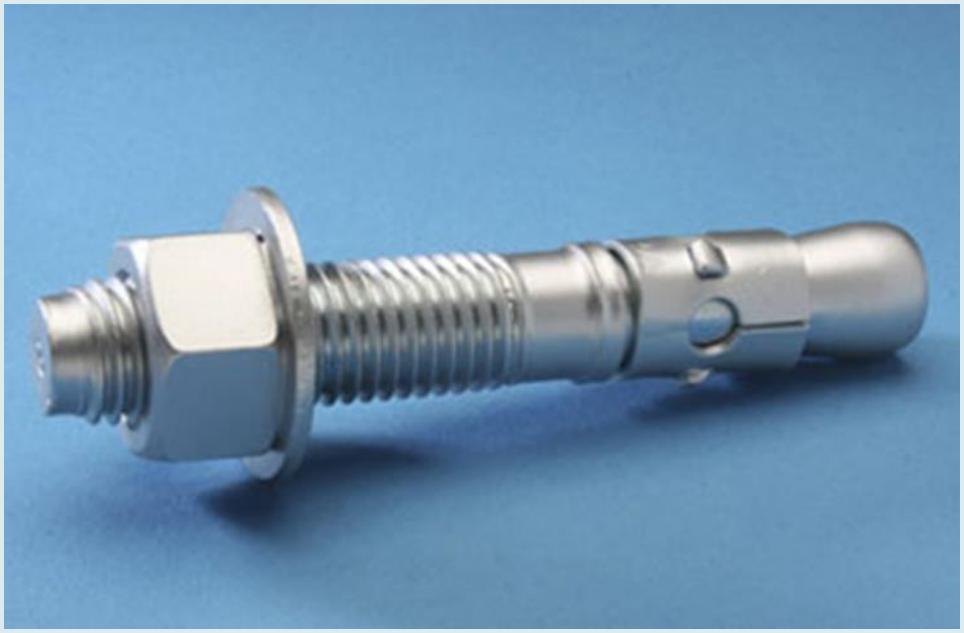
- Tests projectile impact on structures
- Uses a standard 15 lb 2”x4”
- Speeds of up to 100 mph horizontally
- Speeds of up to 67 mph vertically
- Creates a momentum force on cross-sectional area of 68 lb_f/s
- Energy on impact of 5,017 ft-lb

DOOR FRAME & DOOR

- Requires five 3/8” lag screws in door jam & three in head
- Steel door composed of 14 gauge steel or stronger
- Attached to a solid frame at six points
  - Three points on latch side
  - Three points on hinge side
- Three contact points on each side

ANCHOR SYSTEM

- Determined by the size of shelter
- Must be of sufficient tensile strength



http://www.confast.com/products/thunderstud-anchor.aspx

VENTILATION

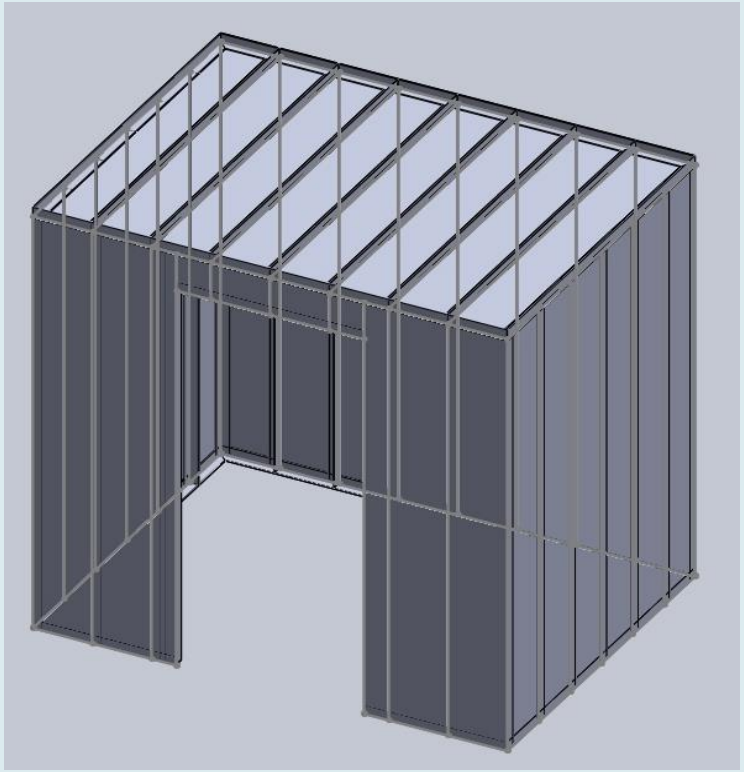
- Apply by local jurisdiction
- Two possible locations
- Vertical is best
- Protection
- For residential shelter, 2 in^2 per person

