A SYSTEM AND UNIT DESIGN FOR FOOD DISTRIBUTION

DURING DISASTER RECOVERY

Except where reference is made to works of others, the work and processes described in this thesis are my own, or were generated in collaboration with my advisory committee. This thesis does not include proprietary of classified information.

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A SYSTEM AND UNIT DESIGN FOR FOOD DISTRIBUTION

DURING DISASTER RECOVERY

Brandon Ray Boycher

A Thesis

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A SYSTEM AND UNIT DESIGN FOR FOOD DISTRIBUTION

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VITA

Brandon Ray Boycher, son of Billy Ray Boycher and Lesa Heath Boycher, was born April 2, 1979, in Baton Rouge, Louisiana. He graduated from Walker High School in 1997. There he excelled in many directions. He was a three year varsity letterman on the baseball team, actively involved in the BETA and math clubs on campus, and graduated, with honors, fifth in his class. In his senior year he was awarded the TOPS scholarship, which would cover tuition to any state university. He also was the first student in his schools history to receive the Tulane Legislative Scholarship, which covered four years of academic study at Tulane University in New Orleans, Louisiana. After one year of study in the mechanical engineering program at Tulane University he felt the direction he was headed would not fill the creative needs he desired. Upon much deliberation he chose to enter Louisiana State University and begin studies in graphic design and photography. After two years of this curriculum there was still something missing. The void was the link between the two subjects of his captivation, engineering and art. He knew there had to be a discipline that linked these two. After much research, industrial design was found; he immediately transferred to Auburn University in Auburn, Alabama. There he found the void, and began an intense study of industrial design.

THESIS ABSTRACT

A SYSTEM FOR FOOD DISTRIBUTION AND UNIT DESIGN

DURING DISASTER RECOVERY

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137 Typed Pages

Directed by Randall Bartlett

Because of the steadily increasing population, disaster needs have been steadily increasing in number and scale. This increasing trend intensifies the need for aid in the recovery areas of disaster situations. The development of a self-contained, mobile food distribution unit along with an efficient operation evaluation system will be of immeasurable significance in the future of disaster recovery.

In this study, data are collected from library references, applicable industries, and concept studies. We provide a detailed workload characterization of the system, and then proceed to design a model that could be used to drive a simulation of this distribution system. The particular model that we have designed is an accurate CAD, considering the

time and financial constraints of the project. The model is distribution-based for disaster recovery.

The major contribution of this study is its furthering of the understanding of the tools and methodology that can be used in design development of a complete self-contained, mobile food distribution unit. We demonstrate how analysis and other techniques can be used to provide meaningful answers to the needs in the recovery of disaster situations; including recovery workers and disaster victims. In addition to the specific results that we present, we feel that the collective wisdom provided by the discussion of the methodology throughout this thesis will provide a stable model for the development of the proposed system.

ACKNOWLEDGEMENTS

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Style Manual Used	APA Publication Manual, Fifth Edition
Computer Software Used	Microsoft Word

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1. INTRODUCTION

1.1 PROBLEM STATEMENT

The problem I am in the process of solving is based on the feeding the multitude of people that are involved in the recovery of disaster situations. The problem is providing the victims and rescuers with quality food in a restricted amount of time.

1.2 NEED FOR STUDY

In our world there are many things we consider catastrophes; however, only a few can be truly defined tragedies. A true tragedy is something that leaves a large number of people suffering in a relatively confined area. The focus of this project is to provide relief in this type of situation. More specifically, it focuses on the aftermath of natural and manmade disasters.

There are five different situations I have compiled to provide relief for: hurricane, tsunamis, flood, earthquake, and terrorist attack. The range of these disasters covers most of the United States. The hurricane mainly affects the southern part of the United States. Tsunamis are mainly focused in the coastal states. The flood can occur anywhere in the country. An earthquake can also turn up in odd places, but mainly attack the western states. The final scenario, terrorist attacks, is a new subject but very relevant in today's list of large scale disasters. From these descriptions it is easy to deduce that no where in the United States is free from the threat of disaster. When these disasters strike they leave many people suffering and bring in a multitude of people to aide in the recovery. These people are usually sustained by canned goods or government rations. Eating the same bland food over and over again is not good for the morale of the parties.

Imagine if there were a self-contained food service system that was modular and easily transportable. The system will be self-sufficient in providing clean water through innovative filtration and be able to supply its own power from the sun, efficient generation, or available power source. It utilizes professional equipment that can be modified to fit the confined area of the system. The goal of service will be making the system and equipment modular and easy enough for a volunteer to use, but have the quality any professional chef would be proud to use.

The purpose of the proposed system is two-fold. First it is an efficient device that is capable of feeding many people in areas of need. But the most convincing reason to employ such a system is to increase the morale of people involved in the restoration of the disaster. If you are bagging sand for a flood and every meal is served in a plastic wrapper you will begin to lose enthusiasm in the project. But if you know you are going to have a hot meal served with a little influence of the given area you are going to work harder. This also works in raising spirits for the victims. They may have lost their homes, but the reassurance of a home cooked meal will provide positive thoughts of the restored future.

Life after a disaster is never easy, but being able to make everyone feel as close to normal as possible is a great way to start. This system is the first positive step in this direction.

1.3 OBJECTIVE OF STUDY

- To define the areas of need in certain disasters.
- To locate or develop new ways of food distribution.
- To understand food service in a compact and transportable way.
- To develop an evaluation of compact kitchen needs.
- To find or develop appliances to use in the compact kitchen environment.
- To develop a package of the system to market.
- To adapt the system to as many forms of transportation as possible.

1.4 LITERATURE REVIEW

The initial research began in books concerning the different types of disasters in the world today. These disasters include the natural and manmade. The first disaster to confront is the earthquake. Earthquakes are primarily a problem in the western United States. In an earthquake there is destruction of property from the movement of plates in the earth’s crust. The natural shifting of these plates causes the surface of the earth to move. Shifting usually destroys roads, building, and utilities. It also causes fires and explosions in the affected areas. This type of disaster will leave people without many conveniences and a need for new renovation. The destruction from an earthquake closely resembles the aftermath of 911, yet on a smaller scale. There is much debris left in its wake. Overcoming of dry and burning debris will be the most challenging obstacle in transportation of the service unit in an earthquake situation.

The next natural disaster to discuss is hurricanes. They occur mainly in the southeastern United States. States like Louisiana, Mississippi, Florida, and Georgia are the prime targets. The destruction from hurricanes is two-fold; the damage is from high winds and torrential rain. The high winds destroy most structures in their way. This destruction clutters the area with debris from damaged housing: shingles, wood, furniture, etc. Then the rain damage begins. The immense amounts of rain come quickly causing flash flooding. This further spreads the debris over the targeted area. This situation is also subject to many utility outages and a need for intense recovery operations. Here the transportation will also have to deal with the scattered debris, but it will also have a need for the conquering problems of standing water and extreme rainfall.

This subject leads into the next form of disaster relevant in the United States, the flood. The flood is capable of causing problems in any area of the country. Rapidly melting snow can cause floods in the north and heavy rains can cause havoc anywhere. The most vulnerable places are along the major rivers, like the Mississippi. When these areas flood, it is usually in very populated places. Flood waters can totally cut an area off causing power failure and road closings. People are essentially trapped if they do not evacuate in time. There is not much that can be done while the waters are up, but when they recede the real trouble begins. There is debris to move, but not as extravagant as in a hurricane. The main focus will be getting the unit in place to feed the people who are isolated by the loss of transportation routes. Airlift by helicopter may be an alternative solution to getting the survival facility into these areas.

Now we can discuss the service of areas hit by extreme tsunamis. Tsunamis are not a predictable disaster. They hit without notice, and can leave a wake of horrible disaster. A tsunami situation would be the easiest application for transportation of the survival facility. The disaster would have already passed only leaving roads to be cleared of debris. The real challenge will come from the task of feeding people who had no time to prepare for the disaster. Nearly everyone will be caught by surprise and need a resourceful system of maintaining the quality of life.

The last type of disaster to discuss is a terrorist attack, or man made disaster. These types of disaster usually occur in heavily populated areas and cause extreme amounts of damage. The damages are not only physical, but also very psychological.

Now that the disasters are defined we can start to look into the ways of defining the makeup of the actual survival facility. The catering industry was the first industry that offered information. The idea of catering is based on feeding a number of people quickly and efficiently. The actual food distribution is also usually confined to a small area. All these factors will be very relevant in the overall development of a mobile self-contained food distribution facility.

The first information offered in nearly all kitchen related publications is the preservation of hygiene. To accomplish this feat, adequate plumbing is a necessity. There must be hot and cold water readily available for keeping the kitchen clean, for cleaning equipment, and for the personal cleanliness of the staff on hand. Standard water pressure should not be lower than thirty psi and not higher than eighty psi. The survival facility will need a complex filtration system that will allow the conservation and quality of water to be preserved. A water production system may also be an option.

After the plumbing we go straight to the specifications of the physical surroundings: floors, walls, and ceilings. The kitchen floors have to deal with a considerable amount of wear and tear, so the material must be durable. However, this is not the only consideration. It must also be capable of easy cleaning, smooth but not slippery, even in construction, lack of cracks, and impervious. Being impervious will reduce the build up of harmful bacteria in the kitchen. The walls and ceilings follow the same general guidelines, except the walls should be light in color to maximize visibility.

Now it is time to discuss the transfer of heat in a kitchen. This area is divided into three main categories. The first is conduction. This method involves the traveling of heat from one solid to another. Then we have convection, which is the passage of heat through liquids of gasses. Lastly is the method of radiation. Here heat travels from a hot object in straight rays, and any object in the path or the rays becomes heated.

The next issue is providing the water needed. By law water authorities are required to provide a supply of clean water. The water is obtained from rainfall and collocated by natural lakes, rivers reservoirs, etc. Then it is treated before distribution to the consumers. In a disaster these options may not be available. Because of this the survival facility would need a way of recycling or producing an adequate water supply for itself and the people in need.

From here we can move into the mechanics of the kitchen atmosphere. Kitchen equipment can be classified in to three categories of discussion. The categories are broken up by the size of the appliance needed. It can also be divided into hot food prep, cold food prep, and ware washing for a more general interpretation.

The first category is large equipment. This includes stoves such as convection ovens. They operate by circulating a current of hot air throughout the oven cavity. There are microwave cookers which use high frequency waves to adequate molecules in the food in turn causing a heating effect. A combination of the previous two is also available. The combination convection and microwave uses both factors to cook the food. The final example is an induction cooker. This product utilizes solid top plates of vitroceramic material which provide heat only when pans are placed upon them. It works by a generator producing a two-way magnetic field. When the pan is place on top, the magnetic energy begins to flow through it causing heat. Induction cookers would be crucial in a tight area. They are safe because the stove surface is not hot. They are also more efficient, faster, flexible in applications, and easy to maintain.

Steamers are a popular device used in most commercial type kitchens. There are four main types: atmospheric steamer, pressure steamer, high-pressure steamer, and a pressure less convection steamer. The pressure steamer is the most popular. It can be dangerous, but it offers the most efficient productivity.

The most exciting piece of equipment is called a Bratt pan. It can act a shallow fryer, deep fryer, stewing device, brazing device, or a boiling apparatus. This unit will be ideal for application in the survival facility. Its multifunctional capabilities send it to the forefront of needs for an efficient kitchen.

Along with these heating devices I also need cooling devices. In this area there are not many options. There is a need for refrigeration and freezing. In this application the task is going to be providing enough refrigeration in the allowed space.

The final information acquired from the catering field is general but important. The application I am looking for is more along the lines of welfare catering. In this area it is important to understand that the survival facility will not be based on profits. In this case it is important to focus on providing quality food just a catering venture based on profit would; however, it will require some ingenious planning in order to provide top quality food without quality funds.

After the mechanical aspect of the kitchen is laid out there is a need to announce the environmental setting and the power need involved in running a kitchen. Without power the efficiency of the survival facility would be hindered. The facility will need to supply a durable self-contained power source, possibly a solar generator, fuel generator, or an efficient hybrid of the two different units. Inside the kitchen area the distribution of the outlets should not exceed more than six feet apart.

Lighting is an essential aspect of performing kitchen duties. Some specs to go by are that older people need more light to see. Mature people also see more amber light than blue light, and slight contrasts in color are harder to distinguish for them. So in the design the lighting should try and find a happy medium for all who might work in the area.

The survival facility is going to be a confined area. Ventilation is going to be vital in its success. Natural ventilation is going to be available, but only under allowable circumstances. Otherwise an exhaust system is going to be needed. In an exhaust system the air is captured by the ventilation unit and exhausted to the outdoors. The system will need to take into account the foods being prepared. Factors like, condensation of water when it cools and the fact that grease particles also condense into solid droplets as they cool. To capture these types of particles, select a hood that extends over most of the cooking area or possibly a downdraft system. The airflow rate must at least be 250 cfm and adequate outdoor air must be provided (Rainsford, 1996).

The next subject is the efficient storage of all the needed items in a restricted space. Cabinets are going to allow the best storage possibilities. To do this it will initially be necessary to contract a custom cabinet builder. In this area there is a need for extensive anthropometric study. Such a study will revolve around the allowed area, number of users, and types of users.

Finally, the transportation aspect has to be addressed. The plans are to integrate the above information into a self contained unit; this also includes the travel of the unit when possible. From the description of the obstacles in the first few paragraphs, the unit will need a suspension modified for all types of terrain, a higher clearance when conquering obstacles, a lower clearance during travel, a true all terrain tire, and an efficient-powerful power plant (Bargo, 1998). When self-transport is not possible it must be able to adapt to other forms, such as helicopter or train.

From all the research conducted there has been no correlation between the information found and the intended outcome of my proposed outcome. Only in the catering industry has information been found that could directly impact the project. This leaves a wide gap for my intended development, and a positive reinforcement that my findings will be new to the world.

1.5 DEFINITION OF TERMS

<u>cater</u>
Pronunciation: ‘kA-t&r
Function: verb
Etymology: obsolete cater buyer of provisions, from Middle English catour, short for acatour, from Anglo-French, from Old North French acater to buy—more at CATE
Date: 1600
intransitive senses
1: to provide a supply of food
2: to supply what is required or desired <catering to middle-class tastes>
transitive senses : to provide food and service for <catered the banquet>
- ca·ter·er /-t&r-&r/ noun

convection
Pronunciation: k&n-‘vek-sh&n
Function: noun Etymology: Late Latin convection-, convectio, from Latin convehere to bring together, from com- + vehere to carry—more at WAY
Date: circa 1623
1: the action or process of conveying
2 a: the circulatory motion that occurs in a fluid at a nonuniform temperature owing to the variation of its density and the action of gravity b : the transfer of heat by convection

debris
Pronunciation: d&-‘brE, dA-‘, ‘dA-“, British usually ‘de-(“)brE
Function: noun
Inflected Form(s): plural de·bris /-‘brEz, -“brEz/
Etymology: French débris, from Middle French, from debriser to break to pieces, from Old French debrisier, from de- + brisier to break—more at BRISANCE
Date: 1708
1: the remains of something broken down or destroyed
2: an accumulation of fragments of rock
3: something discarded : RUBBISH

distribution
Pronunciation: “dis-tr&-‘byü-sh&n
Function: noun
Date: 14th century
1 a: the act or process of distributing b : the apportionment by a court of the personal property of an intestate
2 a: the position, arrangement, or frequency of occurrence (as of the members of a group) over an area or throughout a space or unit of time b : the natural geographic range of an organism
3 a : something distributed b (1) : FREQUENCY DISTRIBUTION (2) : PROBABILITY FUNCTION (3) : PROBABILITY DENSITY FUNCTION 2
4: the pattern of branching and termination of a ramifying structure (as a nerve)
5: the marketing or merchandising of commodities

earthquake
Pronunciation: ‘&rth-“kwAk
Function: noun
Date: 14th century
1: a shaking or trembling of the earth that is volcanic or tectonic in origin
2: UPHEAVAL 2

flood
Pronunciation: ‘fl&d
Function: noun

Etymology: Middle English, from Old English flOd; akin to Old High German fluot flood, Old English flOwan to flow
Date: before 12th century
1 a: a rising and overflowing of a body of water especially onto normally dry land; also : a condition of overflowing <rivers in flood> b capitalized : a flood described in the Bible as covering the earth in the time of Noah
2: the flowing in of the tide
3: an overwhelming quantity or volume; also : a state of abundant flow or volume <a debate in full flood>

generator
Pronunciation: ‘je-n&-“rA-t&r
Function: noun
Date: 1646
1: one that generates
2: an apparatus in which vapor or gas is formed
3: a machine by which mechanical energy is changed into electrical energy
4: a mathematical entity that when subjected to one or more operations yields another mathematical entity or its elements; specifically

hurricane
Pronunciation: ‘h&r-&-“kAn, -i-k&n, ‘h&-r&-, ‘h&-ri-
Function: noun
Etymology: Spanish huracán, from Taino hurakán
Date: 1555
1: a tropical cyclone with winds of 74 miles (118 kilometers) per hour or greater that occurs especially in the western Atlantic, that is usually accompanied by rain, thunder, and lightning, and that sometimes moves into temperate latitudes—see BEAUFORT SCALE table
2: something resembling a hurricane especially in its turmoil

hygiene
Pronunciation: ‘hI-“jEn also hI-‘
Function: noun
Etymology: French hygiène & New Latin hygieina, from Greek, neuter plural of hygieinos healthful, from hygiEs healthy; akin to Sanskrit su well and to Latin vivus living—more at QUICK
Date: 1671
1: a science of the establishment and maintenance of health
2: conditions or practices (as of cleanliness) conducive to health

impervious
Pronunciation: (“)im-‘p&r-vE-&s
Function: adjective
Etymology: Latin impervius, from in- + pervius pervious

Date: 1650
1 a: not allowing entrance or passage : IMPENETRABLE <a coat impervious to rain> b : not capable of being damaged or harmed <a carpet impervious to rough treatment>
2: not capable of being affected or disturbed <impervious to criticism>
- im·per·vi·ous·ly adverb
- im·per·vi·ous·ness noun

psi
Function: abbreviation
pounds per square inch

survival
Pronunciation: s&r-‘vI-v&l
Function: noun
Usage: often attributive
Date: 1598
1 a: a living or continuing longer than another person or thing b : the continuation of life or existence <problems of survival in arctic conditions>
2: one that survives

terrorism
Pronunciation: 'ter-&r-"i-z&m
Function: noun
: the systematic use of terror especially as a means of coercion

tornado
Pronunciation: tor-‘nA-(“)dO
Function: noun
Inflected Form(s): plural -does or -dos
Etymology: modification of Spanish tronada thunderstorm, from tronar to thunder, from Latin tonare—more at THUNDER
Date: 1556
1 archaic : a tropical thunderstorm
2 a: a squall accompanying a thunderstorm in Africa b : a violent destructive whirling wind accompanied by a funnel-shaped cloud that progresses in a narrow path over the land
3: a violent windstorm : WHIRLWIND
Bottom of Form

transportation
Pronunciation: “tran(t)s-p&r-‘tA-sh&n”
Function: noun
Date: 1540
1: an act, process, or instance of transporting or being transported

2: banishment to a penal colony`
3 a: means of conveyance or travel from one place to another b : public conveyance of passengers or goods especially as a commercial enterprise

tsunami
Pronunciation: (t)su-'nä-mE
Function: noun
Inflected Form(s): *plural* tsunamis *also* tsunami
Etymology: Japanese, from *tsu* harbor + *nami* wave
: a great sea wave produced by submarine earth movement or volcanic eruption : TIDAL WAVE

ventilation
Pronunciation: “ven-t&l-‘A-sh&n
Function: noun
Date: 1519
1: the act or process of ventilating
2 a: circulation of air <a room with good ventilation> b : the circulation and exchange of gases in the lungs or gills that is basic to respiration
3: a system or means of providing fresh air
Bottom of Form

1.6 ASSUMPTIONS

- There is a need in disaster situations for a modular, self-contained food distribution center.
- This center will have to be highly mobile.
- There will be a need for an efficient system to successfully run the operation.
- Workers involved in restoring, rescuing disaster victims will work better provided real meals.
- The victims will suffer less and have higher hopes by providing them with cooked meals.

1.7 SCOPE AND LIMITS

1.71 SCOPE OF THESIS

The scope of this project will entail discovery of efficient kitchen design, restaurant operation, kitchen appliance design, and knowledge of all large scale disasters through research conducted in the library, internet, and human interaction. There will be research, drawings, CAD models, anthropometric charts, and diagrams produced during the project.

1.72 LIMITS OF THESIS

The limitations I anticipate on encountering involve the physical size of the project. A complete physical model of the system will require funding and time not available. I also do not plan on first hand experience of all the disasters I plan to design for.

1.8 PROCEDURE AND METHODS

1.81 PROCEDURE OF RESEARCH

- Identify a real need for full a full service food distribution plan in disaster recovery situations.
- Go to libraries, internet, and facilities to gather research materials.
- Make notes on gathered research materials.
- Define the transportation limits.
- Define the optimal containment size.
- Discover the most versatile food service appliances for allowed size.
- Discover the most compact food service appliances for allowed size.
- Report findings

- Develop unique adaptations of findings.
- Arrange adaptations into the most efficient way possible for given containment size.
- Develop an efficient distribution system for the projects purpose (quality food distribution in recovery situations).
- Arrange all findings into a thesis.

1.82 MEATHODS OF RESEARCH

- To identify the need, focus was placed on the need for quality food needs in disaster situations. The people involved in disasters, like victims and recovery personnel, are at a loss for prepared food. Having a unit and system, as proposed, will accomplish the goal of quality food distribution and the raising of moral and productivity in the time following a large scale disaster.
- To gain the knowledge needed I have called on library research, internet research, and human input. The subjects I have employed include: Natural disasters, Man-made disasters, how to run a successful restaurant, how to develop a successful restaurant, commercial kitchen guidelines, appliance research, catering research, food distribution on trains, food distribution by the military, kitchen design, appliance design, all-terrain drive systems.
- From these areas I can develop notes and opinions relevant to my desired outcome.
- To define transportation limits it will be wise to look into the areas of eighteen-wheeled freight, as well as road restrictions in the country.

- From here I will be able to set restrictions for my design. It will give me maximum limitations that I can work within to develop the best possible solution.
- From the above research I can gain the knowledge of the appliances I will need in the facility. My plan is to manipulate these known products and develop my own variations that will provide the most effective result in my confined environment. This step will require concept development and anthropometric studies.
- Next the guidelines for the way of running the system will be needed. Again I will call on the research to find these answers. This section will be more on the side of running restaurants and catering services.
- Finally the project will be complete.

1.9 ANTICIPATED OUTCOME

The anticipated outcome of my research is to develop a final system and a CAD prototype. I will have research of disasters, research of commercial kitchen equipment, and environmental design. There will be a final CAD prototype of the operation unit. I also plan on having a system developed to evaluate the food distribution in the given situations. The final deed will be the compiling of information into a successful thesis.

2. DISASTERS AND THEIR COMPONENTS

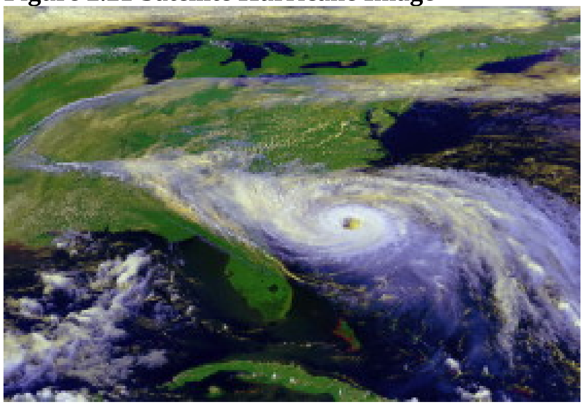
2.1 INTRODUCTION

This chapter will offer a further understanding of the disasters being dealt with throughout this thesis. This understanding will set a firm knowledge base to build the remainder upon. The discussion will include the definition of five different types of disasters the human race deals with many times a year. These disasters are: hurricanes, floods, earthquakes, tsunamis, and terrorism.

2.2 HURRICANES

By definition a hurricane (figure 2.21) is a tropical cyclone with winds of 74 miles (118 kilometers) per hour or greater that occurs especially in the western Atlantic, that is usually accompanied by rain, thunder, and lightning, and that sometimes moves into temperate latitudes (Merriam-Webster, 1997). They occur mainly in the southeastern United States. States like Louisiana, Mississippi, Florida, and Georgia are the prime targets. The hurricane's cousin, the typhoon, is a similar storm that causes trouble in the Pacific Realm. The destruction from hurricanes is two-fold; the damage is from high winds and torrential rain. The high winds destroy most of the structures in their way. This destruction clutters the area with debris from destroyed housing: shingles, wood, furniture, etc. The immense amounts of rainfall quickly accumulate, causing flash flooding. The flooding further spreads the debris over the area.

Figure 2.21 Satellite Hurricane Image



2.3 FLOODS

The flood (figure 2.31) is a rising and overflowing of a body of water especially onto normally dry land (Merriam-Webster, 1997). A flood is capable of causing problems in any area of the country. Rapidly melting snow can cause floods in the north and heavy rains can cause havoc anywhere. The most vulnerable places are along major rivers. This is due to the fact that most river basins prove to be heavily populated due to shipping and fertility issues. Flood waters can totally cut an area off; this includes travel and power resources. People are trapped if they do not evacuate in time. There is not much that can be done while the waters are up, but when they fall there is extreme property damage along with an abundance of scattered debris.