MORE REQUIREMENTS

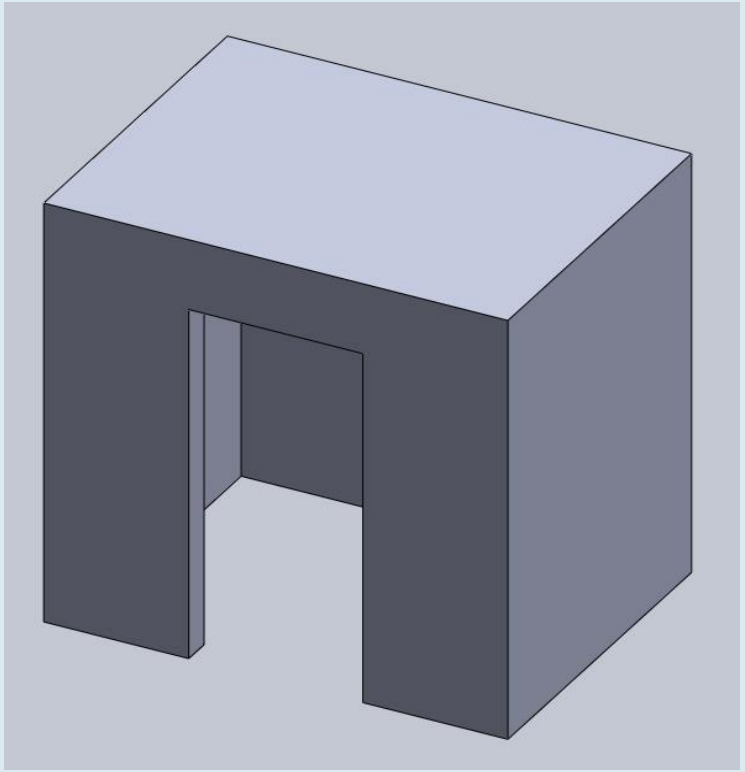
- Amount of time for occupancy
- Wall height specification
- Recommended area per occupant

ENGINEERING DESIGNS

Steel Structure



Concrete Structure



ENGINEERING

- Blowing away
- Uplift
- Frame deformation
- Perforation
- Plate deformation

BLOW AWAY

- Wind Pressure [psf] =

$$0.00256 * \text{Velocity [mph]}^2$$

$$= 0.00256 * (250 \text{ mph})^2$$

$$= 160 \text{ psf}$$

- Wall force = Wall area $*$ Wind Pressure
- Force = 8’ $*$ 8 ’ $*$ 160 psf = 10,240 lb
- 1,280 lb force per foot of wall width

BOLT INFORMATION

- 3/8” Grade 2 Bolt:

  Ultimate tensile strength = 74ksi

- Shear strength = 0.60 $*$ Tensile strength

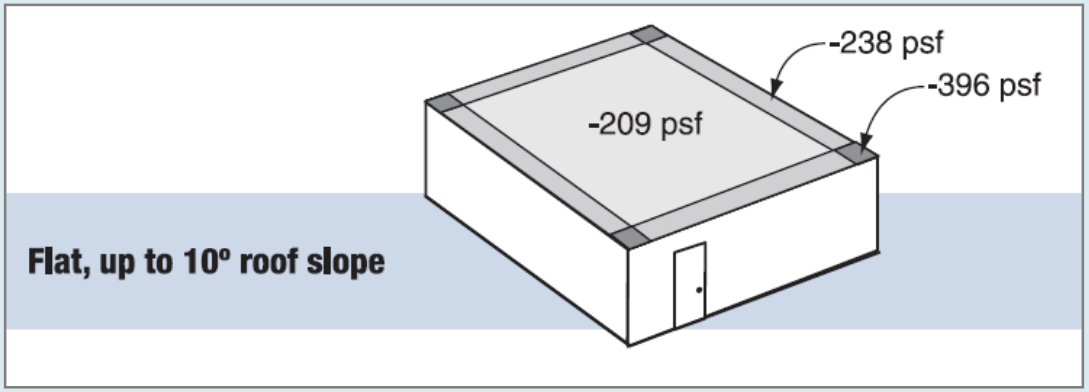
  $= 0.60 * 74 \text{ ksi} = 44.4 \text{ ksi}$

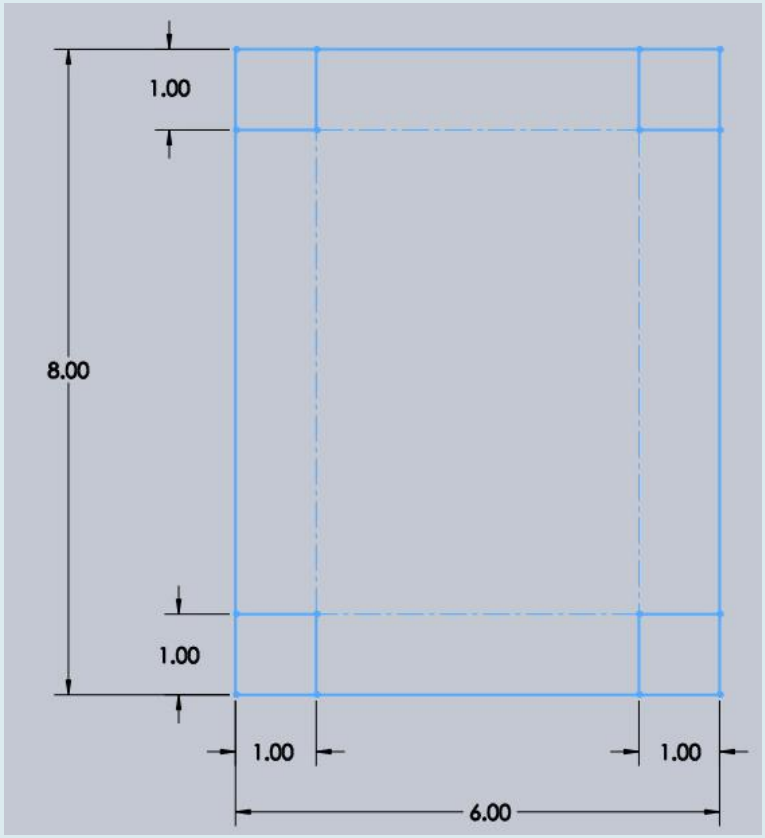
- Bolt area = (Design factor $*$ Force) / Stress

$$= \frac{2*1280 \text{ lb}}{44400 \text{ psi}} = 0.0577 \frac{\text{in}^2}{\text{ft wall width}}$$

- Bolt diameter = $\sqrt{0.0577 * \frac{4}{\pi}} = 0.271$ inches

FEMA P-361 Figure 4-3: ROOF UPLIFT PRESSURES





UPLIFT CALCULATIONS

- Edge Force = Edge Area $*$ Edge Pressure

  $= 238 \text{ psf} * 44 \text{ ft}^2 = 10{,}472 \text{ lb}$
- Corner Force = Area $*$ Corner Pressure

  $= 4 \text{ ft}^2 * 396 \text{ psf} = 1{,}584 \text{ lb}$
- Total Force = Edge + Corner Uplift Forces