Figure 2.31 Rising Flood Waters

2.4 EARTHQUAKES

The definition of an earthquake (figure 2.41) is a shaking or trembling of the earth that is volcanic or tectonic in origin (Merriam-Webster, 1997). Earthquakes are primarily a problem in the western United States; however, they are capable of occurring anywhere on earth. In an earthquake there is destruction of property from the movement of plates in the earth's crust. The natural shifting of these plates causes the surface of the earth to move. This violent activity destroys roads, building, and utilities. Because many utilities are now put underground they are a prime target for the effects of an earthquake.

Figure 2.41 Earthquake Highway Destruction

2.5 TSUNAMIS

A tsunami (figure 2.51) is a great sea wave produced by submarine earth movement or volcanic eruption (Merriam-Webster, 1997). This type of disaster can affect any coastal region. Because the water surge is produced by offshore activity they are not often recognized until it is too late. Tsunamis are also very destructive due to the population concentrations on most habitable coastlines. The wall of water comes ashore rapidly and can reach miles past the original coastline. After the surge recedes there is expensive property damage and devastation very similar to that of a coastal hurricane.

Figure 2.51 Tsunami Storm Surge

2.6 TERRORISM

Terrorism is the systematic use of terror especially as a means of coercion (Merriam-Webster, 1997). 9-11 (figure 2.61) showed our society that terrorism is capable of occurring anywhere in the world. The element of surprise is the biggest destruction factor, and when that is combined with a densely populated situation the outcome is potentially devastating. Most attacks utilize some type of explosion for the desired effect. These large-scale explosions resemble an earthquake in most facets. There is human, utility, and property loss in nearly all terrorist attacks.

Figure 2.61 Twin Towers Destruction

2.7 Conclusion

By describing, in detail, what the five most common disasters: hurricanes, floods, earthquakes, tsunamis, and terrorist attacks entail. There is a solid foundation upon which to build the rest of this document. This knowledge will aid in understanding the scale of the situations this system will be providing for and the logistic system explained in the next chapter.

3. PREDISTRIBUTION EVALUATION SYSTEM

3.1 INTRODUCTION

After a disaster occurs there is a need to determine the extent of the damage. To determine this I developed a logistic system, in the form of a bubble diagram, to properly evaluate the disaster at hand. The goal of the system is to properly state the number of people in need after any type of disaster. It is designed in a graphic model to allow every aspect of the disaster situation to be seen at once and easily understood by all involved in the recovery. The system is broken into three phases. The first phase allows the users to determine the amount of people in need. The second phase uses the information from the previous phase to determine the amount of food needed for the project. In the final phase you are allowed to take the compiled information, and modularly equip the food distribution unit for the task. These three phases will make for the most efficient and productive use of the food distribution unit.

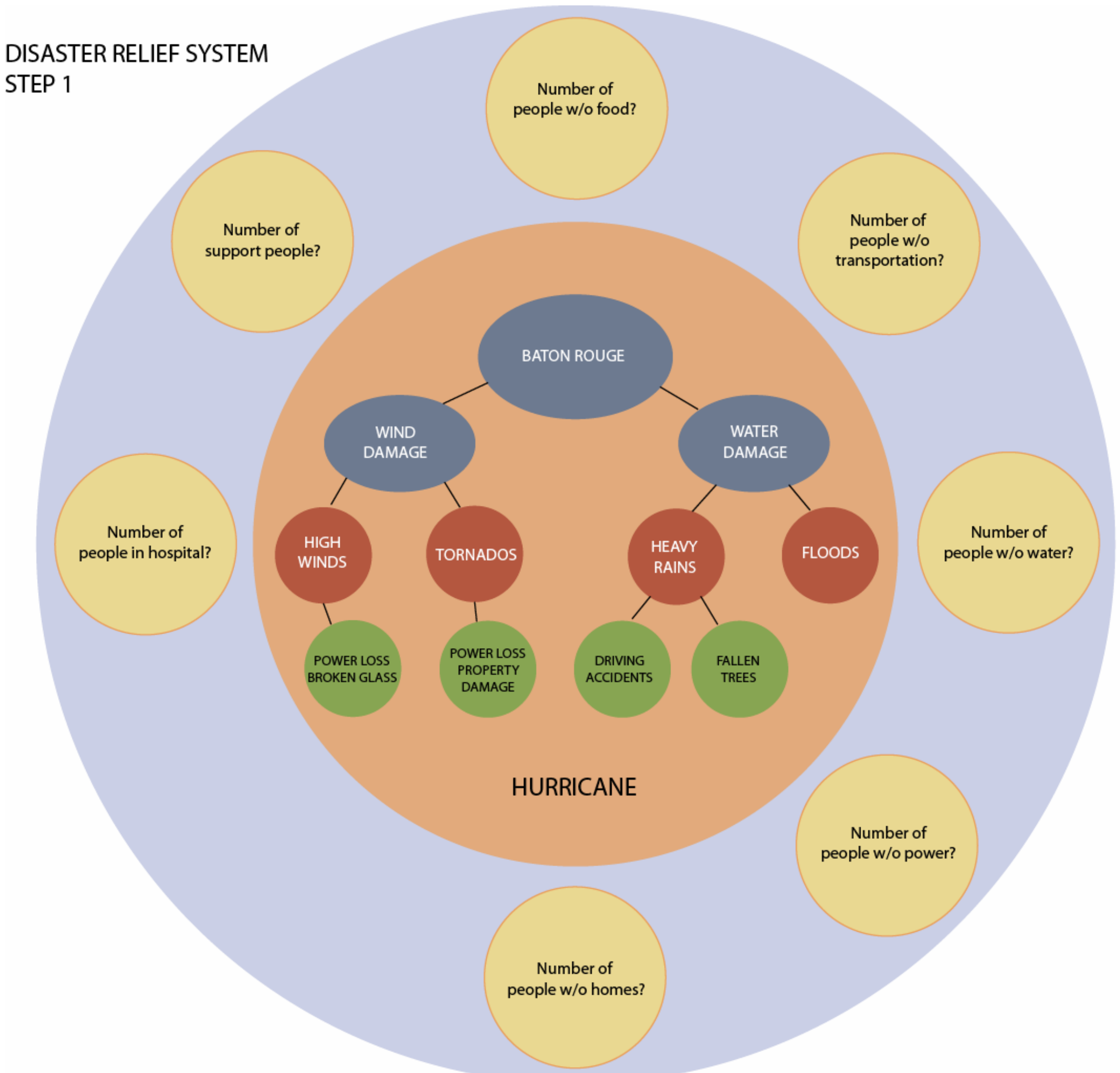
3.2 PHASE ONE

The challenge of the first phase is to determine the number of people that will be needing food aide after a disaster strikes. The first step, represented by the inner circle, is used to state the type of disaster being dealt with. After the disaster type is stated, a flow chart begins on the inside of the circle.

The flow chart starts with area affected: city, county, state. The next flow describes the general types of damage the particular disaster can inflict on an area: wind, water, fire. The third set in the flow breaks down the exact forces that caused damage during the disaster: tornadoes, heavy rain, high winds. The final step of the flow chart describes the obstacles that occurred from the natural forces applied to the area: power loss, downed trees, driving accidents. After this flow chart is completed, there will be a focused description of all the possible situations the relief group may encounter during the relief effort.

With a detailed effort in the first two steps there will be an opportunity to determine the number of people that will be needing food relief in the given area. The outer bubble uses the inner bubbles information to do this. By finding out the populous of areas with problems such as no power, blocked roads, no transportation, and the number of relief workers that will be brought in, the relief coordinators will have an accurate count of the people needing food. The numbers found in this section are put into individual bubbles and placed in the outer part of the larger bubble. The final part of phase one is only simple addition. By taking the person totals in the outer ring and adding them together, the total person need will be displayed. The graphic display of phase one is provided in (figure 3.21).

Figure 3.21 Disaster Relief System Phase One



3.3 PHASE TWO

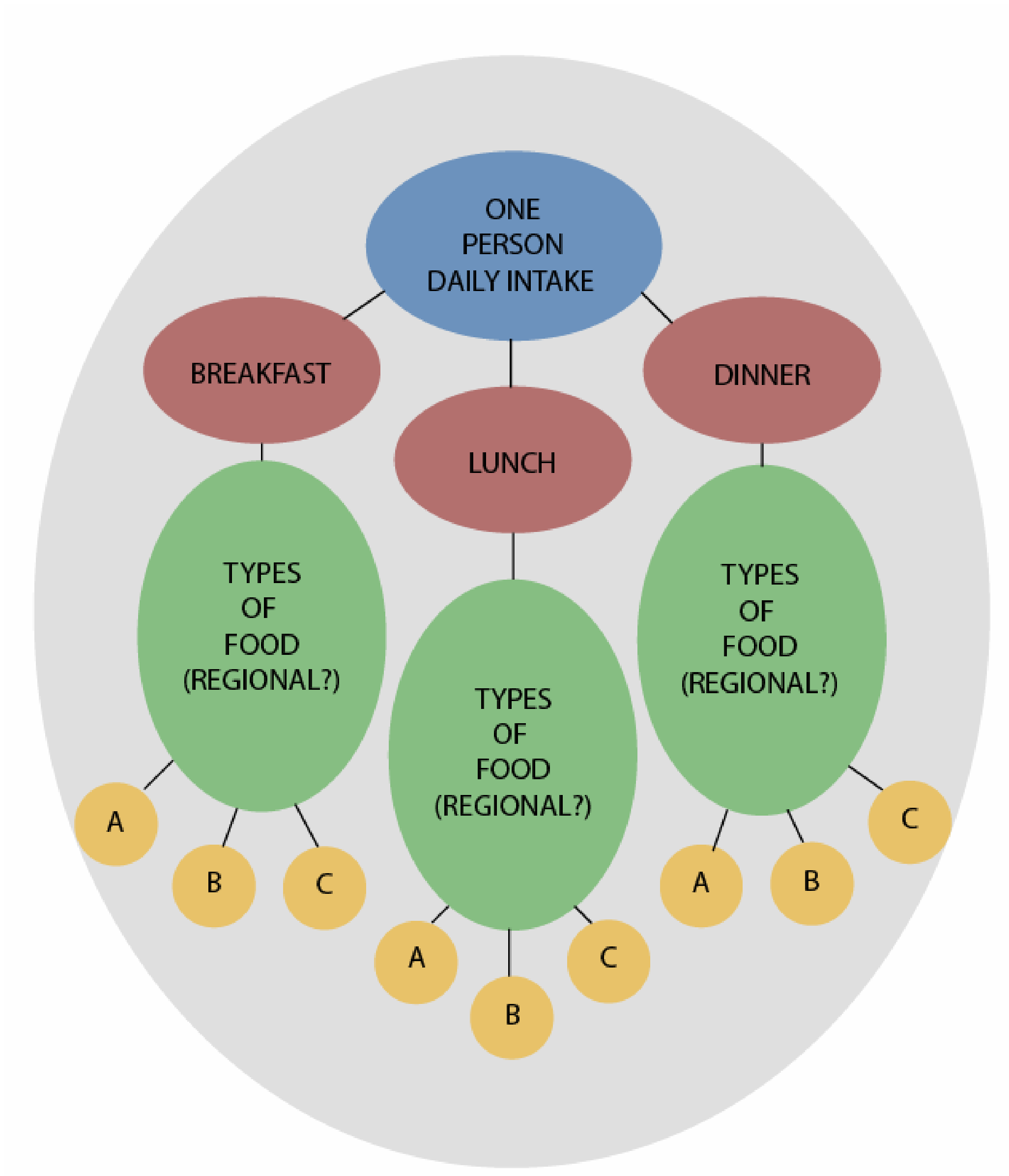
The second phase of this system allows the relief coordinators to decide what the plan will be for feeding the number of people determined in Phase One. It breaks down the amount, type, and menu items the effort will provide on a daily basis. This phase is laid out in a flow chart format encased in one bubble. The first step in this phase is to determine the amount of food needed for one person to remain in a healthy and productive state. These numbers will need to be verified by a certified nutritionist.

The next step will be to determine the number of meals the relief effort will provide daily. In the provided example (figure 3.31) the number is three: breakfast, lunch, and dinner. This is an example of a perfect supply situation. If there are not enough supplies to allow a three meal effort, adjustments will have to be made to provide the most relief.

The third level is a unique element that will provide increased moral and productivity to the disaster situation. The element is called regional sensitivity. Regional sensitivity is the idea that by finding menu items that appeal to the culture of the people in the affected area, they will feel more comfortable in the adverse situation. Obviously, this will not be possible in all situations, but if possible it will be advantageous.

The final section of phase two gives the relief team a place to lay out the menu items that will be available for each serving session. These items will be relative to the time of day, for example: morning = breakfast, and will be regionally sensitive if the items are available. After this is complete the total amount of food needed is determined by simply multiplying the phase one total by the phase two totals. A graphic representation of phase two is (figure 3.31).

Figure 3.31 Disaster Relief System Phase Two



3.4 PHASE THREE

The third phase is a flow chart (figure 3.41) designed to use the information found from the previous two phases to pin-point the needs for the relief effort. It charts out what is going to be needed to equip one truck for the most effective and efficient dispersal of food and the other supplies needed to feed the distressed. It takes in to account five initial subjects that can be broken down into specific needs for the completion of the job.

The first subject to look at is the “types of equipment” needed for the actual food preparation and service. Under this subject are three very important subcategories: cooking, dining, and drinking. Because the types of equipment will determine the amount of food one distribution unit can prepare and deliver in one day it is possibly the most important. This section is directly determined by the numbers found in the previous two phases. The cooking equipment is initially going to be determined, first, by the amount of food needed daily, and, second by the types of food. The main goal in a large scale disaster is to provide the maximum amount of food in the shortest amount of time. If the scale is small and mildly threatening, more consideration on the meal types will be necessary. The second part of this section is dining. The dining equipment will be separate from the kitchen truck, but is vital to the project. This category includes plates and utensils, and here the decision will be made to use reusable or disposable items. The last part of the equipment section is drinking. Here the decision is made on cups. The decisions here also include reusable or disposable, but there is also a need to determine the volume of the cups. This is directly affected by the supply of drinking liquids available and the recommended size provided by a licensed nutritionist.

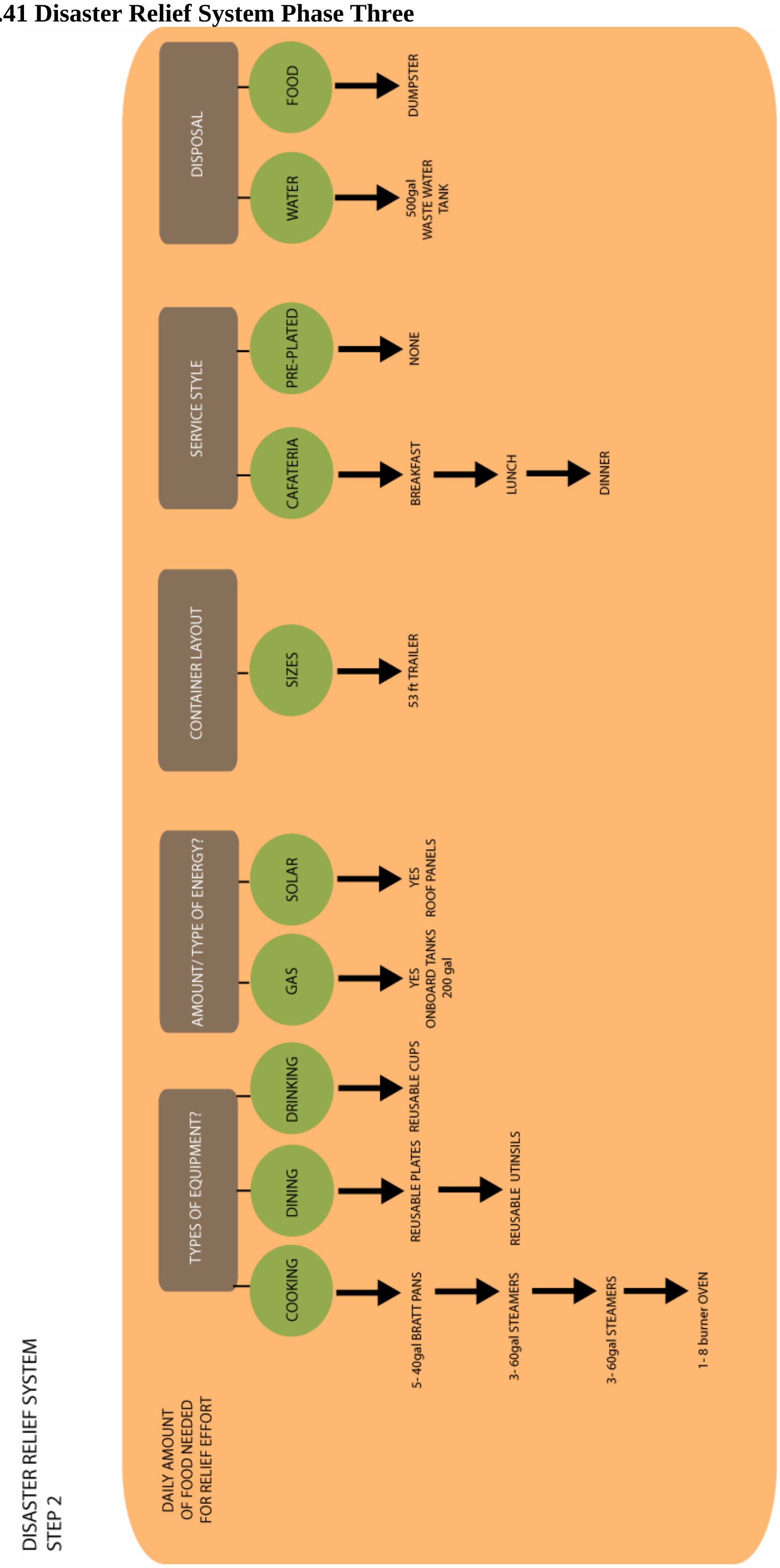
The second subject is titled "amount/ type of energy" needed to run one truck in the most efficient and environmentally safe manner. This area allows the project coordinators to decide what energy types will best fit the situation. In an area where electricity is available, the kitchen unit will be able to use it, but if electricity is unavailable the unit will use a generator along with solar energy. A solar source will be incorporated into the units design and used on all units. The other energy source will be used to operate the kitchen equipment. Because the equipment will be of professional grade the energy source of choice is natural gas. The only factor that will need consideration is the size of the tank needed for the given relief effort.

The next subject, "container size," is not a very in depth subject, but obviously vital to the project. In this study the length of fifty-three feet will be used, which is under the sixty-five feet limit allowed by the Federal Highway Administration (FHWA).   The average container height of eight feet and the average width of one hundred and two inches will also be used in this study. These sizes will be used in the anticipation of providing for large scale disasters, in which the most possible productivity of food preparation is needed. If the system is adopted for actual use, it can be adapted to smaller container sizes for smaller scale situations.

Fourth on the list of main subjects, "service style," does not directly affect the design on the actual container. However, it is essential for the efficient operation of the food distribution project. The two options possible in this system diagram are a "cafeteria" style of service or a "pre-plated" style of service. A cafeteria style of service is used in this example. Depending on the scale of the project and resources available the style of service may be adjusted. If the environment restricts placement of the distribution unit, a pre-plated style may be used, thus allowing for food to be brought into confined areas. Cafeteria style will be the most efficient, but having options will provide a more versatile operation.

The final section of phase three involves waste disposal. Waste disposal includes trash waste and water waste. The trash waste will have to be stored in an approved waste dumpster. If a recycling option is available in the area it will also be utilized. The waste water situation has a couple of options. The most efficient and easy option would be access to an underground disposal tank or sewer system. The unit may need to be fitted with a grease trap, which will be an option. In cases where this option is not available, there will be a need for a waste water tank. Waste water tanks are available in most areas, and are easily transportable.

Figure 3.41 Disaster Relief System Phase Three



3.4 CONCLUSION

By breaking down the project into individual elements the project manager will have an easier time grasping the project as a whole. By placing these elements into a flow chart format the project is organized in a graphic form. The graphic layout allows for easier understanding by all the parties involved. When all the parties are able to see and understand the goals and objectives, the solution will efficiently come to fruition.

4. EQUIPMENT RESEARCH AND APPLICATIONS

4.1 INTRODUCTION

The third phase of the pre-distribution evaluation system, discussed in the previous chapter, provides a graphic starting point for this chapter. This chapter will specifically discuss the different types of equipment that can be used in the construction of the distribution unit, and the optimal ways the equipment will be used in the final product. At the end of this chapter, all the necessary components will be available for the final design.

4.2. UNIT FRAME

The first section will primarily discuss the trailer options that are available and the restrictions that will need to be followed in order for legal transport of the unit. The food distribution unit is going to be built as a tractor-trailer transport. It will be taken to needed locations primarily on roadways. The design, however, is going to incorporate airlift and maritime transport options.

Standard large trailer sizes range from twenty-eight to fifty-three feet (figure 4.21). The overall length limit given by the United States Department of Transportation Federal Highway Administration (FHWA) for a tractor-semitrailer combination is sixty-five feet (FHWA, 1998).

In this study, a modified fifty-three feet trailer will be used (Figure 4.22). The trailer's width will be eight feet, and the height will be eleven and a half feet. These dimensions will allow for optimal equipping and transportability.

Figure 4.21 Comparative Trailer Chart

	Inside Length	Inside Width	Inside height Center	Inside height front	Door opening width	Door opening height	Rear floor height	Overall height	Cubic capacity
 **28' x 102" Trailer**	27' 3"	97"	111"	109"	105"	93"	105"	50"	2,024 c.ft.
 **45' x 96" Trailer**	44' 2"	91"	111"	108"	105"	87"	105"	50"	3,076 c.ft
 **48' x 102" Trailer**	47' 2"	97"	111"	109"	105"	93"	105"	50"	3,470 c.ft.
 **53' x 102" Trailer**	52' 3"	97"	111"	109"	105"	93"	105"	50"	3,963 c.ft

Figure 4.22 Modified Trailer Example

4.3 COOKING EQUIPMENT

This section discusses three types of cooking equipment that will provide the most production in the limited space. Professional style equipment will be used because of the output capabilities. Durability is also an aspect that professional equipment offers. The final design is based on modularity of these components. The modularity will come from an innovative design solution; the solution will be discussed in the final chapter.

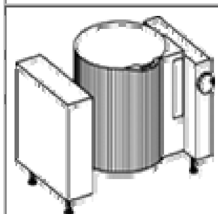
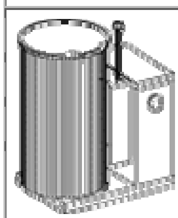
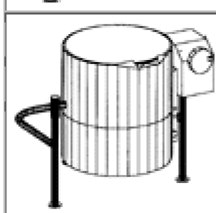
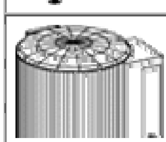
4.31 STEAMER

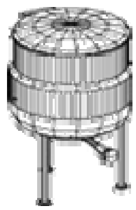
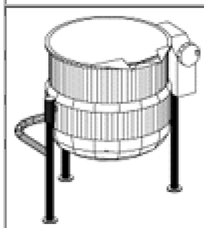
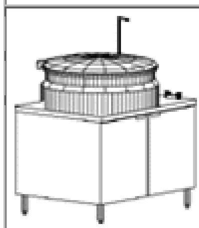
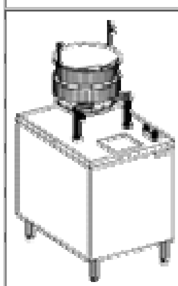
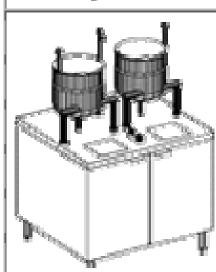
The first type of equipment is the steam kettle (figure 4.31.1). Steam kettles are widely used as a substitute for stock-pot cooking. Kettle cooking is more gentle, consistent, and, most importantly, faster than other cooking methods. Steam kettles are available in self-contained gas or electric models. This study is going to incorporate a gas model because of speed and possible lack of electricity in disaster areas. Most of the large kettles also have a tilt option for easy dispersal of the given contents.

Figure 4.31.1 Large Kettle Steamer

They range in capacity from six gallons to eighty gallons. The most desirable range for this study is forty gallons to eighty gallons. A sixty gallon unit will be used in the final design of this thesis. Below (figure 4.31.2) is a product comparison chart of the different styles and sizes that may be used in the unit in different circumstances.

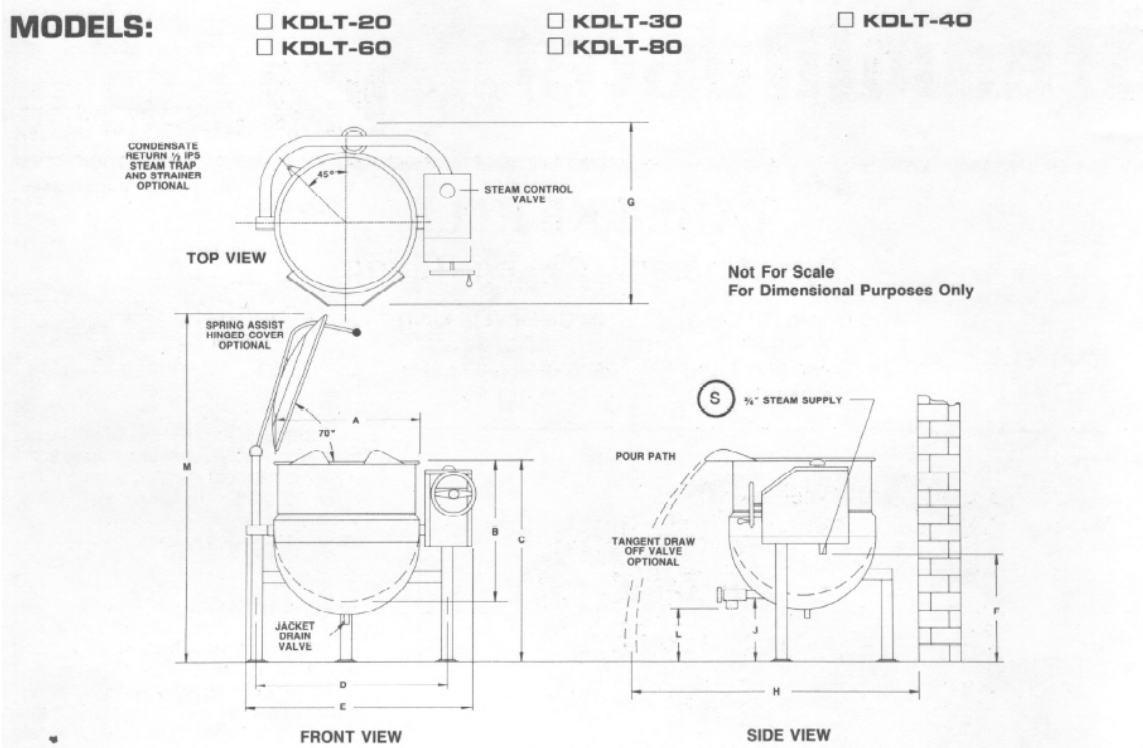
Figure 4.31.2 Kettle Steamer Comparison Chart

DESIGN	MODEL	CAPACITY	STYLE	ENERGY
	KSLG-20	20 gallon	Stationary	gas
	KSLG-40	40 gallon	Stationary	gas
	KSLG-60	60 gallon	Stationary	gas
	KTLG-20	20 gallon	Tilting	gas
	KTLG-40	40 gallon	Tilting	gas
	KTLG-60	60 gallon	Tilting	gas
	KECT-06	6 gallon, counter	Tilting	electric
	KECT-10	10 gallon, counter	Tilting	electric
	KECT-12	12 gallon, w/legs	Tilting	electric
	KECT-30	20 gallon, w/legs	Tilting	electric
	KELS-20	20 gallon	Stationary	electric
	KELS-40	40 gallon	Stationary	electric
	KELS-60	60 gallon	Stationary	electric
	KELS-80	80 gallon	Stationary	electric
	KELT-20	20 gallon	Stationary	electric
	KELT-40	40 gallon	Stationary	electric
	KELT-60	60 gallon	Stationary	electric
	KEPS-20	20 gallon	Stationary	electric
	KEPS-40	40 gallon	Stationary	electric
	KEPS-60	60 gallon	Stationary	electric

	KDLS-20	20 gallon	Stationary	direct steam
	KDLS-30	30 gallon	Stationary	direct steam
	KDLS-40	40 gallon	Stationary	direct steam
	KDLS-60	60 gallon	Stationary	direct steam
	KDLS-80	80 gallon	Stationary	direct steam
	KDLS-20F	20 gallon, full jacketed	Stationary	direct steam
	KDLS-40F	40 gallon, full jacketed	Stationary	direct steam
	KDLS-60F	60 gallon, full jacketed	Stationary	direct steam
	KDLS-80F	80 gallon, full jacketed	Stationary	direct steam
	KDLT-20	20 gallon	Tilting	direct steam
	KDLT-40	40 gallon	Tilting	direct steam
	KDLT-60	60 gallon	Tilting	direct steam
	KDLT-80	80 gallon	Tilting	direct steam
	DMT-40	40 gallon	Tilting	direct steam
	DMT-60	60 gallon	Tilting	direct steam
	DMS-20	20 gallon	Stationary	direct steam
	DMS-40	40 gallon	Stationary	direct steam
	DMS-60	60 gallon	Stationary	direct steam
	GMT-6	6 gallon kettle with boiler base	Tilting	gas
	EMT-6	6 gallon kettle with boiler base	Tilting	electric
	DMT-6	6 gallon kettle with boiler base	Tilting	direct steam
	GMT-10	10 gallon kettle with boiler base	Tilting	gas
	EMT-10	10 gallon kettle with boiler base	Tilting	electric
	DMT-10	10 gallon kettle with boiler base	Tilting	direct steam
	GMT-6-6	Two 6 gallon kettle with boiler base	Tilting	gas
	EMT-6-6	Two 6 gallon kettle with boiler base	Tilting	electric
	DMT-6-6	Two 6 gallon kettle with boiler base	Tilting	direct steam
	GMT-10-6	10 gallon and 6 gallon kettle with boiler base	Tilting	gas
	EMT-10-6	10 gallon and 6 gallon kettle with boiler base	Tilting	electric
	DMT-10-6	10 gallon and 6 gallon kettle with boiler base	Tilting	direct steam

The model chosen for this thesis application is the KDLT-60 (figure 4.33) from the North Carolina company, Southbend. The following chart gives exact specifications that will be vital in the design process.

Figure 4.31.3 60 Gallon Steam Kettle Dimension Diagram



DIMENSIONS: ( ) = Millimeters

MODEL	Capacity	A	B	C	D	E	F	G	H	J	K	L	M
☐ KDLT-20	20 U.S. Gal. 76 Liter	20" (508)	18" (460)	37" (940)	34.75" (885)	28.5" (724)	22" (559)	28.5" (724)	41" (1041)	15.25" (390)	12" (305)	16.87" (440)	59.5" (1512)
☐ KDLT-30	30 U.S. Gal. 114 Liter	24" (610)	20" (510)	37" (940)	37.75" (960)	31.5" (800)	20.75" (527)	30" (762)	42.5" (1080)	13.25" (335)	12.5" (317)	14.87" (390)	62.5" (1588)
☐ KDLT-40	40 U.S. Gal. 151 Liter	26" (660)	22.5" (570)	37" (940)	39.75" (1010)	33.5" (850)	20.25" (514)	32" (813)	45" (1143)	10.75" (275)	13" (330)	12.37" (314)	64" (1626)
☐ KDLT-60	60 U.S. Gal. 227 Liter	29.5" (750)	26" (660)	40.5" (1030)	43.25" (1100)	37" (940)	18.75" (476)	35.75" (910)	48.5" (1232)	10.25" (260)	13.75" (350)	12.37" (314)	71.5" (1816)
☐ KDLT-80	80 U.S. Gal. 303 Liter	33" (840)	28" (710)	42.5" (1080)	46.75" (1185)	40.5" (1030)	20" (508)	40" (1016)	52.5" (1334)	9.75" (250)	14.5" (368)	12.37" (314)	76" (1930)

SERVICE CONNECTIONS

S Steam supply: ¾" IPS (19 mm)   CR Condensate return: ½" IPS (13mm)

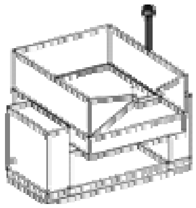
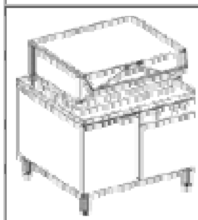
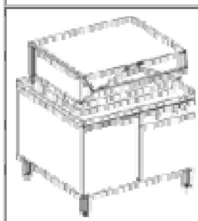
4.32 BRAISING/ BRATT PANS

The Bratt pan (figure 4.32.1) is a unit like a griddle with high sides and a cover. They are the most versatile unit incorporated in this study. They can: roast, fry, braise, boil, simmer, thaw, sauté, grill, steam, hold, and serve almost any menu item desired. For these reasons the braising pan will be the most utilized equipment type in the final design. Bratt pans range in size from twelve gallons to forty gallons. As seen in the

Figure 4.32.1 Large Braising/ Bratt Pan

picture the unit also has a tilting function that aides in the dispersal of the contents. The forty gallon model will be used in this study. Below (figure 4.32.2) is a product comparison chart to outline the model styles available for other applications.

Figure 4.32.2 Braising/ Bratt Pan Product Comparison Chart

STYLE	MODEL	CAPACITY	ENERGY
	BECT-12	12 gallon capacity, counter unit	electric
	BGLT-30	30 gallon capacity, open base, manual tilt	gas
	BGLT-40	40 gallon capacity, open base, manual tilt	gas
	BECT-24	30 gallon capacity, open base, manual tilt	electric
	BECT-30	40 gallon capacity, open base, manual tilt	electric
	BECT-40	40 gallon capacity, open base, manual tilt	electric
	BGMTS-30	30 gallon capacity, cabinet base, hydraulic tilt	gas
	BGMTSE-30	30 gallon capacity, cabinet base, electric tilt	gas
	BGMTS-40	40 gallon capacity, cabinet base, hydraulic tilt	gas
	BGMTSE-40	40 gallon capacity, cabinet base, electric tilt	gas
	BEMTS-30	30 gallon capacity, cabinet base, hydraulic tilt	electric
	BEMTSE-30	30 gallon capacity, cabinet base, electric tilt	electric
	BEMTS-40	40 gallon capacity, cabinet base, hydraulic tilt	electric
	BEMTSE-40	40 gallon capacity, cabinet base, electric tilt	electric

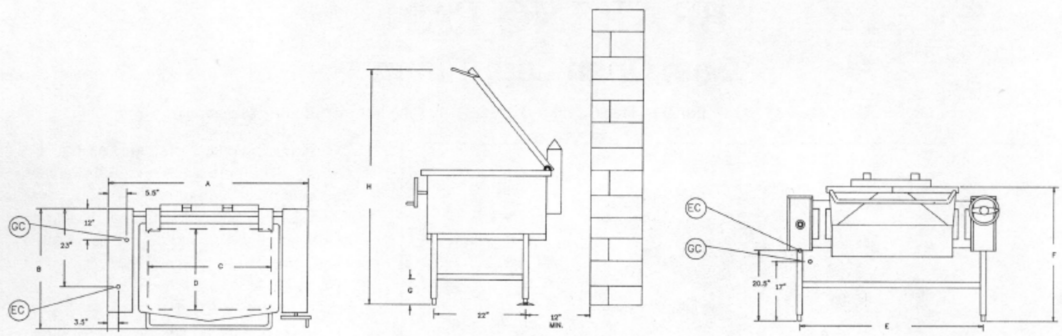
The model chosen for the final design is the BGLT-40, produced by the North Carolina company, Southbend. The chart below (figure 4.32.3) provides the specifications necessary to incorporate the unit into the final design.

Figure 4.32.3 40 Gallon Braising Pan Dimension Diagram

MODELS: ☐ BGLT-30 ☐ BGLT-40

Specifications are subject to change without notice.

For dimensional purpose only. Not for scale.



TOP VIEW SIDE VIEW FRONT VIEW

DIMENSIONS:

( ) = Millimeters

MODEL	CAPACITY	A	B	C	D	E	F	G	H
☐ BGLT-30	30 gallons 114 litres	49.5″ (1257)	35″ (889)	33.5″ (851)	24″ (610)	43.125″ (1095)	37″ (940)	10.5″ (267)	68″ (1727)
☐ BGLT-40	40 gallons 152 litres	58.5″ (1486)	35″ (889)	43.5″ (1105)	24″ (610)	52.125″ (1324)	37″ (940)	10.5″ (267)	68″ (1727)

MODEL	Gas Type	BTU/HR.	Water Column Pressure
BGLT-30	Natural	80,000	3.5″
	Propane	80,000	10″
BGLT-40	Natural	100,000	3.5″
	Propane	100,000	10″

SERVICE CONNECTIONS

GC – Supply gas through 1/2″ pipe with pressure of approx. 7″ W.C. For propane use 11″ W.C. pressure. A gas shut-off valve must be installed in supply piping convenient and adjacent to appliance.

EC – Unless otherwise specified, Field Wire Electrical Connection to be 120 Volts, 60 Hertz single phase with grounding wire.

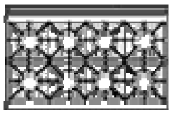
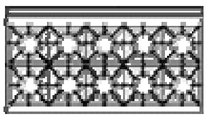
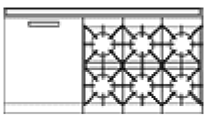
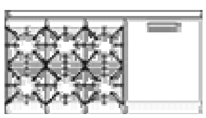
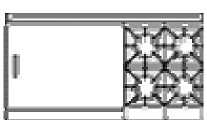
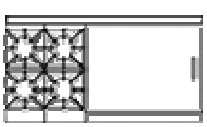
4.33 RANGE AND OVEN

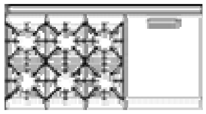
In a professional kitchen a range top is essential to operation; however, in this study it is slightly less important because of capacity restrictions. The high output needed for disaster relief lends itself better to the previous two pieces of equipment. The grate top ranges do offer another positive element. They are very diverse in their space usage. They offer options of two, six, or eight burners. An eight burner setup (figure 4.33.1) will be used in the final design of this study. The other great

Figure 4.33.1 Eight Burner/ Two Oven Unit

feature of these range systems is the under the range options. Models can be chosen with ovens, cabinets, or shelves. The eight burner system used here will utilize the space with two ovens. The ovens will allow for baking and food heating. On top there will be eight, sixteen inch, burners. These burners will allow for large skillet sauté, and large pot cooking when necessary. Below (figure 4.33.2) is a product comparison chart to outline the available model styles available for other applications.

Figure 4.33.2 Burner Stove Product Comparison Chart

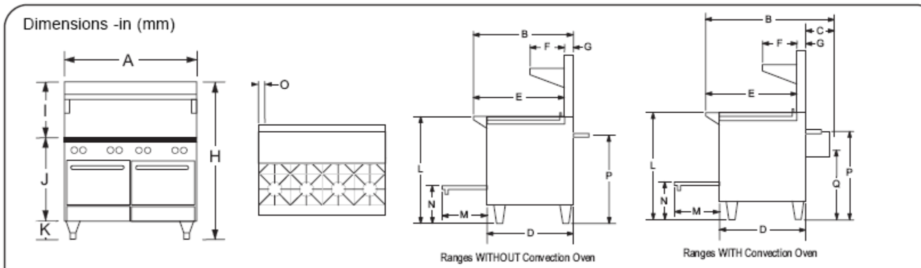
CONFIGURATION	MODEL	DESCRIPTION	OVEN BASE
	448EE	8 Burners	standard
	448EE-2GL	4 burners, 24" griddle on left	standard
	448EE-2TL	4 burners, 24" griddle on left with thermostatic controls	standard
	448EE-2GR	4 burners, 24" griddle on right	standard
	448EE-2TR	4 burners, 24" griddle on right with thermostatic controls	standard
	460DD	10 Burners	2 std.
	460AD	10 Burners	conv./std.
	460AA	10 Burners	conv./conv.
	460DD-2GL	6 burners, 24" griddle (left)	2 std.
	460DD-2TL	6 burners, 24" griddle (left) with thermostatic controls	2 std.
	460AD-2GL	6 burners, 24" griddle (left)	conv./std.
	460AD-2TL	6 burners, 24" griddle (left) with thermostatic controls	conv./std.
	460AA-2GL	6 burners, 24" griddle (left)	conv./conv.
	460AA-2TL	6 burners, 24" griddle (left) with thermostatic controls	conv./conv.
	460DD-2GR	6 burners, 24" griddle (right)	2 std.
	460DD-2TR	6 burners, 24" griddle (right) with thermostatic controls	2 std.
	460AD-2GR	6 burners, 24" griddle (right)	conv./std.
	460AD-2TR	6 burners, 24" griddle (right) with thermostatic controls	conv./std.
	460AA-2GR	6 burners, 24" griddle (right)	conv./conv.
	460AA-2TR	6 burners, 24" griddle (right) with thermostatic controls	conv./conv.
	460DD-3GL	4 burners, 36" griddle (left)	2 std.
	460DD-3TL	4 burners, 36" griddle (left) with thermostatic controls	2 std.
	460AD-3GL	4 burners, 36" griddle (left)	conv./std.
	460AD-3TL	4 burners, 36" griddle (left) with thermostatic controls	conv./std.
	460AA-3GL	4 burners, 36" griddle (left)	conv./conv.
	460AA-3TL	4 burners, 36" griddle (left) with thermostatic controls	conv./conv.
	460DD-3GR	4 burners, 36" griddle (right)	2 std.
	460DD-3TR	4 burners, 36" griddle (right) with thermostatic controls	2 std.
	460AD-3GR	4 burners, 36" griddle (right)	conv./std.
	460AD-3TR	4 burners, 36" griddle (right) with thermostatic controls	conv./std.
	460AA-3GR	4 burners, 36" griddle (right)	conv./conv.
	460AA-3TR	4 burners, 36" griddle (right) with thermostatic controls	conv./conv.

	460DD-2RR	6 burners, 24" griddle, raised broiler combination	2 std.
	460AD-2RR	6 burners, 24" griddle, raised broiler combination	conv./std.
	460AA-2RR	6 burners, 24" griddle, raised broiler combination	conv./conv.

The model chosen for the final design is the 400 Series Restaurant Range, produced by the North Carolina company, Southbend. The chart below (figure 4.33.3) provides the specifications necessary to incorporate the unit into the final design.

Figure 4.33.3 Eight Burner Stove Dimension Diagram

Models: ☐ **448EE**



MODEL	Exterior											Cook Top	Door Opening	Oven Bottom	3/4" Gas Conn.		Electric	
	Width A	Depth B	C	D	E	F	G	Height H	I	J	K	L	M	N	O	P	Q	R
448EE	48.625" (1235)	34" (864)	-	29.75" (756)	31" (787)	12" (305)	2.75" (70)	59.5" (1511)	22.5" (587)	31" (787)	6" (152)	37" (914)	15.5" (394)	13.0" (318)	3.25" (64)	30.25" (768)	-	-

MODEL	OVEN INTERIOR			BURNER (BTU each)		CRATE SIZE			CUBIC VOLUME	CRATED WEIGHT
	Width	Depth	Height	Open	Oven	Width	Depth	Height		
448EE	19.5" (660)	26.5" (673)	14" (356)	8 (33,000)	2 (45,000)	67" (1702)	45.5" (1158)	67" (1702)	55.6 cu.ft (1.58 cu.m.)	450 lbs (204 kg)

BTU's In Natural Gas rating

UTILITY INFORMATION

GAS:
- 448EE Total BTU-NAT: 354,000; LP: 252,000
- One 3/4" female connection.
- Required minimum inlet pressure
  - Natural gas 4" W.C.
  - Propane gas 10" W.C.

NOTICE:
Southbend has a policy of continuous product research and improvement. We reserve the right to change specifications and product design without notice. Such revisions do not entitle the buyer to corresponding changes, improvements, additions or replacements for previously purchased equipment.

MISCELLANEOUS

- If using Flex-Hose, the I.D. should not be smaller than 3/4" and must comply with ANSI Z 21.69
- If casters are used with flex hose, a restraining device should be used to eliminate undue strain on the flex hose
- For installation on combustible floors (with 6" high legs) and adjacent to combustible walls, allow 6" clearance.
- Recommended - Install under vented hood
- Check local codes for fire, installation and sanitary regulations.
- If the unit is connected directly to the outside flue, an A.G.A approved down draft diverter must be installed at the flue outlet of the oven.
- Two speed motors are not available on Restaurant Range Convection Ovens.

OPTIONS AND ACCESSORIES

- 10" flue riser
- 3/4" quick disconnect with flexible hose complies with ANSI Z 21.69 (specify 3', 4', 5')
- Casters - all swivel - front with locks
- Hot Top plates- each plate 2 Open burner section
- S-36 Salamander Radiant Broiler
- CM-36 Cheesemelter
- MRA-36 Infrared Salamander Broiler
- auxiliary griddle plates
- Extra Oven Racks
- Cabinet base
- Top burner pilot ignition

4.4 VENTILATION

After the last section, the natural progression would be the ventilation of the food distribution unit. Because the final design will use a modified fifty-three feet long trailer, the ventilation section will be described to accommodate this size. The standard lengths range from eight feet to eighteen feet. The ventilation system has three main parts, and can be custom made for certain situations. To aide the flow of air, innovative design modifications are going to be added to the trailer. Modifications, like strategic vent placement, will be explained in the design chapter.

The first part is a hood (figure 4.41) that is located on the inside of the unit, above the cooking equipment. The hood is made of stainless steel, and is of fairly simple construction. The hood usually contains a light source for the cooking area it covers. The removable grate system you see at the bottom of figure 4.41 is used to catch grease and moisture vapors. The grates need to be maintained weekly.

Figure 4.41 Ventilation Hood on Its Side

The second part is the most integral part of the ventilation system. This is the fan (figure 4.42) which actually pulls the air and heat away from the cooking equipment. The fan is mounted on the roof of the unit, above the hood. Because this is going to be in a confined area it will also play an important role in removing heat from the unit, and as an air circulation device. There will be an air conditioning unit on the trailer, but if the weather permits the ventilation system may be the only device needed.

Figure 4.42 Ventilation Hood Fan

The last part of the ventilation system may not be used very often, but it is the most important. The fire suppression system (figure 4.43) is required in any commercial cooking application. The system has to be manually engaged, but offers the best cook-top fire prevention. There are a few different brands available, and there is the option of having a custom suppression system made.

Figure 4.43 Ventilation Hood Fire Suppression System

4.5 PREPARATION EQUIPMENT

The section on preparation equipment is going to involve two different types of equipment. The first item, the sink, is used for the cleaning of fruits and vegetables. They are also used for draining of items, like pastas. Sinks also are used for the obvious, washing hands and pans. The other preparation equipment is table tops. The table tops are going to be used for the preparation of meals and for limited storage possibilities.

4.51 SINKS

Commercial sinks come in many different sizes, but the biggest factor in determining your sink is the number of bays it has. The standard numbers are one to four bays. Most commercial sinks also have the option of having a drain board. They can be built on the right side, left side, both sides, or no sides.

In the design phase the decision has been made to use two, three bay sinks (figure 4.51.1). The drain board options will be decided during the final design layout.

Figure 4.51.1 Three Compartment Sink with Dual Drain Boards

4.52 TABLES

Commercial preparation tables are offered in a wide array of options. The only real constraint is the use of stainless steel. Most commercial kitchen equipment is made of stainless steel because of price, durability, and bacteria resistance. Standard tables can be ordered to size; however, in this study an innovative retractable table is going to be used. These tables are manufactured by Retract-It tm (figure 4.52.1). The tables mount to the wall and fold easily when not in use. This type of mounting will allow for more space in the food distribution unit when needed.

Figure 4.52.1 Retract-It Folding Preparation Table

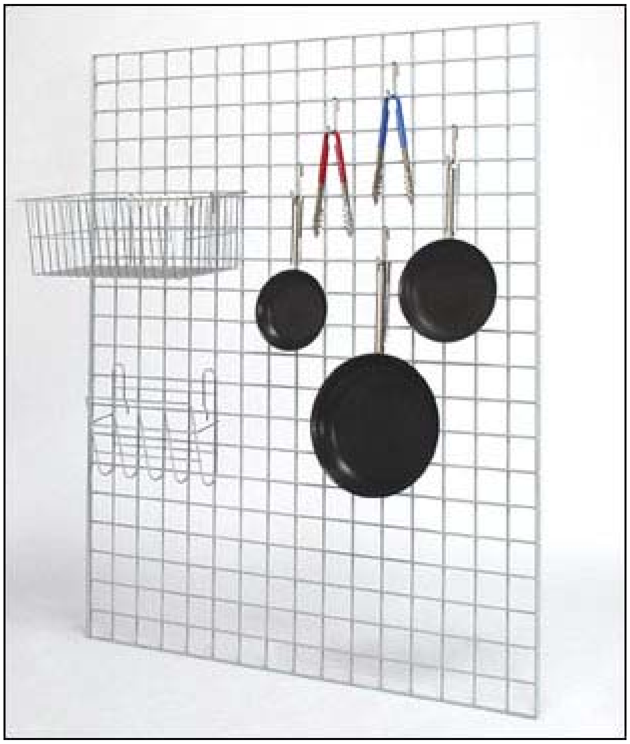
4.6 STORAGE

The storage section is also going to be divided into two simple areas, dry and cold storage. Dry storage is defined as items such as canned goods, pastas, spices, etc. The majority of the items are going to be donated, and require storage away from the actual cooking unit. However, there is going to be limited dry storage in the from of baskets and shelving. The cold storage of the main food item will also have a need to be stored away from the cooking unit. The cooking unit will have a refrigeration and freezing unit on board. These will store what they can, but be mainly used for items like dairy and perishable ingredients.

4.61 DRY STORAGE

The dry storage option for this application is going to involve a modular grid type system (figure 4.61.1). This type of system will offer the versatility desired in the

Figure 4.61.1 Wall Grid System



cooking unit. As the figure shows, the basket options can be use for shelving and organizing dry goods. Also shown in the figure is the ability to store actual pots and pans. By using this type of item the stocking of the unit can be performed before transportation without worry of loose items falling, barring any type of accident.