  $= 10{,}472 \text{ lb} + 1{,}584 \text{ lb} = 12{,}056 \text{ lb}$

UPLIFT

- Hold Down Force =

  $$\text{Uplift Force} - \text{Shelter Weight}$$

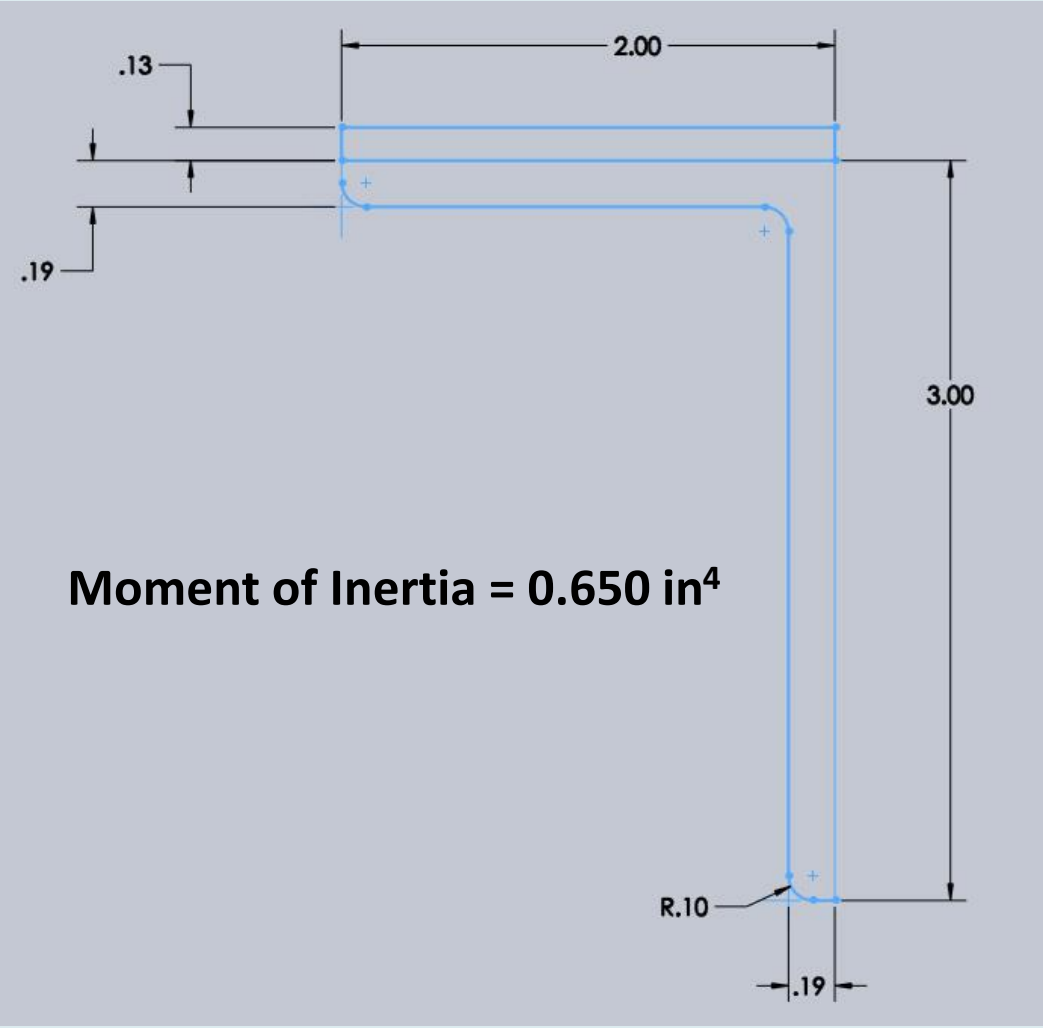
  $$= 12{,}056\ \text{lb} - 2{,}000\ \text{lb} = 10{,}056\ \text{lb}$$

- $$\text{Bolt Stress} = \frac{\text{Force}}{\text{Area}} = \frac{\text{Total Force}}{\text{Total Bolt Area}}$$

  $$= \frac{10{,}056\ \text{lb}}{25 * \frac{\pi}{4} * \left(\frac{3}{8}\,\text{in}\right)^2} = 3{,}642\ \text{psi (tension)}$$

- Approximately 402 lb per bolt

FRAME INERTIA



Moment of Inertia = 0.650 in^4

FRAME DEFORMATION

- Double 2” x 4” stud wall
  - $E * I = 17.15$ million $lb*in^2$
- 2” x 3” x 3/16” angle iron
  - $E * I = 19.5$ million $lb*in^2$
- Steel is approximately 14% stronger
- Surpasses the double stud wall structure

PERFORATION

- FEMA P-361 Section 7.3.2 states:

  “In laboratory tests at Texas Tech University, 12-gauge or heavier steel sheets have never been perforated with the 15 lb wood 2”x4” traveling at 100 mph.”