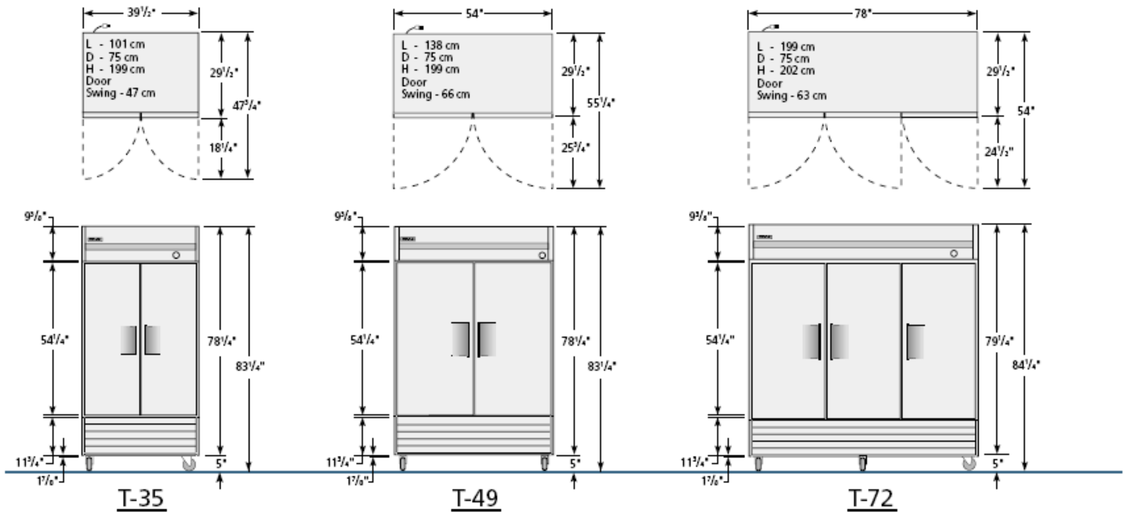
4.62 COLD STORAGE

The cold storage for the food distribution unit is going to use two separate cooling units. The first unit is going to be a thirty-five cubic foot refrigerator by True Food Service Equipment, Inc (figure 4.62.1). It will be a side-by-side unit, with a bottom mounted condensing unit. The bottom mount condenser will allow for better stability. The unit specification data is provided in figure 4.62.2.

Figure 4.62.1 T-Series Reach-In Refrigerator

Figure 4.62.2 T-Series Dimension Diagram

T-Series: Solid Two & Three Door Reach-In Refrigerators



Rough-In Data													
Model	Doors	Capacity (Cu. Ft)	# of Shelves	Dimensions (inches) L	D	H*	HP	Volts	PH	Amps	NEMA Config.	Cord Length (feet)	Crated Weight
T-35 (1)	2	35	6	39 1/2	29 1/2	78 1/4	1/2	115	1	9.2	5-15	9	359
T-49 (1, 2)	2	49	6	54	29 1/2	78 1/4	1/2	115	1	9.5	5-15	9	425
T-72 (1, 2)	3	72	9	78	29 1/2	79 1/4	1/2	115	1	11.8	5-15	9	576

(1) Available with full glass doors
(2) Available with solid half doors, glass half doors & combination solid/glass half doors
* Height does not include 5" for castors or 6" for optional legs.

Specifications subject to change without notice.

Standard Features

- Oversized and balanced, environmentally friendly (134A) refrigeration system - holds 33°F to 38°F.
- 300 series stainless steel doors & front.
- Interior - NSF approved, white vinyl coated aluminum sides and top, 300 series stainless steel floor with coved corners.
- Anodized quality aluminum top, sides and back.
- Recessed handles (lifetime guarantee).
- Exterior mounted temperature monitor.
- Door locks standard.
- Magnetic door gaskets.
- Adjustable vinyl coated wire shelves.
- Epoxy coated evaporator.
- Incandescent interior lighting (fluorescent interior lighting for glass door models).
- 4" diameter swivel castors standard equipment - locking castors provided for front set.
- Foamed-inplace polyurethane high density cell insulation (CFC free).
- Slide out compressor can be serviced easily and accessed by a single repairman.
- 1 year parts & labor warranty (USA).
- 5 year compressor warranty.

Optional Accessories

- ❐ Left hinged model available on the T-23 (no charge)
- ❐ Dual left or right hinges available on the T-49 (no charge)
- ❐ T-72 available with three right or three left hinges (no charge).
- ❐ Available with 6" stainless steel or optional seismic legs.
- ❐ Additional shelves available
- ❐ T-49 available as a pass-thru model (T-49PT).
- ❐ T-72 available with optional wine racks.
- ❐ T-49 & T-72 available with optional novelty baskets.

KCL Model	Front	Right	Plan	3D
T-35	TFEY04E	TFEY04S	TFEY04P	TFEY043
T-49	TFEY02E	TFEY02S	TFEY02P	TFEY023
T-72	TFEY01E	TFEY01S	TFEY01P	TFEY013

Clearance Required For Coolers (USA)		
Sides Inches/mm	Top Inches/mm	Rear Inches/mm
0 / 0	0 / 0	1 / 26

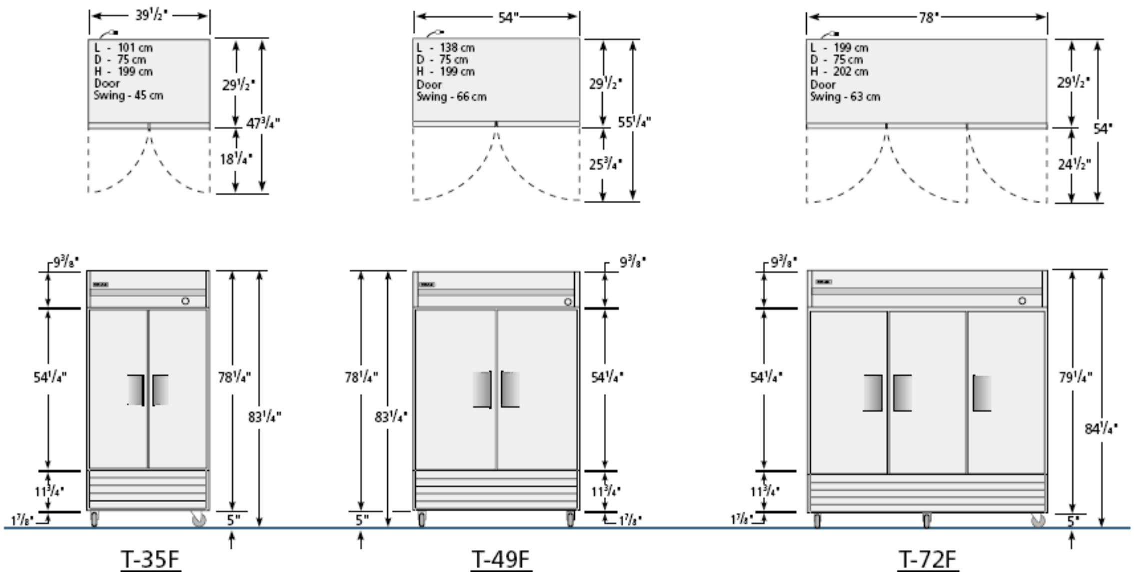
TRUE FOOD SERVICE EQUIPMENT
St. Charles Industrial Center • P.O. Box 970 • O'Fallon, Missouri 63366 • (636)240-2400 • FAX (636)272-2408 • (800)325-6152 • www.truemfg.com
Printed in U.S.A.

The second unit is going to be a thirty-five cubic foot freezer by True Food Service Equipment, Inc (figure 4.62.3). It will be a side-by-side unit, with a bottom mounted condensing unit. The bottom mount condenser will allow for better stability. The unit specification data is provided in figure 4.62.4.

Figure 4.62.3 T-Series Reach-In Freezer

Figure 4.62.4 T-Series Dimension Diagram

T-Series: Two and Three Solid Door Reach-In Freezers



Rough-In Data													
Model	Doors	Capacity (Cu. Ft)	# of Shelves	Dimensions (inches) L	D	H†	HP	Volts	PH	Amps	NEMA Config.	Cord Length (feet)	Crated Weight
T-35F	2	35	6	39 1/2	29 1/2	78 1/4	3/4	115	1	13.0	5-20	9	425
T-49F (1, 2)	2	49	6	54	29 1/2	78 1/4	3/4	115	1	13.2	5-20	9	515
T-72F* (2)	3	72	9	78	29 1/2	79 1/4	1	115/208-230	1	10.5	14-20	9	620

(1) Available with full glass doors
(2) Available with solid half doors
* Requires 115/208-230/60 Hz, single phase, 3 pole, 4 wire.
† Height does not include 5" for castors or 6" for optional legs.

Specifications subject to change without notice.

Standard Features

- Oversized and balanced, environmentally friendly (R404A) refrigeration system holds -10°F.
- 300 series stainless steel doors & front.
- Interior - NSF approved, white vinyl coated aluminum sides and top, 300 series stainless steel floor with coved corners.
- Anodized quality aluminum top, sides and back.
- Standard backguard improves airflow.
- Recessed handles (lifetime guaranteed).
- Exterior mounted temperature monitor.
- Door locks standard.
- Magnetic door gaskets.
- Adjustable vinyl coated wire shelves.
- Epoxy coated evaporator.
- Incandescent interior lighting (fluorescent interior lighting for glass door models).
- 4" diameter swivel castors standard equipment - locking castors provided for front set.
- Foamed-in-place high density polyurethane insulation (CFC free).
- Slide out compressor can be serviced easily and accessed by a single repairman.
- Large evaporator and coil heater permit short defrost cycle.
- Defrost system time initiated, temperature terminated.
- Automatic evaporator fan motor delay during defrost cycle.
- 1 year parts & labor warranty (USA).
- 5 year compressor warranty.

Optional Accessories

- ❒ Available with 6" stainless steel or optional seismic legs.
- ❒ Additional shelves available.
- ❒ Remote condensers available for T-49F & T-72F.
- ❒ T-49F available with dual right or dual left hinges - no charge.
- ❒ T-72F available with three right or three left hinges - no charge.
- ❒ Novelty baskets available for T-49F & 72F.

Model	Front	Right	Plan	3D
T-35F	TFEY04E	TFEY04S	TFEY04P	TFEY043
T-49F	TFEY02E	TFEY02S	TFEY02P	TFEY023
T-72F	TFEY01E	TFEY01S	TFEY01P	TFEY013

Clearance Required For Coolers (USA)		
Sides Inches/mm	Top Inches/mm	Rear Inches/mm
0 / 0	0 / 0	3 / 77

TRUE FOOD SERVICE EQUIPMENT

St. Charles Industrial Center • P.O. Box 970 • O'Fallon, Missouri 63366 • (636)240-2400 • FAX (636)272-2408 • (800)325-6152 • www.truemfg.com

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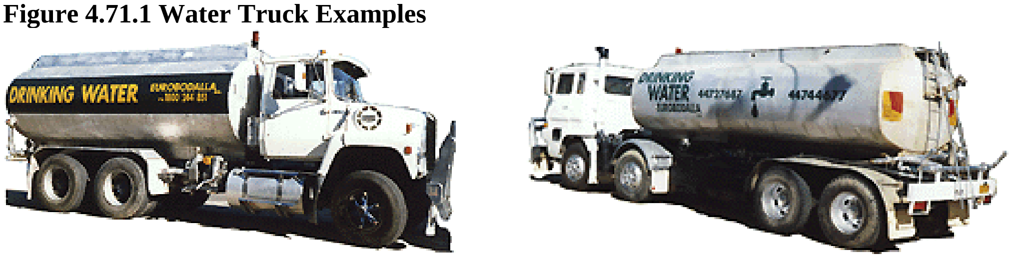
4.7 WATER

Water is a huge concern in any type of disaster situation. In most cases a large source of water can be found in a relatively quick manner. This section is going to discuss the different types of water sources available. It will also discuss the filtration of the water sources. Lastly, this section will discuss the disposal of used water.

4.71 WATER SOURCES

Usually the normal water supply can be tapped into; in these cases a direct tap will be available on the cooking unit. However, in some disasters the area's water source is disrupted or contaminated. The next option is to have a water tanker truck (figure 4.71.1) sent in. There are many companies available for this action, and in the case of a large scale disaster this resource should be easily obtainable.

Figure 4.71.1 Water Truck Examples

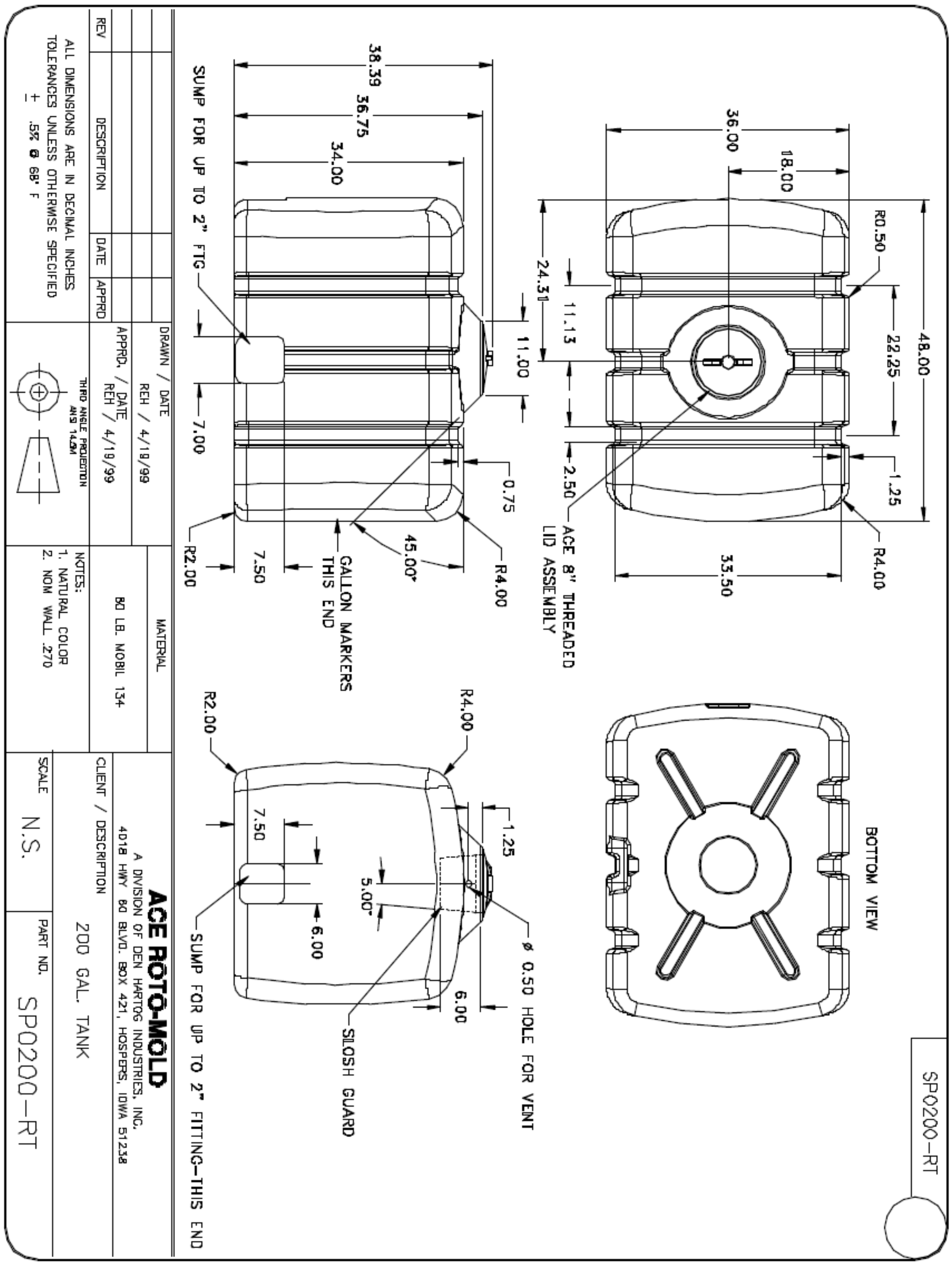


Because this may take a small amount of time the food distribution unit will have a small holding tank of two hundred gallons (figure 4.71.2) of clean water on board for emergency use.

Figure 4.71.2 200 Gallon Clean / Waste Water Tanks

The specifications for the two hundred gallon tank are provided in figure 4.71.3. The tank is built by The Tank Depot Inc.

Figure 4.71.3 200 Gallon Tank Dimension Diagram



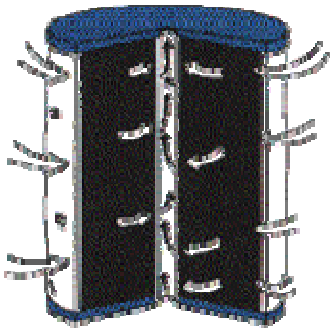
4.72 WATER FILTRATION

No matter where the water comes from it will need to be filtered, so there will be a filtration unit for all outside water sources. The filtration system (figure 4.72.1) used in this study will be a compact unit capable of treating twelve hundred gallons of water.

Figure 4.72.1 1200 Gallon Water Filtration System

These fine drinking water systems reduce a wide range of contaminants for a low cost per gallon. The superior effectiveness of solid carbon block systems is confirmed through testing and certification by NSF International; independent laboratory tests; certification by the State of California Department of Health Services; and, more importantly, by the more than two million satisfied customers throughout the world. The performance of the solid carbon block filter technology (figure 4.71.2) exceeds that of all other filter types and meets only the highest standards for quality.

Figure 4.72.2 500 Gallon Carbon Water Filter



Removes 100% of Chlorine

- Reduces a wide range of contaminants of health concern
- Microstrains physical matter down to sub micron range (0.5 micrometer)
- Tests and certified by NSF International to reduce contaminants being considered as established or potential health hazards
- Treated up to 500 Gallons of water; replacement filter can easily be changed
- Does not waste water
- No electricity required
- Does not remove trace minerals that are beneficial to good health
- Does not add salt or silver to the water
- Provides spring fresh, delicious drinking water

4.73 WATER HEATING

There is not going to be a great need for a lot of hot water. There will be a ten gallon, RV style (figure 4.73.1) water heater outfitted on the unit. It uses propane gas or electric, and is turned on with the flip of a switch. The cutout for the unit needs to be 16" wide, 15-1/2"high and 21" deep. The manufacturer is Atwood Mobile Products Inc.

Figure 4.73.1 10 Gallon Propane Water Heater

4.74 WASTE WATER DISPOSAL

The last aspect of water, water disposal, may seem unimportant. However, the water cannot just flow onto the ground. The optimal situation would allow for direct tapping into an existing sewer system. If this option is not available there will be a need for a waste water tank. These are very similar to the water holding tank discussed in section 4.71, and usually fit onto a trailer for easy transport.

4.8 POWER

This section is going to discuss the power options available to the food distribution unit. The inside of the unit will be outfitted with an electrical panel box capable of powering the inner electrical equipment (220/ Single Phase/ 110v). There are two options available for the outside electrical power sources. The first is an existing power source, and the second is a generator source. The other power source is the LP (propane) gas used for the cooking equipment.

4.81 PLUG-IN POWER

The unit will have a one hundred fifty foot cable, capable of plugging into a power source in the area. This is if electricity is available. In the majority of disasters the power is the first thing to go out, and is usually what takes the longest to fix. This would be the optimal situation, but probably the most unlikely.

4.82 POWER GENERATION

A generator is a must have element to the final design. As mentioned before electricity is usually the most needed resource during a disaster. Even if there is electricity available, one of the main points of this study is to make the unit as self reliant as possible. A fifteen kilowatt generator (figure 4.82.1) is sufficient for most applications, and the units are small enough to mount under the food distribution unit. The other great aspect is that its power source is propane gas, the same as the cooking equipment. The unit will also incorporate a solar cell system for smaller electrical applications.

Figure 4.82.1 Winco 15 kW Propane Generator

The unit being used is manufactured by Winco Inc. The specification for the 15 kW unit is provided in figure 4.82.2.

Figure 4.82.2 Winco 15 kW Specification Sheet

Packaged Standby Series, 15 kW (18.75 kVA), SKU WIRE-015T312, Mfr. Model: PSS15B2W

Winco: PSS15B2W		**SKU WIRE-015T312**	
Power Phases	three phase	Engine Brand	Briggs & Stratton
Frequency	60 Hertz	Engine Model / Cylinders	
Voltage AC	120/208	HP / Displacement	31 / 895 cc
Voltage Regulator	AVR	Fuel	LP / NG
Voltage Accuracy (no load to rated load)	+/- 1%	Cooling	air
Frequency Accuracy	3%	RPM	3600
Maximum (Standby) Output	15 kW	Governor	mechanical
Continuous (Prime) Output	13.5 kW	Control Panel	
Reconnectable	no	Starting System	electric
Main Circuit Breaker		Idle Control	no
Alternator Brand	Winco	Remote Starting / Choke	yes /
Alternator Model	4 - Pole Rev Field	Mount Type	base & cover
Alternator Type	brushless	Manufacturer Requires Startup	No

Load Amperage at Voltage

Volts >	**120**	**208**	**240**
Maximum Load Amps (kW / kVA)	90/94	52/54	45/49
Continuous Load Amps (kW / kVA)	81/85	47/49	41/44

Fuel Consumption

% >	**50%**	**75%**	**100%**
Fuel Use Gallons	1.2	1.8	2.4
Run Time Hours	83.3	55.6	41.7

Included Equipment: **Included Equipment:** Generator engine and alternator on welded steel frame base & cover mount platform, oil drain cock, mechanical governor, critical muffler (enclosed models), spring isolators, 12 volt electric starter, air filter, radiator (liquid cooled), blower fan and guards, battery tray, battery cables, owners manual and warranty. Batteries are not included. Other options are NOT included please purchase the options from the option lists.

Fuel Tank

Day Capacity (Gal / Liters)	Typical tank 100 gallons (not included)
Base Tank Capacity (Gal / Liters)	

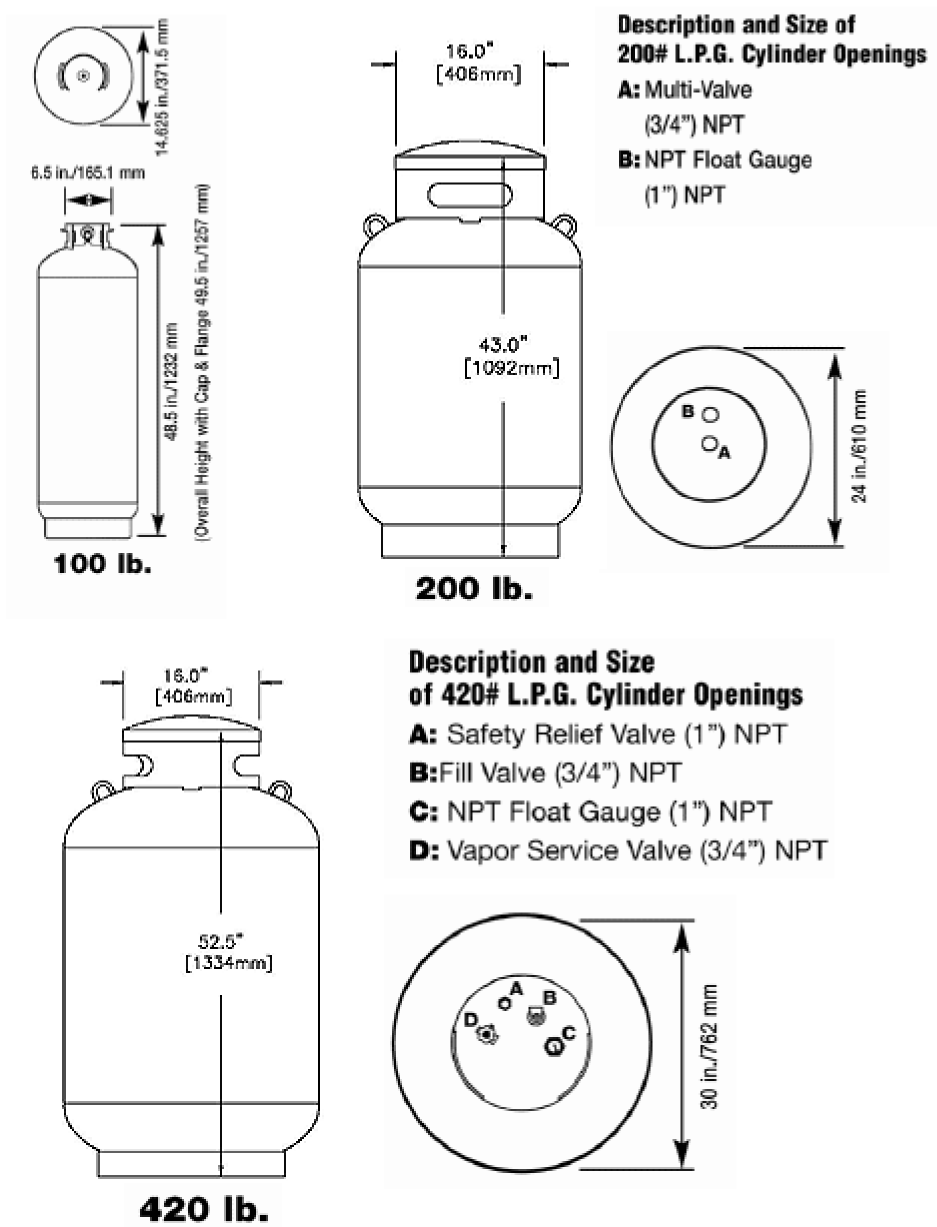
Dimensions "Enclosed" Model		**Dimensions "Open" Model**	
Length (inches / mm)	44.1 / 1,120	Length (inches / mm)	
Width (inches / mm)	33.2 / 843	Width (inches / mm)	
Height (inches / mm)	38.1 / 968	Height (inches / mm)	
Weight (Lbs / Kg)	725 / 329	Weight (Lbs / Kg)	
Muffler Type	critical	Muffler Type	
Warranty		**Quietness**	
Engine / Alternator	2 year(s)	Open Noise Level dB @ 1 meters	

4.83 GAS

The gas chosen for this study is propane, LP gas. The choice was made because of the cooking equipment chosen, and the added bonus of finding a generator that utilized the same source. This will require the mounting of a portable propane tank on the outside of the unit; the most desirable placement will be below or in front of the unit. Specifications for this unit are provided in figure 4.83.1. The mounted tanks will mostly provide gas for the generator and water heater; an outside propane source may be needed to supply the cooking equipment.

Figure 4.83.1 Steel Propane Tank Specifications

Steel 100, 200, 420 lb. Specifications



Cylinder Model	LPG Capacity	Water Capacity	Tare Weight	Cylinder Volume	Collar Height	Foot ring Dia. o/s	DOT/ASME Specification
	gallons	lb.	lb.	cu. in.	inches	inches	
	liters	kg	kg	liters	mm	mm	
100	23.6	239.0	71.0	6629	5.1	14.5	DOT-4BW240
	89.3	108.4	32.2	108.7	130	368	

200	47.2	474	147.0	13147	6.6	19.0	DOT-4BW240
	178.5	215.0	66.7	215.5	168	483	
420	99.1	1000	272.0	27737	6.6	22.0	DOT-4BW240
	375.1	453.6	123.4	454.6	168	559	

Dimensions and capacities are approximate and may vary slightly from pictures

4.9 CONCLUSION

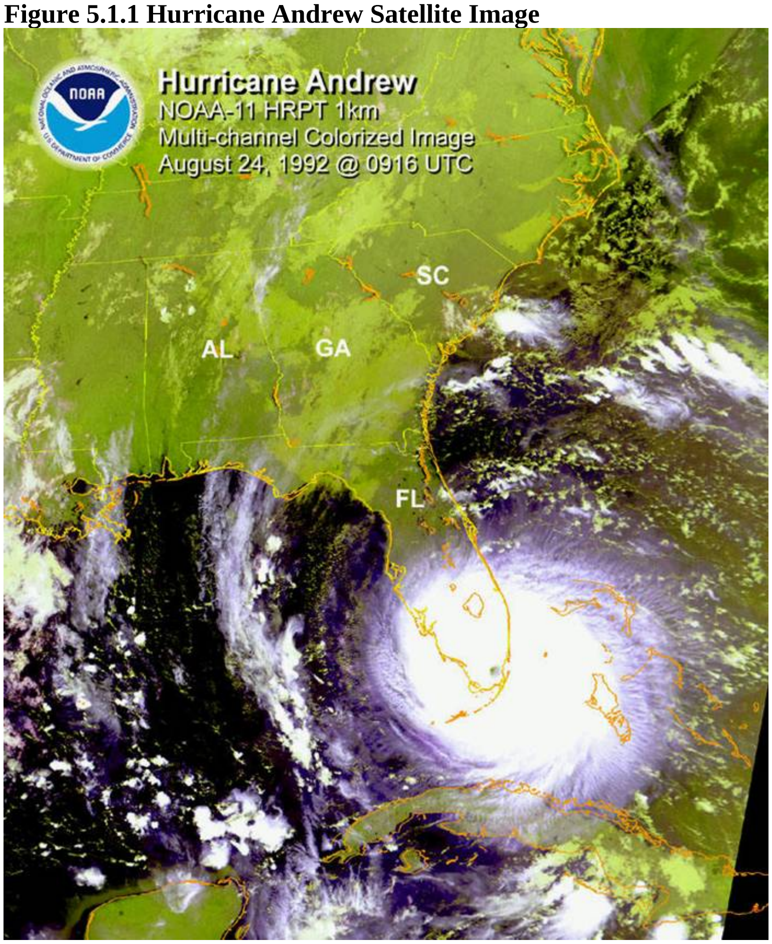
This chapter specifically discussed the different types of equipment that can be used in the construction of the distribution unit, and the optimal ways the equipment will be used in the final product. This chapter provides a solid base to initiate the design process. The equipment specifications are available, and a firm knowledge base has now been established.

5. HURRICANE ANDREW SCENERIO

5.1 INTRODUCTION

This chapter was made to test the pre-distribution system. A real life scenario would be the best source for this experiment. Because Hurricane Andrew (figure 5.1.1) was one of the largest and most reported on disasters, it was chosen. If the system can handle such a large scale disaster, it theoretically would be able to handle any disaster of equal or smaller scale.

Figure 5.1.1 Hurricane Andrew Satellite Image



5.2 THE DISASTER

The next two sections will give details about Hurricane Andrew. The first is going to describe its formation and the path it took from its conception. Then the second section will lay out the horrible aftermath of Hurricane Andrew.

5.21 HURRICANE ANDREW

Hurricane Andrew cost the United States more than $25 billion dollars. Andrew also claimed 26 lives and left more than 250,000 people homeless. It lasted eleven days from August 16-27, 1992 and hit land in the Bahamas, southern Florida, and south central Louisiana. This particular hurricane originated off the West Coast of Africa in early August, 1992. On August 17, 1992 it became a tropical depression halfway between Africa and the eastern islands of the Caribbean. On August 21 it gathered more strength and at 5AM on August 22 it reached hurricane status. On August 23 the hurricane reached Category 4 status. Later on that evening the eye of the storm passed over the Bahamas and the maximum wind gust was measured to be 120 mph. However, when it passed over the Bahamas it began to weaken. Finally, on the morning of August 24 it struck southern Florida. The winds were reported to be up to 140 mph. Eventually, on August 25 Andrew entered the Gulf of Mexico. The hurricane was severely weakened and later on that day it curved northward and struck land in south-central Louisiana. While over Louisiana it was down graded from a Category 4 hurricane to a Category 3. While making its destructive path through Louisiana, it spawned a tornado that had a damage path 9 miles long and 150 yards wide. Finally it was downgraded to a tropical storm near Baton Rouge and Lafayette, Louisiana (University of Arizona's Geosciences Department, 2001).

5.22 ANDREW'S DESTRUCTION

Hurricane Andrew was the third strongest hurricane to hit the United States in the 20th century and the largest to hit Florida in 30 years. Andrew was also the most expensive natural disaster to ever hit the United States. It cost over $25 billion dollars to repair the damages. On it's rampage through the Bahamas, Florida, and Louisiana it killed 26 people, 15 in Dade County, Florida, and left another 250,000 homeless. In southern Dade County the hurricane destroyed 25,524 homes and damaged 101,241 others. In total, there were approximately 600,000 homes and businesses destroyed or severely damaged by the waves, winds, and rain from Andrew. Over 1.4 million people were left without power and some went with out it for up to six months. It was also estimated that ninety percent of all the mobile homes in South Dade County were totally destroyed and in Homestead, Florida 1167 mobile homes out of the 1176 were destroyed completely. It could have been worse, however, if Hurricane Andrew would have struck 20 miles North in Miami, Florida, a city of 1.9 million people. This would have surely raised the death toll and cost tremendously (University of Arizona's Geosciences Department, 2001).

5.3 PHASE ONE IN ACTION

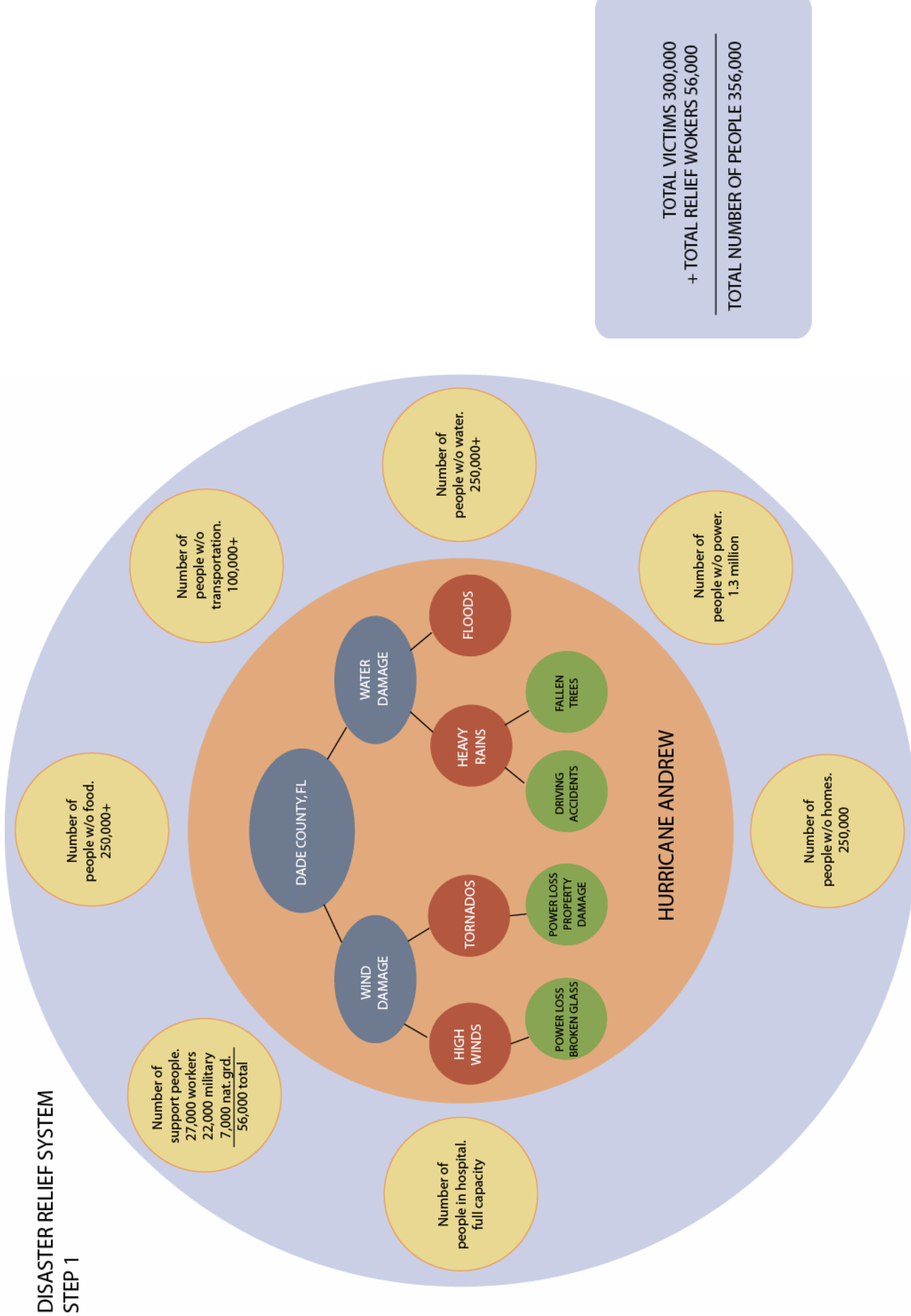
Now that all the information is out on the table, all that needs to be done is to plug the numbers into the Phase One bubble chart. Start in the inner orange circle and name the disaster. By giving it a name it will establish a solid reference point for the future. You can see this disaster is “Hurricane Andrew.”

The next step labels the city the system is going to concentrate on providing for. In this case the focus is on Dade County, Florida, one of the hardest hit areas during Hurricane Andrew.

After the areas are defined a flow chart begins. The chart is going to track all the possible damage situations the disaster recovery operation may encounter. This example charts wind and water damage as main categories. Then it further defines the category into specific occurrences: high winds, tornadoes, heavy rain, and floods. The last level has labeled possible physical obstacles that may need to be prepared for: power loss, broken glass, fallen trees, wrecked vehicles, and property damage.

Now that a background is established of the area and its possible obstructions, the focus can turn to finding out the number of people in need. To make this easier, categories are put in the outer, blue circle. Each category has its own bubble to fill in. Some of the categories overlap, such as the 250,000 people without homes do not have water. This means that when adding up the totals, you do not necessarily add all of the outer bubbles together. The variety of bubbles is there to free thinking, and try to get every scenario accounted for. In the beginning it will be important to coordinate with local officials to get population and destruction estimates. This section is graphically represented below in figure 5.31.

Figure 5.31 Phase One Applied To Hurricane Andrew



5.4 PHASE TWO IN ACTION

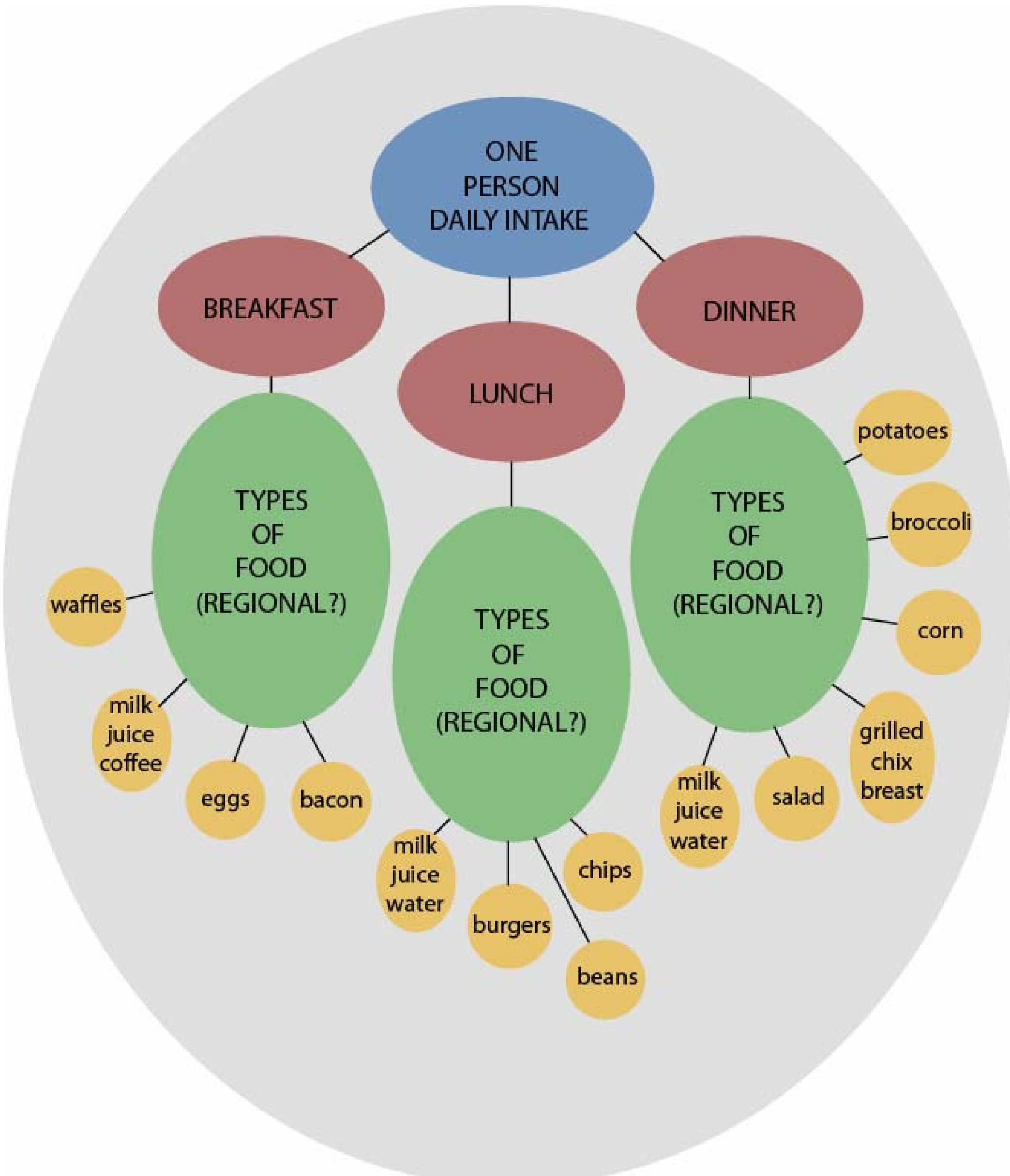
From Phase One we know there is a need to feed three hundred and fifty-six thousand people. Phase Two breaks that back down into a one person scenario. In a large scale disaster this phase may be altered due to time and limit of supplies. In an optimal situation the relief group will know what supplies they are going to have by the completion of Phase One. Assuming that is true a licensed nutritionist and a logistics team member will determine what meals are going to be used, and when. Phase Two's bubble chart is a graphic outline of how to begin this process. It may prove more efficient to continue this phase in a spread sheet format.

The next step will be to determine the number of meals the relief effort will provide daily. In the example provided the number is three: breakfast, lunch, and dinner. This is an example of a perfect supply situation. If there are not enough supplies to allow a three meal effort, adjustments will have to be made to provide the most relief.

The third level is a unique element that will provide increased moral and productivity to the disaster situation. The element is called regional sensitivity. Regional sensitivity is the idea that by finding menu items that appeal to the culture of the people in the affected area, they feel more comfortable in the adverse situation. Obviously, this will not be possible in all situations, but if possible it will be advantageous.

The final section of phase two gives the relief team a place to lay out the menu items that will be available for each serving session. These items will be relative to the time of day, morning = breakfast, and will be regionally sensitive if the items are available. After this is complete the total amount of food needed is determined by simply multiplying the phase one total by the phase two totals. A graphic representation of phase two is (figure 5.41).

Figure 5.41 Phase Two Applied To Hurricane Andrew



5.5 EQUIPMENT OUTPUT CAPABILITIES

This section is needed to determine which types of equipment are going to provide the most relief. These need to be done previously and kept on file to keep outfitting time to a minimum. There are two examples of this in this section. These examples are carried out into the first flow of Phase Three.

5.51 STEAMER OUTPUT

The steamer was mentioned previously as one of the most versatile pieces of cooking equipment available, so we will determine if this is true. One cup of food is an average serving size in the United States for items like soups and sides. A sixty gallon steamer is equal to nine hundred and sixty cups. So theoretically, if a steamer can cook sixty gallons of rice or soup in one hour, then one steamer can feed nine hundred and sixty people every hour. Certain food items may differ in preparation times, but the information can be easily calculated.

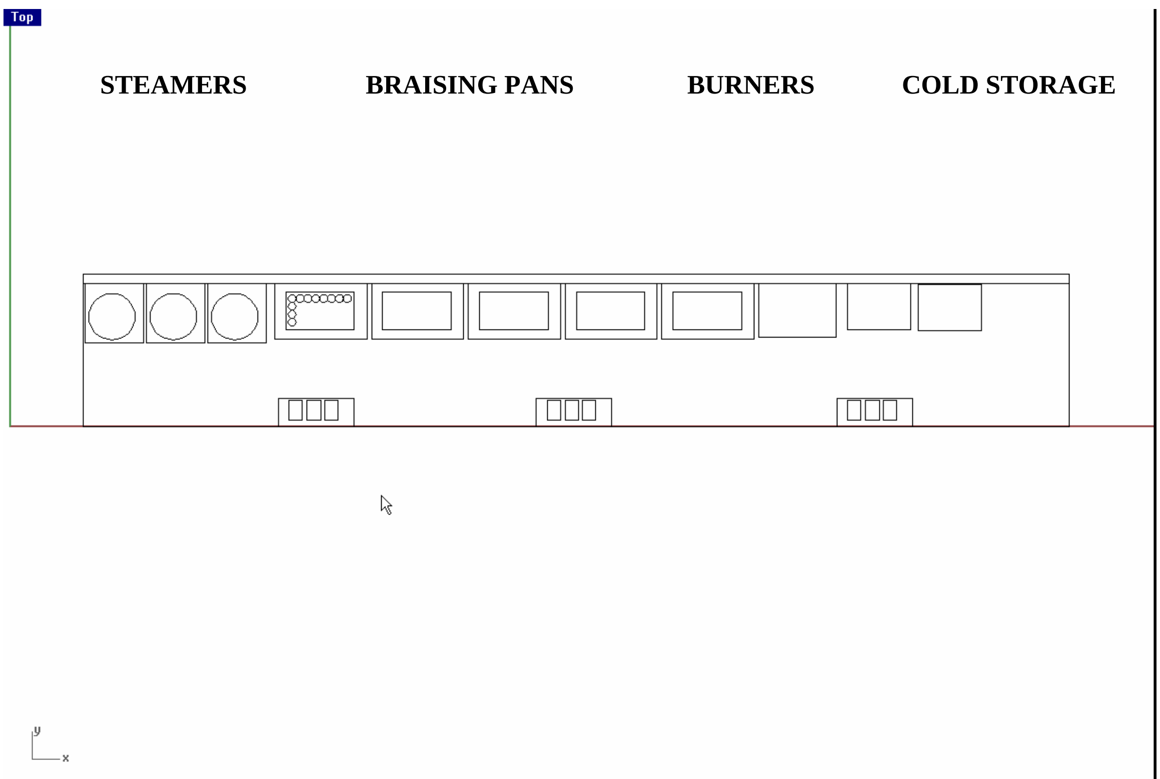
5.52 BRAISING PAN OUTPUT

The braising pan is the most versatile piece of equipment found in this study. Given the dimensions of forty gallon braising pan, it is found that thirty-two five inch burger patties or chicken breasts can fit at one time, or six hundred and forty cups of substance. The average cooking time of the previous two items is around ten minutes. So theoretically, if a braising pan can cook thirty-two burgers every ten minutes, then a forty gallon braising pan can feed two hundred and sixteen people every hour.

5.53 COMBINED EQUIPMENT OUTPUT

By taking the figures from the previous two sections, and making a mock trailer layout (figure 5.53.1), we can get an approximate number of trucks needed. Three, sixty gallon steam kettles, can produce two thousand eight hundred and eighty cups of one item; or nine hundred and sixty cups of three different items. Five braising pans can produce one hundred and sixty patties in ten minutes. When you utilize these eight items, it is estimated that one cooking unit can supply fifteen hundred to two thousand meals, three times a day. If you divide the number of people in need during Hurricane Andrew (356,000) by two thousand, you would have needed one hundred and seventy-eight cooking units to meet the need.

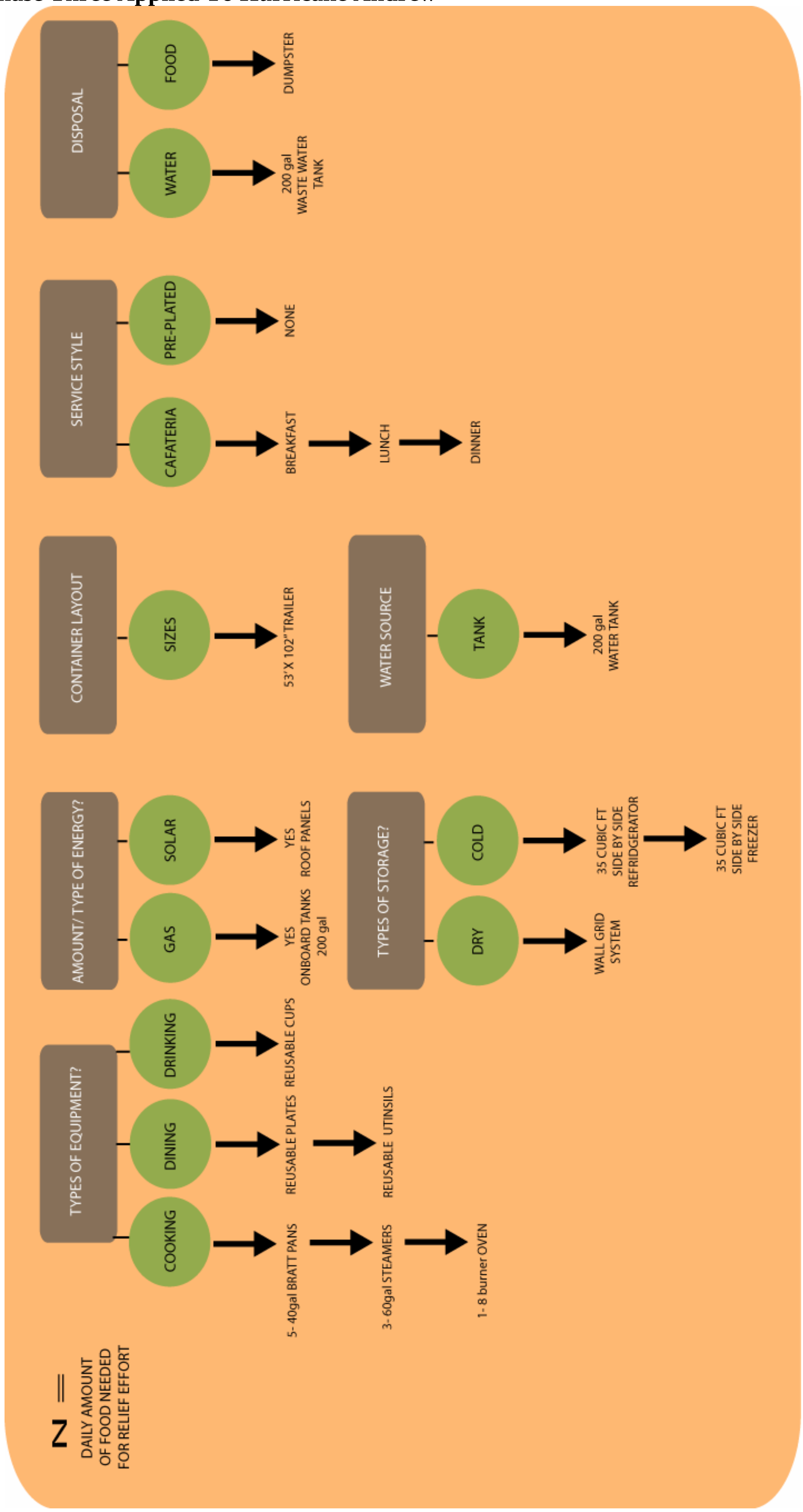
Figure 5.53.1 Mock Trailer Layout



5.6 PHASE THREE IN ACTION

After the previous two phases are complete it is time to equip the truck with the most efficient cooking equipment and external supplies. With Phase Three's flow chart and an accurate equipment output guide, the trailer setup can happen very easily. The revised Phase Three flow chart can be seen below in figure 5.61. The chart shows the selections made from the equipment study, and in which ways they will be used.

Figure 5.61 Phase Three Applied To Hurricane Andrew



5.7 CONCLUSION

By taking a large scale disaster and applying the information available to the pre-distribution system, its functionality becomes more apparent. The system proved to simplify the overwhelming task of relief in a disaster situation. The next and final step will use all the previous found knowledge to produce a complete a cooking unit design.