- 10 gauge steel sheets used for the remainder of the design work

PROJECTILE ENERGY

- Kinetic Energy = $0.5 * \text{Mass} * \text{Velocity}^2$

  $=0.5*15\text{lb}*(100\ \text{mph})^2 = 75{,}000\ \text{lb-mph}^2$
- $\text{KE} = 75{,}000\ \text{lb-mph}^2 = 5{,}015$ ft-lb

  (FEMA P-361 Table 7-2)
- 9 lb 2”x4” at 128 mph $\rightarrow$ 4,932 ft-lb

  (FEMA P-361 Table 7-2)

IMPACT FORCE

- 5,015 ft-lb $\longrightarrow$ 60,180 in-lb (2) = 120,360 in-lb

  (Design Factor = 2)
- Force = Energy / Distance
- Force = 120,360 in-lb / 3 in = 40,120 lb
- Impact Force = 40,120 lb

PLATE DEFORMATION

- Deflection = Force∗Max Radius^2/(16∗π∗D)
- $D = \frac{E*t^3}{12*(1-v)^2} = \frac{(30*10^6\ psi)*0.1345\ in^3}{12*(1-0.3)^2}$
- D = 12,414 in-lb
- Deflection = $\frac{40{,}120\ lb*(6\ in)^2}{16*\pi*12{,}414\ in\ lb} = 2.315$ in

FINAL STEEL DESIGN

- 2” X 3” X 3/16” angle iron 12” o.c.
- 10 gauge sheet metal skin
- 3/8” anchor bolts 12” o.c. around perimeter
- Steel entry door
  - 14 gauge skin
  - 20 gauge reinforcement
  - 6 points of contact

FINAL CONCRETE DESIGN

- Vertical Walls
  - 6” concrete
  - #4 rebar spaced 12” horizontally & vertically
- Roof
  - 4” concrete
  - #4 rebar spaced 12” horizontally & vertically
- Steel entry door
  - 14 gauge skin
  - 20 gauge reinforcement
  - 6 points of contact

MARKET TRENDS

- Highly fragmented industry
- Small private businesses with alternative revenue streams
- $21 million per year, thirteen firms reporting
- Average price same over last five years, due to recession & depressed material prices
- Moves with housing starts
- Housing starts expected to increase over next five years

COMPETITORS

- Direct Competitors: Above ground shelters
  - Mostly above ground steel
  - Most are tremendously over designed
  - Varying prices & sizes
    - 4.5’ x 2.5’ → $2900
    - Propane tank → $3200
    - 6’ x 8’ → $5000
  - Most are sold for garage installation
- Indirect Competitors: Underground shelters

CONCEPT & VALUE PROPOSITION

- FEMA P-361 standards
- Three sizes
  - 3’ x 4’ x 8’
  - 5’ x 6’ x 8’
  - 6’ x 8’ x 8’
- Finished interior
- Seamless integration
- Easy build-in
- Target new homes
- Priced less than competitors

OPERATION DISTRIBUTION

- Homebuilders as distributors
- Homebuilders pick up shelters from A-1 Blasting, Inc., install & finish
- Homebuilder can include storm shelter in price of home
- A-1 Blasting, Inc. does not need installation equipment or sales staff
  - –Leverage risk reduction

PRICING

	Concrete	Steel	Concrete	Steel	Concrete	Steel
	3’x4’	3’x4’	4’x6’	4’x6’	6’x8’	6’x8’
Costs:						
Material	$1188.50	$1553.26	$1312.22	$1864.61	$1477.00	$2277.48
Labor	$713.10	$192.70	$787.332	$287.58	$886.20	$454.82
Variable Costs	$1901.60	$1745.96	$2099.55	$2152.19	$2363.20	$2732.30
CM at 50%	$950.80	$872.98	$1049.78	$1076.10	$1181.60	$1366.15
Price	$2852.40	$2618.94	$3149.33	$3228.29	$3544.80	$4098.45

TULSA VOLUME PROJECTIONS

	Projected				
Year	2012	2013	2014	2015	2016
Number of New Homes	4,382	4,746	5,128	5,526	5,940
Market Share		0.40%	1.00%	1.50%	2.20%
Projected Sales		19	51	83	130

MARKETING PLAN

- Marketing Materials
  - Brochures
  - Mailings
  - Video
- Relationship Building
  - Five largest homebuilders initially
- Local Tradeshows

FINANCIAL HIGHLIGHTS

- $57,000 in sales & $8,000 profit in 2013
- Five year average revenue growth of 186%
- $580,000 in sales & $87,000 profit in 2017

P/E of 24

Valuation $2.1 million

ACKNOWLEDGEMENTS

- Bob Smith & A-1 Blasting, Inc.
- Dr. Paul Weckler
- Dr. James Hardin
- Win Adams

QUESTIONS?