6. DESIGN SOLUTION

6.1 INTRODUCTION

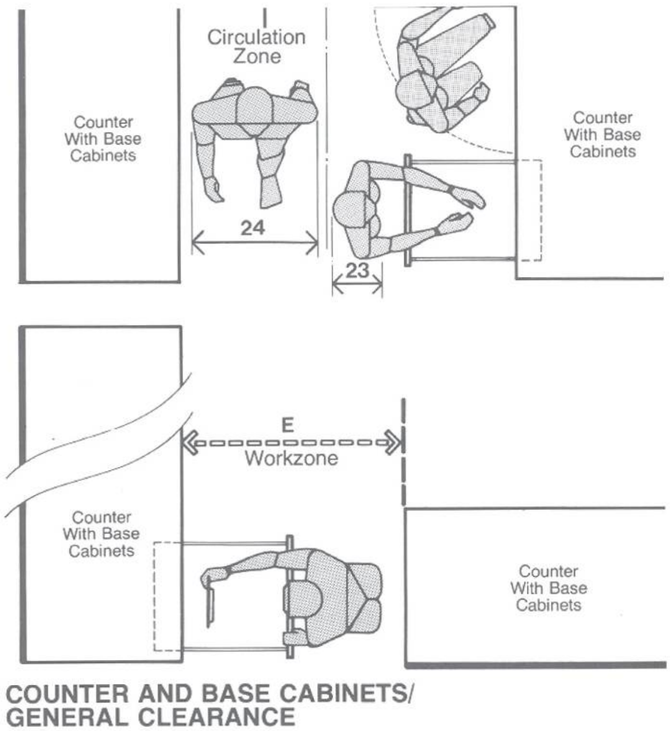
This chapter contains the final design and the development process used to complete the distribution container. This chapter is broken into three different categories. These categories correlate to the design timeline used in this design process. The first phase is the research phase. This phase helps lay a foundation of factors that must be addressed during the following phases. The second area is the conceptualization phase. This is the creative time where the research facts and the designer's ideas come to life on paper. The last section of this chapter is the CAD section. This section will have a computer model of the final design. The representations will be life-like, and provide a great understanding of the distribution unit's modular design.

6.2 RESEARCH PHASE

6.21 ANTHROPOMETRICS AND WORKFLOW

This section provides standard information and diagrams of workflow in a kitchen environment. It provides a set of criteria that needs to be followed throughout the design process. Each diagram provided has a numerical chart to display exactly the desired measurements. The first figure (figure 5.21.1), shows a general set of measurements for circulation in a normal kitchen with counters and drawers. This is not the layout desired for the final design; however, it offers some information. For example, the diagram calls for a minimum of twenty-four inches for a walking lane and a minimum of forty-eight inches for work zone space. These measurements will be helpful during the design phase.

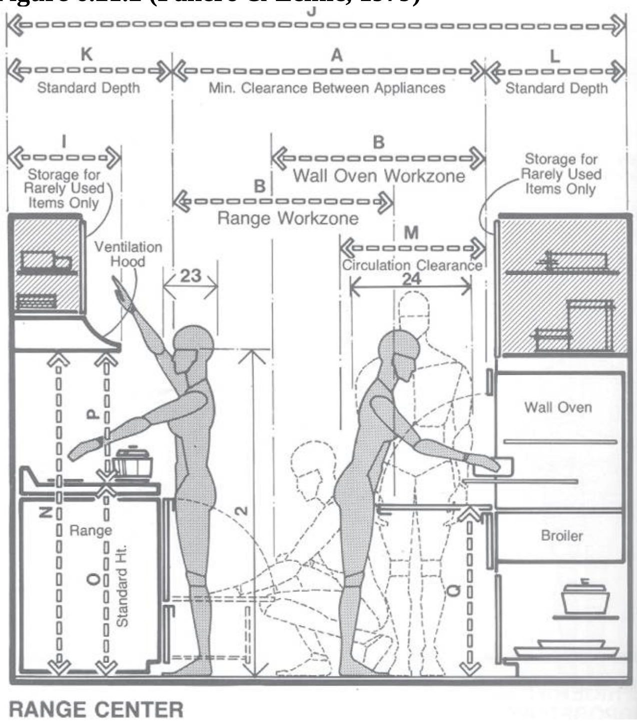
Figure 6.21.1 (Panero & Zelnic, 1979)



	in	cm
A	60–66	152.4–167.6
B	48 min.	121.9 min.
C	24–30	61.0–76.2
D	36	91.4
E	48	121.9
F	12–13	30.5–33.0
G	76 max.	193.0 max.
H	72 max.	182.9 max.
I	59	149.9
J	25.5	64.8
K	24–26	61.0–66.0
L	15 min.	38.1 min.
M	18	45.7
N	35–36	88.9–91.4
O	69 max.	175.3 max.

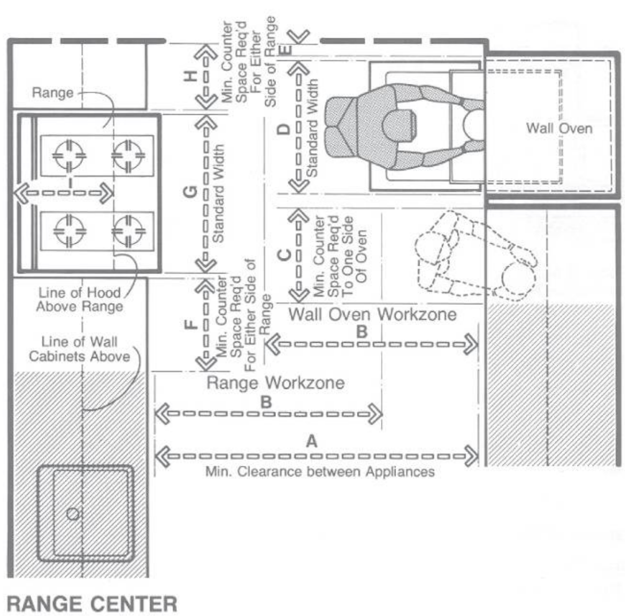
The next two diagrams (figures 6.21.2 & 6.21.3) show information about work flow around cooking equipment. The diagram uses the range as the main type of equipment, but any of the equipment studied for this thesis is interchangeable. The first diagram is a side view of the work area, and the second is a top view of the same situation. The main points of this diagram are the “A” measurement of forty-eight inches, the “B” measurement of twenty-four inches, and the “J” measurement of ninety-six inches. All three of these will help solidify the final design. These diagrams also offer lessons that are not measurements. The fact that they show the oven open gives the designer an option that may have been overlooked otherwise.

Figure 6.21.2 (Panero & Zelnic, 1979)



	in	cm
A	48 min.	121.9 min.
B	40	101.6
C	15	38.1 min.
D	21–30	53.3–76.2
E	1–3	2.5–7.6
F	15 min.	38.1 min.
G	19.5–46	49.5–116.8
H	12 min.	30.5 min.
I	17.5 max.	44.5 max
J	96–101.5	243.8–257.8
K	24–27.5	61.0–69.9
L	24–26	61.0–66.0
M	30	76.2
N	60 min.	152.4 min.
O	35–36.25	88.9–92.1
P	24 min.	61.0 min.
Q	35 max.	88.9 max.

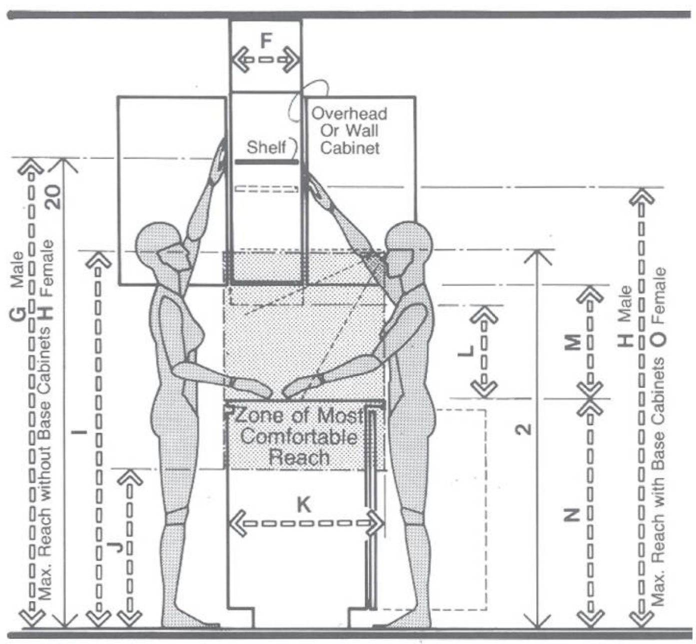
Figure 6.21.3 (Panero & Zelnic, 1979)



	in	cm
A	48 min.	121.9 min.
B	40	101.6
C	15	38.1 min.
D	21–30	53.3–76.2
E	1–3	2.5–7.6
F	15 min.	38.1 min.
G	19.5–46	49.5–116.8
H	12 min.	30.5 min.
I	17.5 max.	44.5 max
J	96–101.5	243.8–257.8
K	24–27.5	61.0–69.9
L	24–26	61.0–66.0
M	30	76.2
N	60 min.	152.4 min.
O	35–36.25	88.9–92.1
P	24 min.	61.0 min.
Q	35 max.	88.9 max.

The following diagram ventures away from the circulation of the kitchen, and describe actual work areas. The figure below (figure 6.21.4) is an evaluation of reach considerations. It gives limitations that will need addressing in the storage situations of the interior design of the unit. This diagram is valuable because it differentiates the reach ability of males and females. It states information for cabinets; however, these measurements also pertain to shelving and overhead equipment.

Figure 6.21.4 (Panero & Zelnic, 1979)

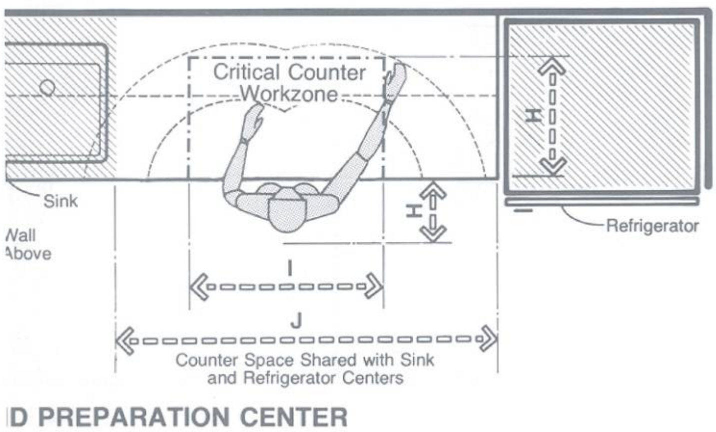


	in	cm
A	60–66	152.4–167.6
B	48 min.	121.9 min.
C	24–30	61.0–76.2
D	36	91.4
E	48	121.9
F	12–13	30.5–33.0
G	76 max.	193.0 max.
H	72 max.	182.9 max.
I	59	149.9
J	25.5	64.8
K	24–26	61.0–66.0
L	15 min.	38.1 min.
M	18	45.7
N	35–36	88.9–91.4
O	69 max.	175.3 max.

CABINET REACH COMPARISONS

The last diagram (figure 6.21.5) in this section provides information for a preparation work zone. This information will be vital in the selection of sink sizes and preparation table sizes in the unit's interior. These items will use the measurement "J" of forty-two inches as a guide.

Figure 6.21.5 (Panero & Zelnic, 1979)



	in	cm
A	18 min.	45.7 min.
B	7.5 min.	19.1 min.
C	32	81.3
D	30	76.2
E	4 max.	10.2 max.
F	4	10.2
G	22–24.5	55.9–62.2
H	18	45.7
I	36	91.4
J	42	106.7

6.22 CASE STUDY

To get some familiarity with a high output kitchen a visual case study was conducted of Amsterdam Café in Auburn, Alabama. This kitchen is small, but has an average daily output of six to eight thousand dollars of food. This number correlates into seven to nine hundred people in a ten hour day. Though these are high numbers, the food distribution unit will need much more output. By designing a modular system the output can be increased, along with the versatility.

The first set of pictures (figure 6.22.1) gives an overview of the kitchen's layout. The layout constraints are very similar to that of a semitrailer, long and slender. The space is divided into two halves. The left side is mainly used for cold food preparation and food delivery to the serving staff. The items that constitute cold are salads and sandwiches. The right side of the kitchen is used for the preparation of hot items. These items include pizzas, fried items, grilled items, and sautéed items. Towards the end there is also a small preparation area. The main food preparation occurs outside of the main cooking area. This observation shows a need to have the cooking equipment on the same side for energy and ventilation needs.

Figure 6.22.1 Amsterdam Café Kitchen 2006

The next part of the case study (figure 6.22.2) shows in detail the types of cooking equipment the café uses to prepare the majority of its food. The first picture in the set is a table top grill. The grill runs on natural gas, and is placed on a table unit to allow for storage underneath. The next picture shows a six burner range, with a convection oven underneath. This range and oven combination runs on natural gas. Also in the top of the picture is a broiler. This item runs on natural gas, and is used for quick broiling or melting of toppings. The third picture is a flat-top griddle. This unit also utilizes natural gas, and is a table top model to allow for underneath storage. The final picture is a stand alone pizza oven. This uses natural gas and is capable of baking multiple items in a maximum of ten minutes. It is learned here that having the cooking equipment in close proximity to each other allows for greater efficiency.

Figure 6.22.2 Amsterdam Café's Cooking Equipment 2006

The third part of this case study (figure 6.22.3) offers some information on storage options the Café has chosen to use. The first picture represents a type of refrigerated storage center. This area is used to keep certain cooking ingredients organized, fresh, and readily available to the cooks. There are multiple units of this type throughout the kitchen. The second picture is an example of a small preparation table and the different uses it can offer. There are more of these tables, of different sizes, in the kitchen; however, they are all constructed and designed the same.

Figure 6.22.3 Amsterdam Café's Storage Options

The last part of this study (figure 6.22.4) shows how the cooking tools and spices are stored in the kitchen of Amsterdam Café. The less used items, spices, are arranged towards the top. This keeps them from being spilled and allows room for the more frequently used items. The more frequently used cooking tools are hung in easily obtainable area, and the less frequently used cooking tools, pots, are stored below the preparation table.

Figure 6.22.4 Amsterdam Café's Storage Option

This study has allowed for a real life application to be viewed and dissected. This will provide valuable insight when the final design process begins. It has also helped fuel new ideas needed for the remaining parts of the thesis, and shows evidence that modularity will be of great importance in the final design.

6.23 INTERACTION MATRIX

The interaction matrix is used to determine which parts of the product interact more or less with the other parts, and aids in the planning of part placement. The chart lists vertically down the left side and horizontally from left to right across the top. It is important that the order of the parts on the left vertical side is repeated in the same order across the top from left to right. A number denotes the level of interaction, two is heavy interaction (the parts frequently interact), one represents light interaction, and zero represents parts that never interact. By charting the items an interaction total is made. This total will aid in the design process by giving insight of the importance of each item in correlation with the other items. Knowing this may put more precedent on more important items. An interaction matrix for the container design is represented in figure 6.23.1.

Figure 6.23.1 Interaction Matrix

KITCHEN UNIT'S INTERACTION MATRIX																				
#	Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
1	Steamer		0	0	0	2	0	0	1	0	0	1	1	1	1	1	1	0	2	**11**
2	Braising Pan	0		0	0	2	0	0	1	0	0	1	1	1	1	1	1	0	2	**11**
3	Range	0	0		0	2	0	0	1	0	0	2	2	1	1	1	1	0	2	**13**
4	Convection Oven	0	0	0		2	0	0	0	0	0	1	1	1	1	0	0	0	2	**8**
5	Ventalation Hoods	2	2	2	2		0	0	0	0	0	1	1	0	0	0	0	0	2	**12**
6	Sinks	0	0	0	0	0		0	2	0	0	2	2	2	2	2	2	1	2	**17**
7	Preparation Tables	0	0	0	0	0	0		2	0	0	1	1	1	1	1	1	0	2	**10**
8	Cutting Boards	1	1	1	0	0	2	2		0	0	1	1	2	2	1	1	1	2	**18**
9	Refrigerator	0	0	0	0	0	0	0	0		0	1	1	1	1	1	1	0	2	**8**
10	Freezer	0	0	0	0	0	0	0	0	0		1	1	1	1	1	1	0	2	**8**
11	Pans	1	1	2	1	1	2	1	1	1	1		1	2	2	2	2	0	2	**23**
12	Pots	1	1	2	1	1	2	1	1	1	1	1		1	2	2	2	0	2	**22**
13	Knives	1	1	1	1	0	2	1	2	1	1	2	1		1	1	1	1	2	**20**
14	Spoons	1	1	1	1	0	2	1	2	1	1	2	2	1		1	1	0	2	**20**
15	Ladels	1	1	1	0	0	2	1	1	1	1	2	2	1	1		1	0	2	**18**
16	Beaters	1	1	1	0	0	2	1	1	1	1	2	2	1	1	1		0	2	**18**
17	Can Opener	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0		2	**5**
18	Chef	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		**34**

0= No Interaction
1= Moderate Interaction
2= Frequent Interaction

6.24 INTERACTION TABLE

The interaction table is set up in a chart form very similar to the interaction table. However, instead of comparing the parts to one another, they are compared to the different environments and environmental conditions they may encounter during their lifespan. The table uses the same scoring system as the interaction matrix, but now you learn the environmental interaction. This helps the designer consider the placement of parts to avoid certain situations. It also provides an insight on the material considerations that may need to be addressed. An interaction table for the container design is provided in figure 6.24.1.

Figure 6.24.1 Interaction Table

KITCHEN UNIT'S INTERACTION TABLE																						
		ENVIRONMENTAL ELEMENTS														HUMAN ELEMENTS						
#	PRODUCT ELEMENTS	RAIN	SUN	WATER	AIR	DUST	GREESE	HEAT	HUMIDITY	COLD	WIND	HAIL	SNOW	FIRE	TOTALS	HAND	FEET	MOUTH	EYES	SWEAT	OIL	TOTALS
1	**Steamer**	0	1	2	2	1	2	2	1	2	0	0	0	0	**13**	2	1	0	2	1	2	**8**
2	**Braising Pan**	0	1	2	2	1	2	2	1	2	0	0	0	0	**13**	2	1	0	2	1	2	**8**
3	**Range**	0	1	1	2	1	1	2	1	2	0	0	0	2	**13**	2	1	0	2	1	2	**8**
4	**Convection Oven**	0	1	1	2	1	1	2	1	2	0	0	0	2	**13**	2	1	0	2	1	1	**7**
5	**Ventalation Hood (Inside)**	1	0	2	2	1	2	2	1	2	0	0	0	1	**14**	1	0	0	1	1	1	**4**
6	**Ventalation Fan (Outside)**	1	1	1	2	1	2	2	1	2	1	1	1	1	**17**	1	0	0	1	1	1	**4**
7	**Sinks**	0	1	2	2	1	2	2	1	2	0	0	0	1	**14**	2	1	1	2	1	1	**8**
8	**Preparation Tables**	0	1	1	2	1	2	2	1	2	0	0	0	0	**12**	2	1	0	2	1	1	**7**
9	**Cutting Boards**	1	1	1	2	1	2	2	1	2	0	0	0	0	**13**	2	1	1	2	1	1	**8**
10	**Refrigerator**	0	1	1	2	1	1	1	1	2	0	0	0	0	**9**	2	1	0	2	1	1	**7**
11	**Freezer**	0	1	1	2	1	1	1	1	2	0	0	0	0	**9**	2	1	0	2	1	1	**7**
12	**Pans**	0	1	2	2	1	2	2	1	2	0	0	0	0	**13**	2	1	1	2	1	1	**8**
13	**Pots**	0	1	2	2	1	2	2	1	2	0	0	0	0	**13**	2	1	1	2	1	1	**8**
14	**Knives**	0	1	2	2	1	1	1	1	1	0	0	0	0	**10**	2	1	1	2	1	1	**8**
15	**Spoons**	0	1	2	2	1	1	1	1	1	0	0	0	0	**10**	2	1	1	2	1	1	**8**
16	**Ladels**	0	1	2	2	1	1	1	1	1	0	0	0	0	**10**	2	1	1	2	1	1	**8**
17	**Beaters**	0	1	2	2	1	1	1	1	1	0	0	0	0	**10**	2	1	1	2	1	1	**8**
18	**Can Opener**	0	1	1	2	1	1	1	1	1	0	0	0	0	**9**	2	0	0	2	1	1	**6**
19	**Chef**	1	1	2	2	1	1	2	1	2	1	1	1	1	**17**	2	2	2	2	2	2	**12**
20	**Windows**	1	1	1	2	1	1	1	1	1	1	1	1	1	**14**	2	0	0	2	1	1	**6**
21	**Doors**	1	1	1	2	1	1	1	1	1	1	1	1	1	**14**	2	2	0	2	1	1	**8**
22	**Floors**	1	1	1	2	1	1	1	1	1	1	1	1	1	**14**	1	2	0	2	1	1	**7**
23	**Outer Shell**	1	1	1	2	1	2	2	1	2	1	1	1	1	**17**	1	1	0	2	1	1	**6**
24	**Inner Shell**	1	1	1	2	1	1	1	1	1	1	1	1	1	**14**	1	1	0	2	1	1	**6**
25	**Frame**	1	0	0	1	1	0	1	1	1	1	1	1	1	**10**	1	1	0	1	0	0	**3**

0= No Interaction
1= Moderate Interaction
2= Frequent Interaction

6.3 CONCEPTUALIZATION PHASE

6.31 CONTAINER IDEATION

The challenge of designing the container is based on the highway size limitations discussed in chapter three. In order for easy transportation the container must meet these guidelines, or design constraints. To combat these limitations the container design is based on technology borrowed from the recreation vehicle area. The container will travel at a width of one hundred and two inches, but will pop out to one hundred thirty-eight inches at the destination. This size allows for the proper work flow dimensions during operation. The ideation sketches of this design are found in figure 6.31.1.

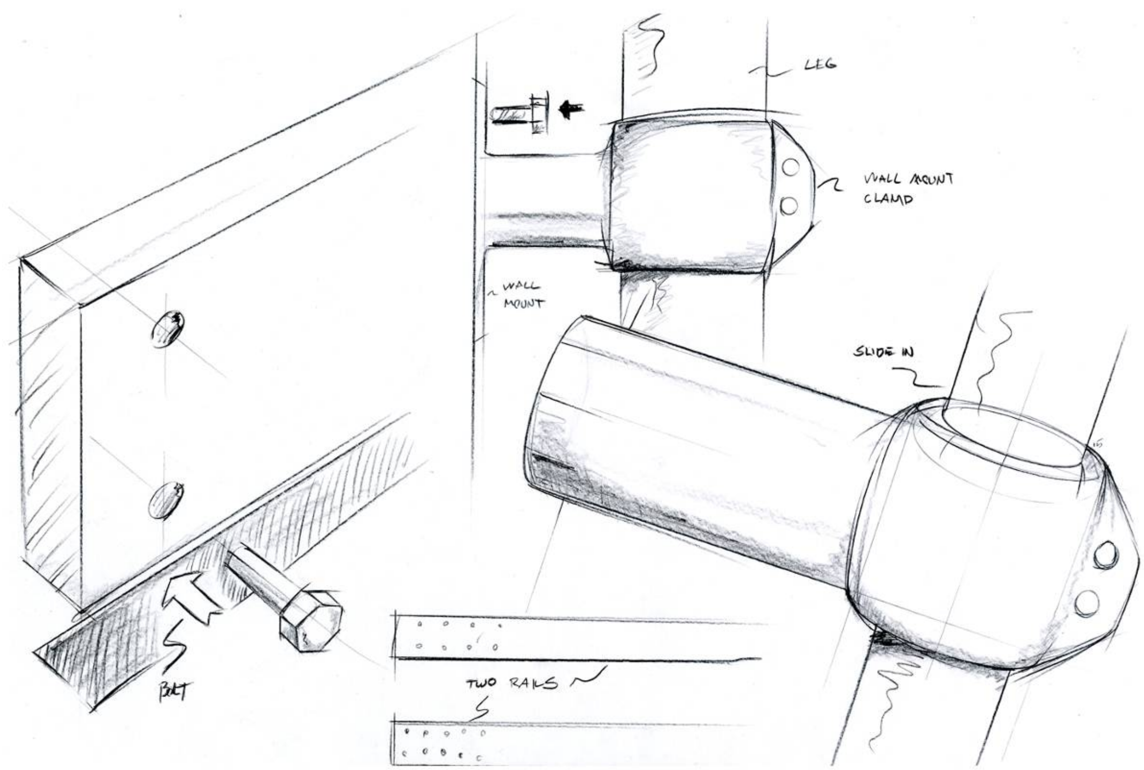
Figure 6.31.1 Trailer Ideation

6.32 MODULAR EQUIPMENT HOLDING DEVICES

This section discusses the ideation of the most important part of the recovery unit. The success of the unit is based on modularity. The ability to interchange the equipment quickly and efficiently is very important to the design.

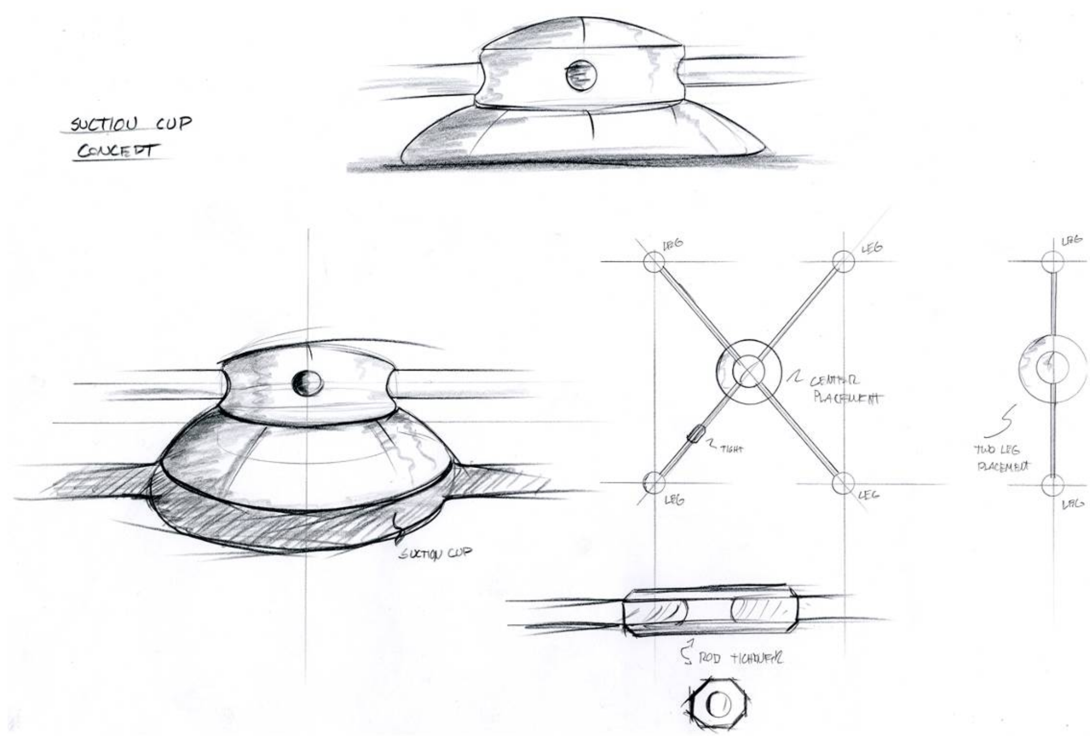
The first concept for modularity is based on a rail system. Two rails would be placed on both sides of the trailer. Then certain style grip arms would bolt to the rails to hold the equipment in place. The system does take some time to assemble, due to bolting the arms on. There are also some location constrictions due to the set bolt pattern on the rails. Overall, the concept is strong and financially feasible. The idea sketch for this concept is provided in figure 6.32.1.

Figure 6.32.1 Rail Concept Sketch



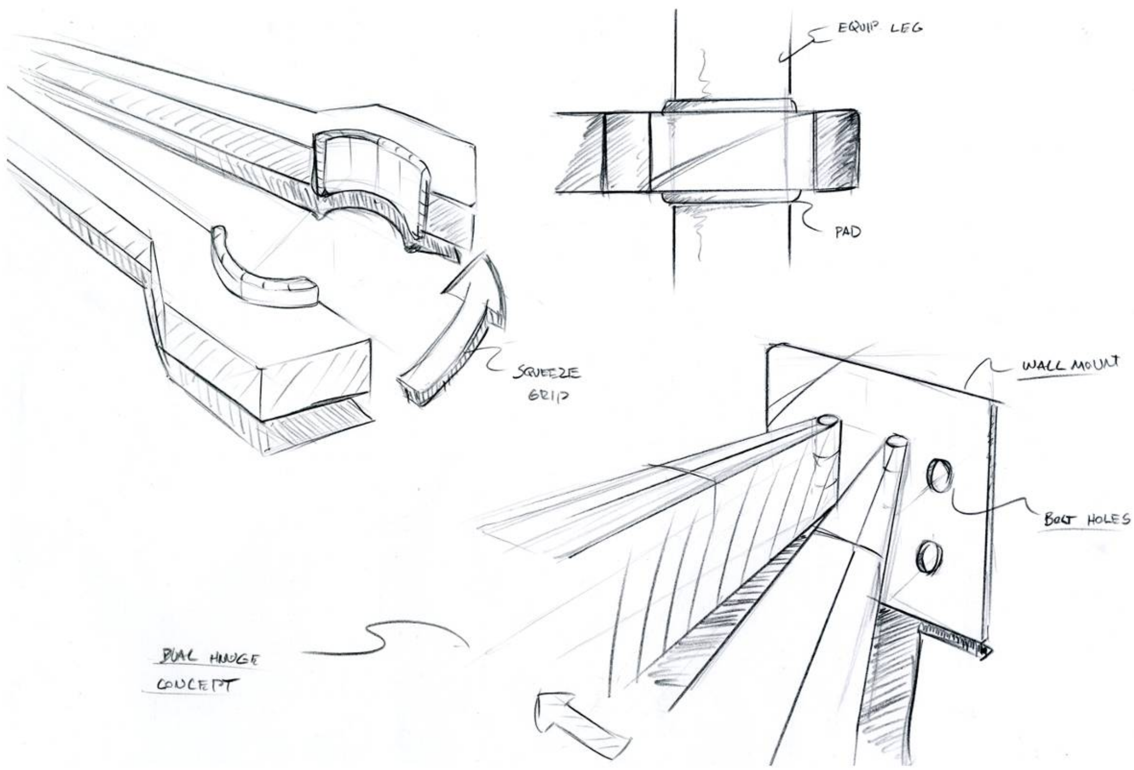
The second concept for equipment holding is an innovative new device. The cost may not be as feasible as the first concept; however its freedom is unparalleled. The concept is based on the use of suction, or magnets. Either choice could easily fit into the design. The device can attach to the wall or floor, which makes it very versatile. Once the device is attached, it uses clamping arms similar to the first concept, to hold the equipment in place. The idea sketch for this concept is provided in figure 6.32.2.

Figure 6.32.2 Suction Concept Sketch



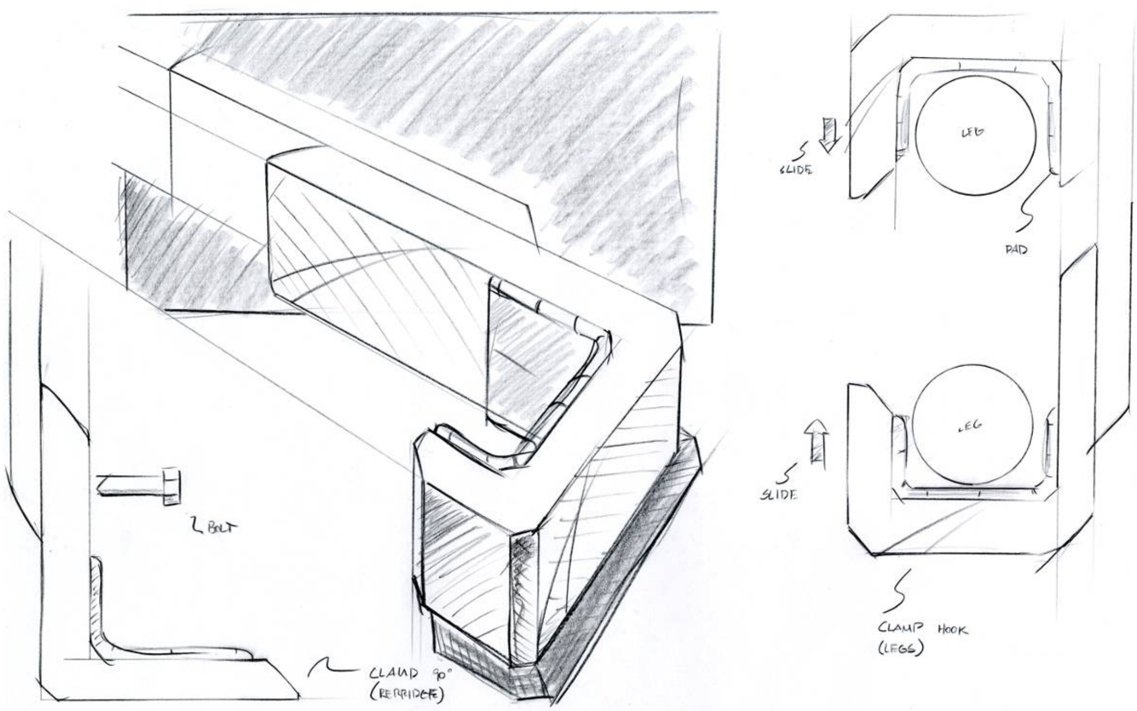
After exploring the base systems, it was necessary to conceptualize the actual arms that will be responsible for attaching to the equipment. Most of the equipment has a configuration of tubular legs. The legs are arranged in a variety of ways. The first concept is a clamping arm. The arm clamps around the leg and then attaches to the desired base. The idea sketch for this concept is provided in figure 6.32.3.

Figure 6.32.3 Clamping Arm Concept



The second arm design is more versatile, and designed with the suction base in mind. This concept uses U and L shaped heads to clamp around the equipment. The U-shaped heads are designed for clamping around the tubular legs, and the L-shaped heads are designed to hold cubical devices (refrigerators). The idea sketch for this concept is provided in figure 6.32.4.

Figure 6.32.4 U and L Shaped Arm Concept



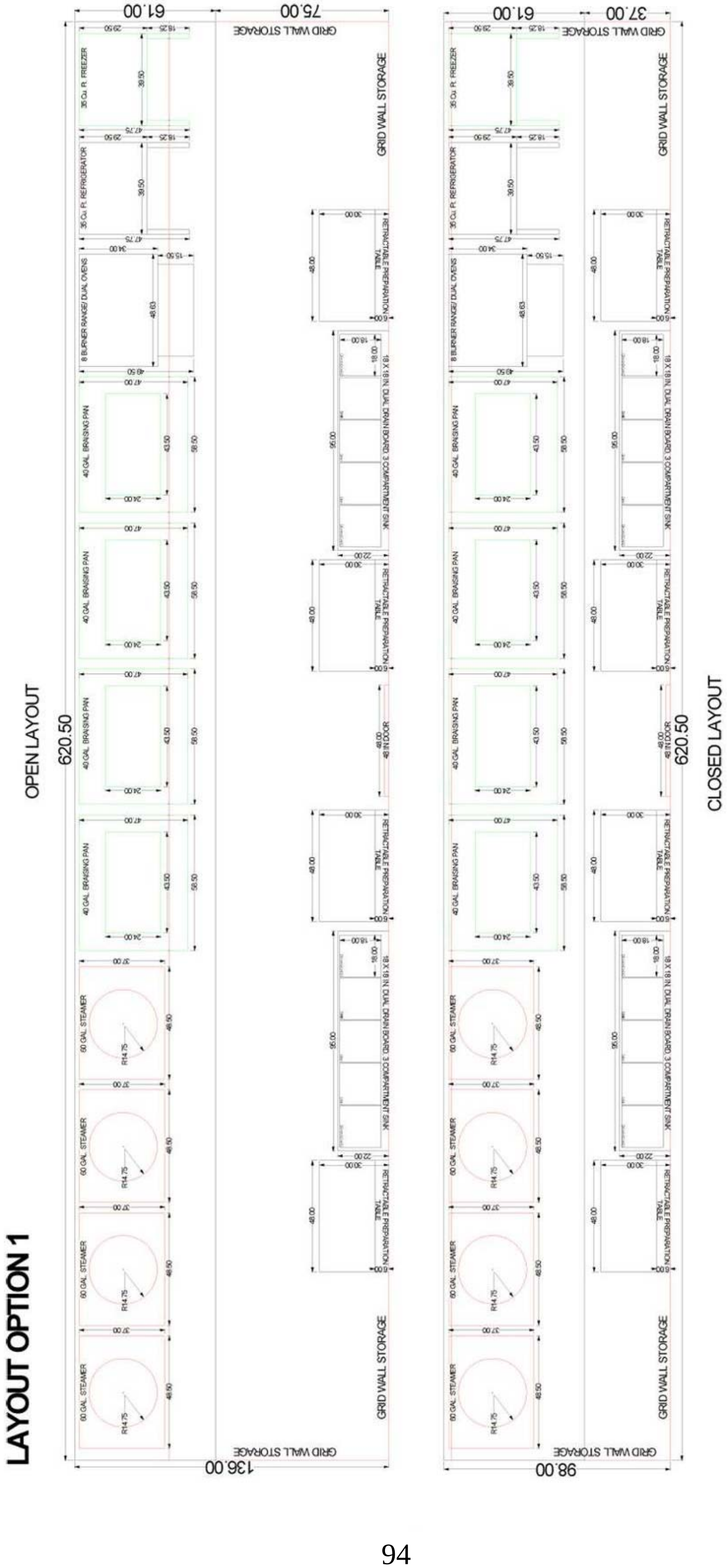
These are the concepts that will be further explored in the later CAD designs. The selected concepts will be built in Rhino 3D and displayed in section 6.43.

6.33 EQUIPMENT LAYOUT FLOOR PLAN OPTIONS

The main goal of the design is modularity, and this section will display different layouts available to the container. There are five different layouts explored. Each layout will be displayed in a dimensioned format, and give information on each ones output capabilities.

The first layout (figure 6.33.1) uses a forty-eight inch door placed in the center of the pop-out section. It contains four, sixty gallon steam kettles. These kettles are capable of producing thirty-eight hundred and forty cups of desired substance. There are also four, forty gallon braising pans. The braising pans are capable of producing twenty-five hundred and sixty cups of substance, or one hundred and twenty-eight patties (5 in.). The other cooking unit is an eight-burner range with two convection ovens. The layout includes a thirty-five cubic foot refrigerator and freezer. The appliances are placed on the non-moving section due to weight. The pop-out side contains four, forty-eight inch preparation tables. The tables fold up to provide more space when not in use. Also on this side is two eighteen inch, three compartment sinks. When the container is open, the required forty-eight inches of workflow space is easily available.

Figure 6.33.1 Layout Option One

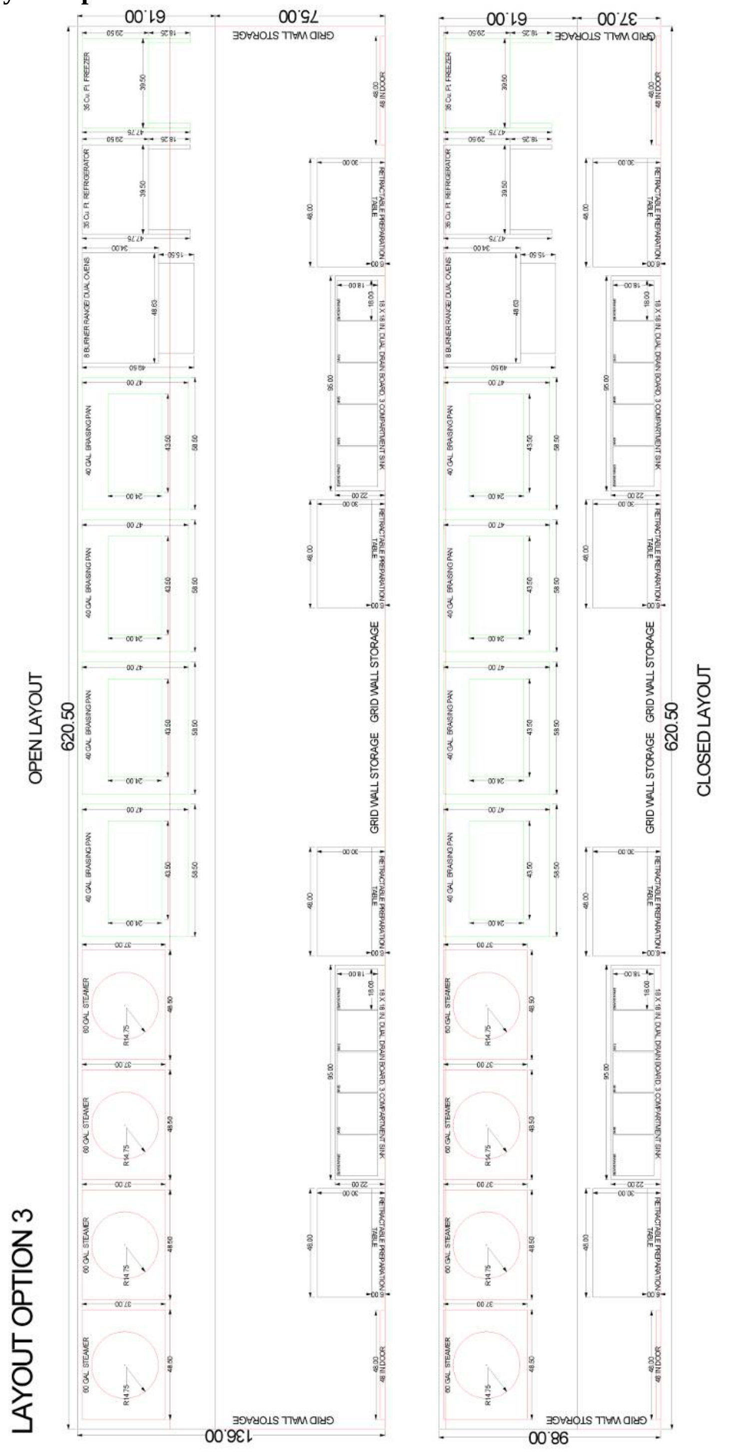


The second layout (figure 6.33.2) uses a forty-eight inch door placed in the center of the pop-out section. It contains four, sixty gallon steam kettles. These kettles are capable of producing thirty-eight hundred and forty cups of desired substance. There are also four, forty gallon braising pans. The braising pans are capable of producing twenty-five hundred and sixty cups of substance, or one hundred and twenty-eight patties (5 in.). This layout flips the placement of the steam kettles with the braising pans. This gives a little more room in the center of the unit. The other cooking unit is an eight-burner range with two convection ovens. The layout includes a thirty-five cubic foot refrigerator and freezer. The appliances are placed on the non-moving section due to weight. The pop-out side contains four, forty-eight inch preparation tables. The tables fold up to provide more space when not in use. Also on this side are two eighteen inch, three compartment sinks. When the container is open, the required forty-eight inches of workflow space is easily available.

Figure 6.33.2 Layout Option Two

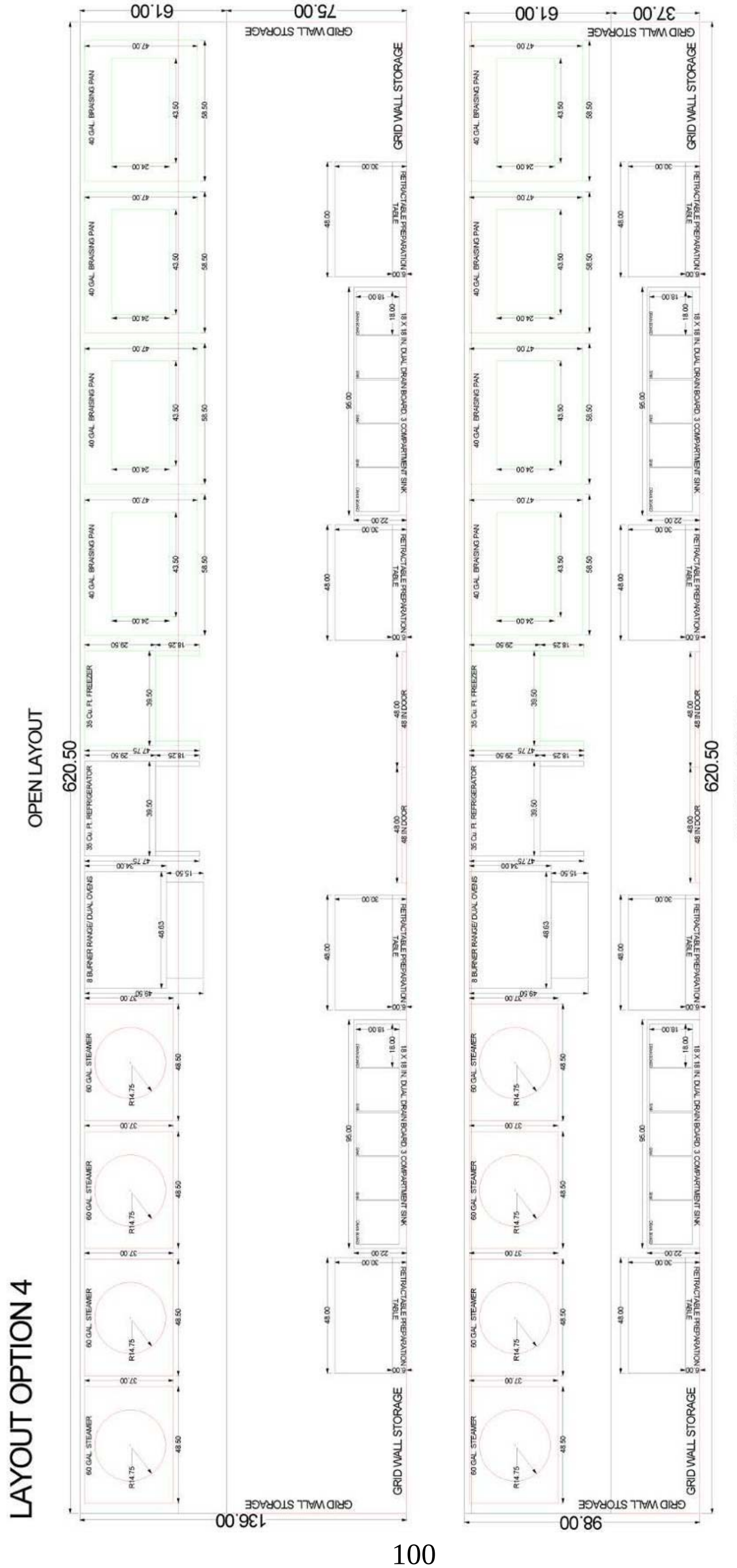
The third layout (figure 6.33.3) uses two forty-eight inch door placed on each end of the pop-out section. This configuration will allow for two entrances for equipment changes, and also two exits in case of an emergency. It contains four, sixty gallon steam kettles. These kettles are capable of producing thirty-eight hundred and forty cups of desired substance. There are also four, forty gallon braising pans. The braising pans are capable of producing twenty-five hundred and sixty cups of substance, or one hundred and twenty-eight patties (5 in.). The other cooking unit is an eight-burner range with two convection ovens. The layout includes a thirty-five cubic foot refrigerator and freezer. The appliances are placed on the non-moving section due to weight. The pop-out side contains four, forty-eight inch preparation tables. The tables fold up to provide more space when not in use. Also on this side are two eighteen inch, three compartment sinks. When the container is open, the required forty-eight inches of workflow space is easily available.

Figure 6.33.3 Layout Option Three



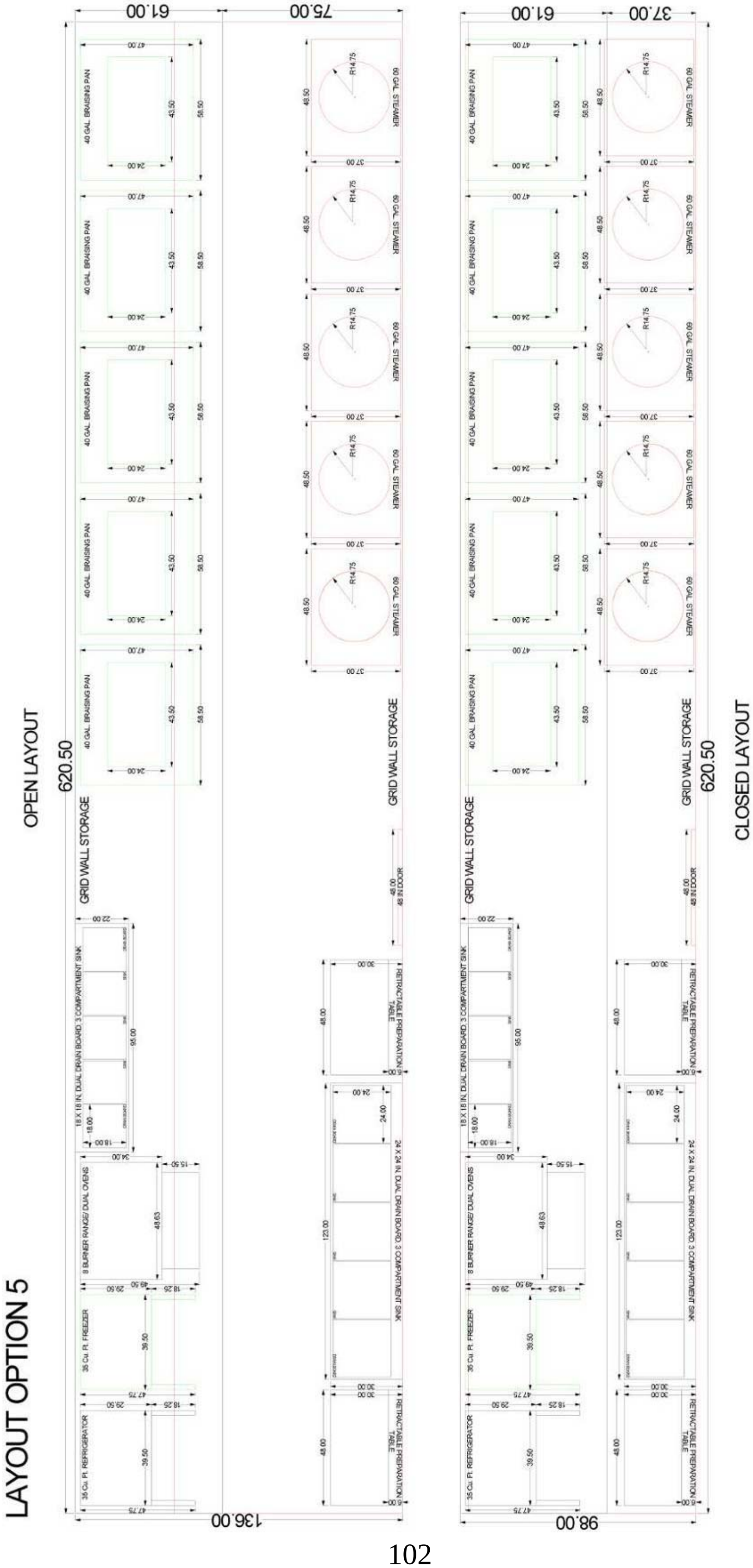
The fourth layout (figure 6.33.4) uses two forty-eight inch doors placed in the center of the pop-out section. Having two doors allows for a ninety-six inch opening in the center of the unit. This will aide in equipment change out efficiency. It contains four, sixty gallon steam kettles. These kettles are capable of producing thirty-eight hundred and forty cups of desired substance. There are also four, forty gallon braising pans. The braising pans are capable of producing twenty-five hundred and sixty cups of substance, or one hundred and twenty-eight patties (5 in.). In this layout the steam kettles and braising pans are placed at opposite ends of the container. This configuration gives greater workflow area in the center of the unit. The other cooking unit is an eight-burner range with two convection ovens. The layout includes a thirty-five cubic foot refrigerator and freezer placed in the center. The appliances are placed on the non-moving section due to weight. The pop-out side contains four, forty-eight inch preparation tables. The tables fold up to provide more space when not in use. Also on this side are two eighteen inch, three compartment sinks. When the container is open, the required forty-eight inches of workflow space is easily available.

Figure 6.33.4 Layout Option Four



The fifth layout (figure 6.33.5) uses a forty-eight inch door placed offset the center of the pop-out section. It contains five, sixty gallon steam kettles. These kettles are capable of producing forty-eight hundred cups of desired substance. There are also five, forty gallon braising pans. The braising pans are capable of producing thirty-two hundred cups of substance, or one hundred and sixty patties (5 in.). These ten cooking devices are placed in the back end of the unit. This concentrates the heat into one area. The other cooking unit is an eight-burner range with two convection ovens. The layout includes a thirty-five cubic foot refrigerator and freezer. The appliances are placed on the non-moving section due to weight. The pop-out side contains two, forty-eight inch preparation tables. The tables fold up to provide more space when not in use. Also on this side is one twenty-four inch, three compartment sink. On the appliance side is one eighteen inch, three compartment sink. When the container is open, the required forty-eight inches of workflow space is easily available.

Figure 6.33.5 Layout Option Five



These five layouts produce about the same amount of food, but they show the modularity of the system. The options are actually infinite in the design. This will also allow for future equipment designs to be incorporated into the existing container.

6.4 CAD PHASE

6.41 EQUIPMENT SECURING DEVICE

Modularity is the main goal of the container's design, and because of this the most versatile equipment securing device was chosen. This is the suction cup or magnetic cup design. This design allows for equipment to be placed in any desired location and be securely stored. If the magnetic cup is used, the floor must me a material that is a magnetic attractant. If the suction cup is used, the floor areas need to be smooth in order to achieve the greatest bond. The magnetic cup will simply attach to the floor, while the suction cup uses a twisting handle to achieve the bond. The following figures display the cup's design and how it attaches to the equipment.

Figure 6.41.1 Cup Design Size Variations

Figure 6.41.2 Cup's Bottom View

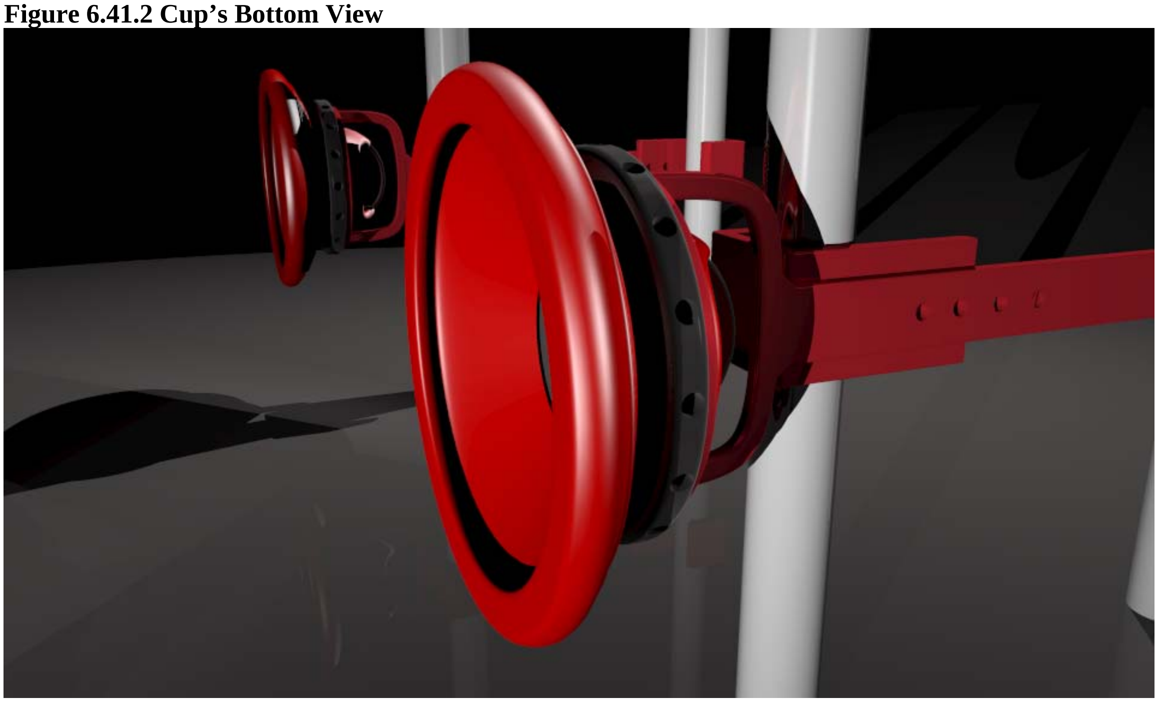


Figure 6.41.2 Cup Design with Attachments

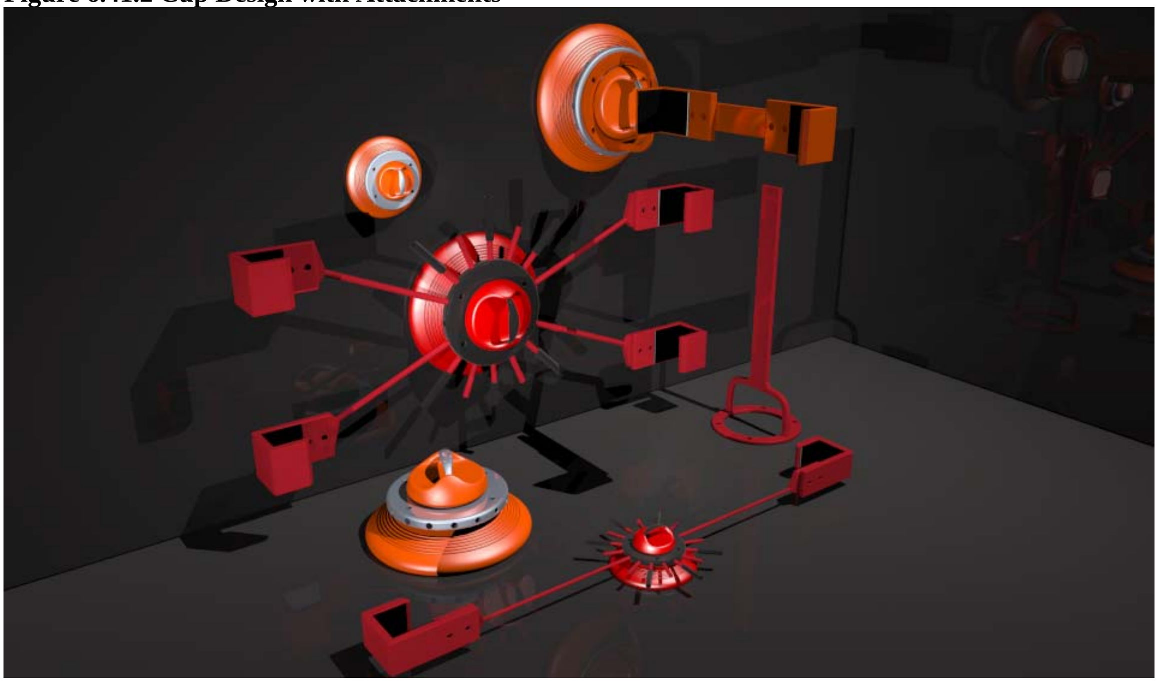


Figure 6.41.3 Cup Design Wall Mounted

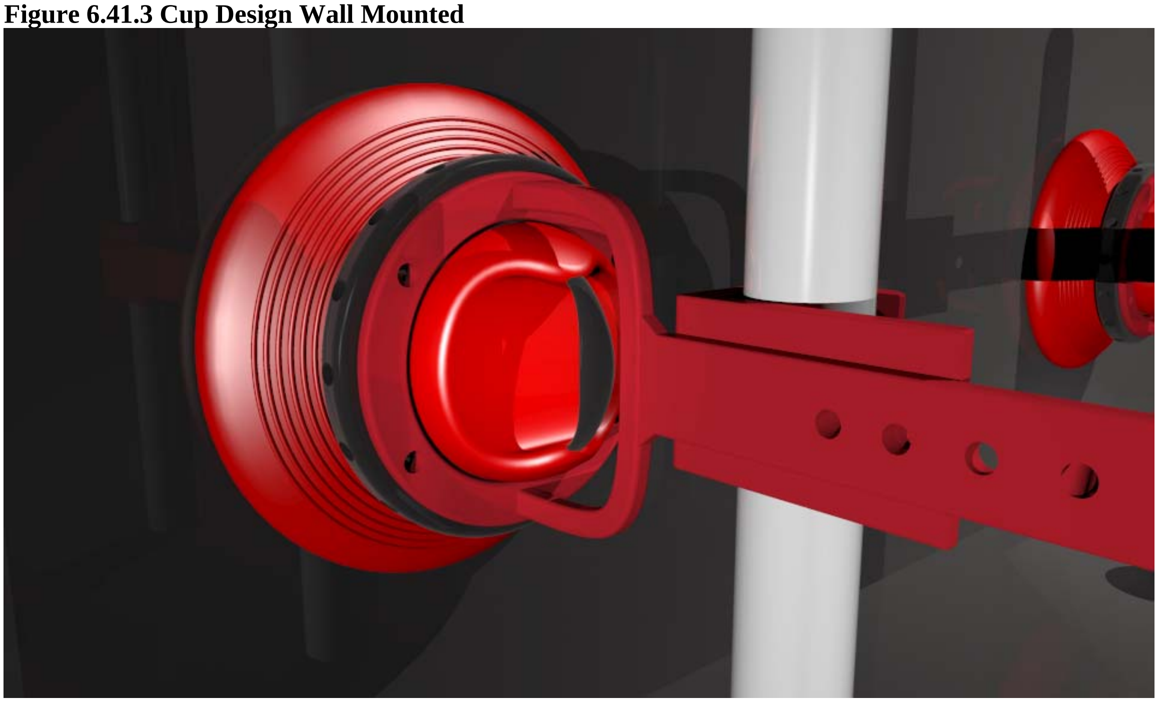


Figure 6.41.4 Cup Design Leg Holding Option

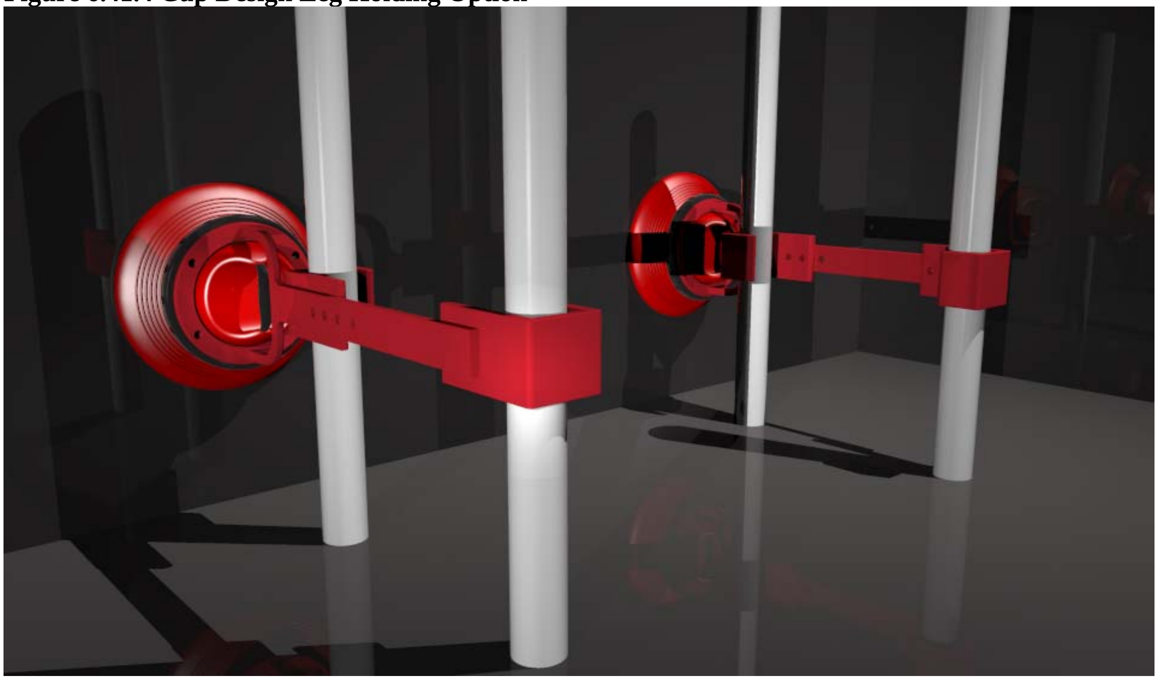
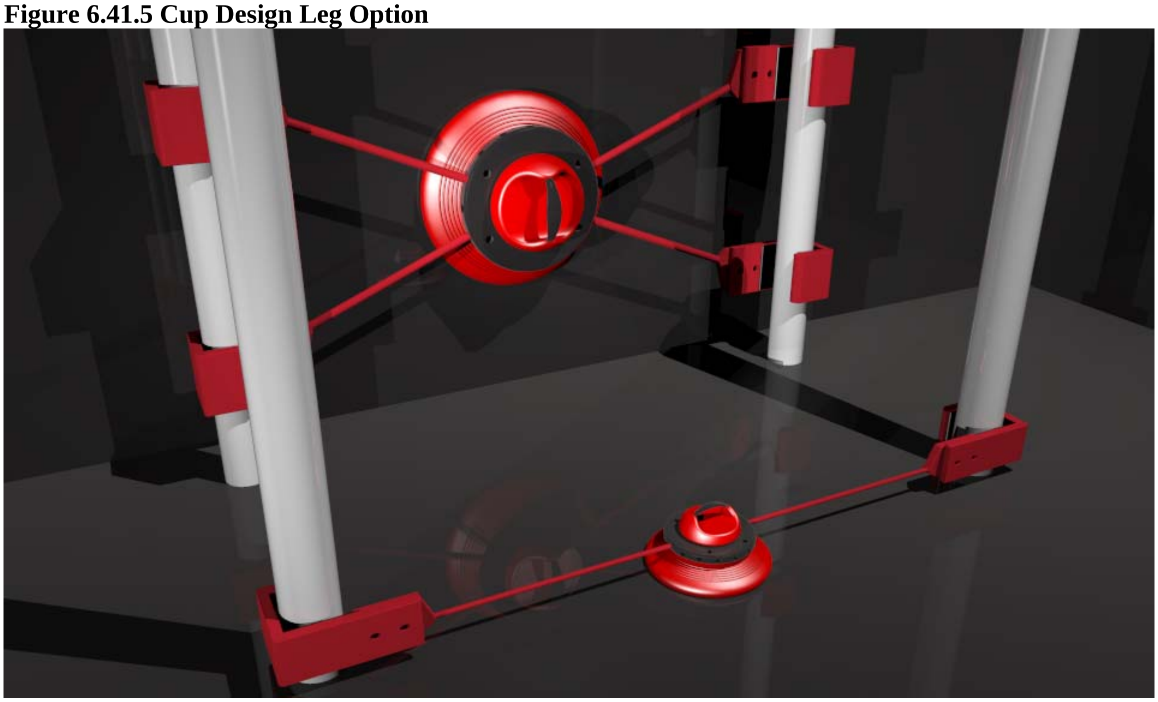


Figure 6.41.5 Cup Design Leg Option



6.42 FRAME DESIGN

The main goal of the frame design was to make it strong enough to handle the equipment weight and to conform it to a semi-trailer. By using a semi-trailer as a design constraint it was easy to fit the design inside the size limitations required by the Federal Highway Administration. The container size also allows for transportation by ship or air. These areas already have systems in place for semi-trailer transport. The problem with the semi-trailer size is its width. The normal one hundred and two inches was not enough room to allow adequate workflow. To combat this problem a pop-out section was employed. The section extends an extra thirty-six inches, which allows for ample work flow and equipment variations. The frame also needed areas to accommodate moderate propane storage, water concerns, power generation, and water heating. The frame's design is displayed in the following figures.

Figure 6.42.1 Whole Frame Closed

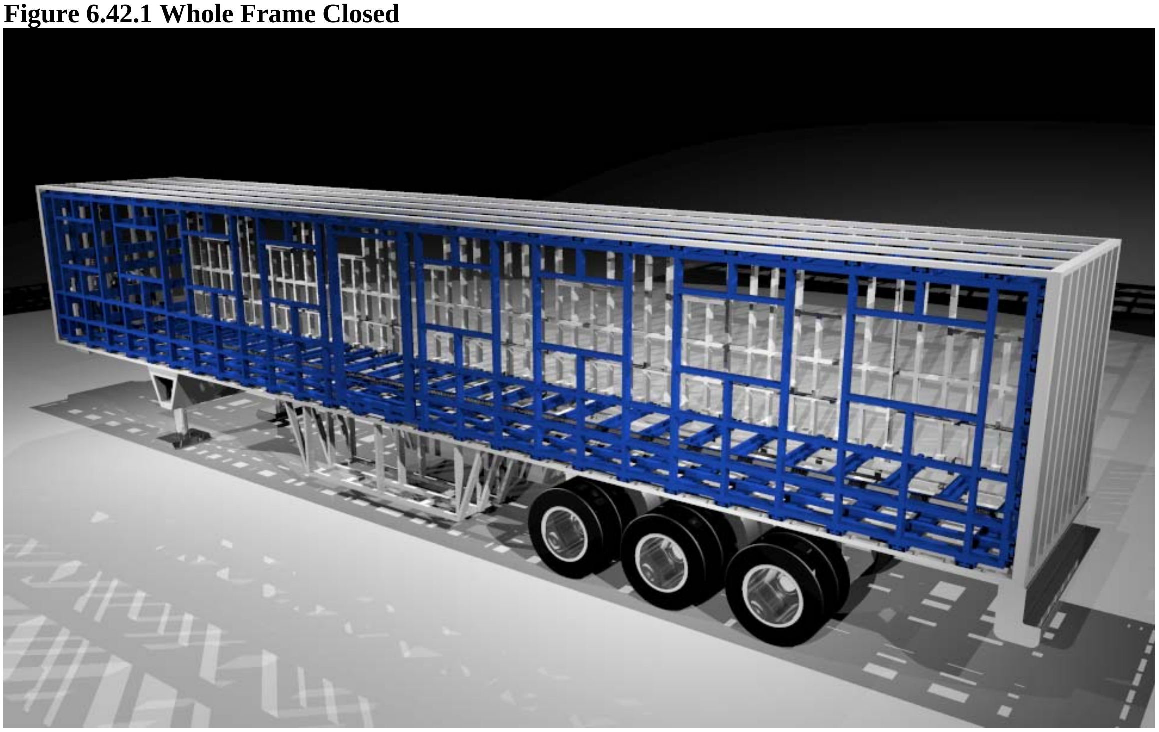


Figure 6.42.2 Whole Frame Opened

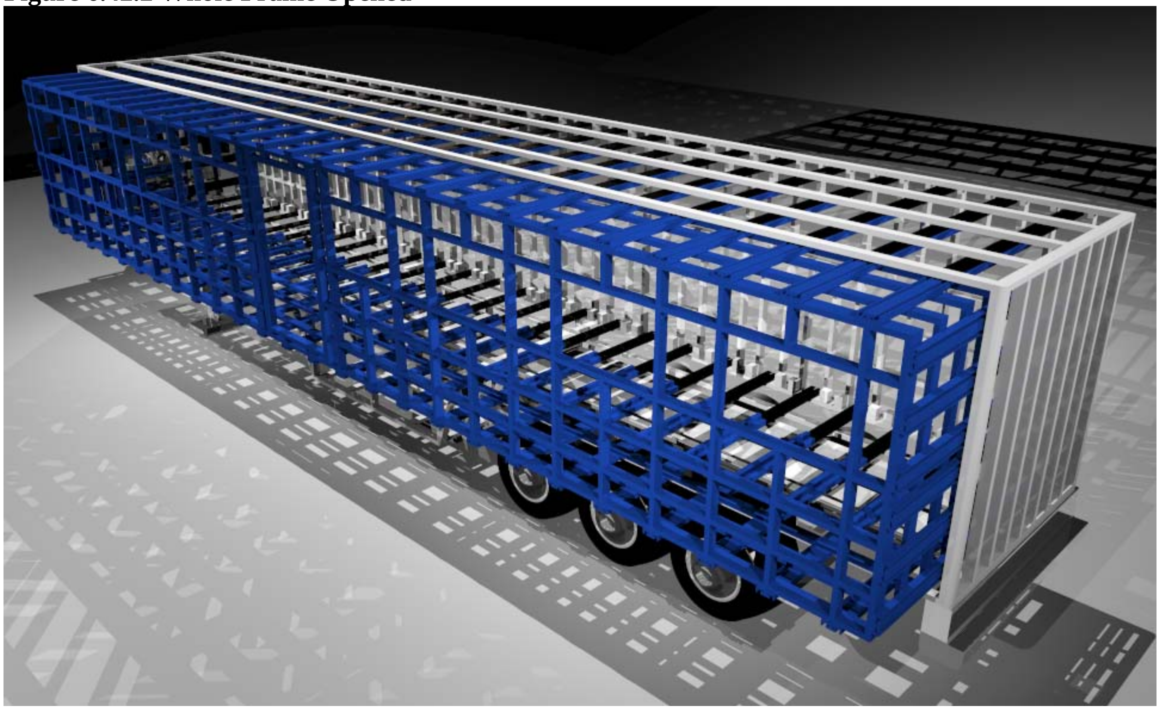


Figure 6.42.3 Frame Pop-Out Joints

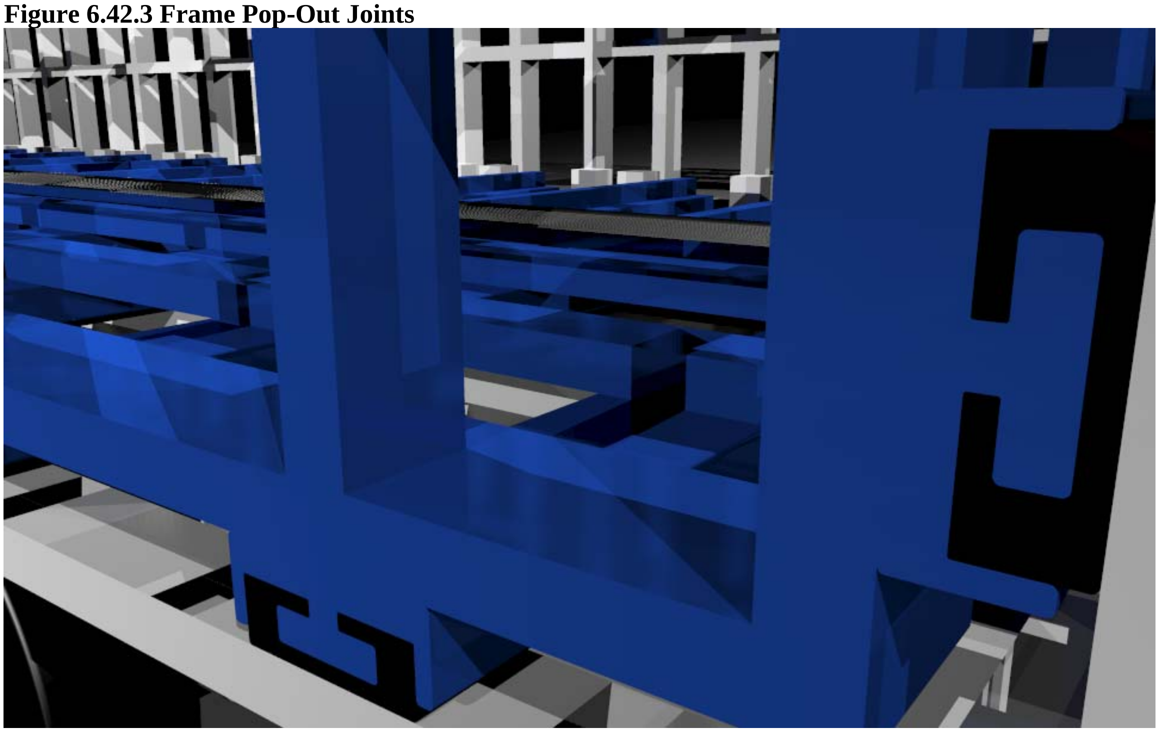


Figure 6.42.4 Propane Storage

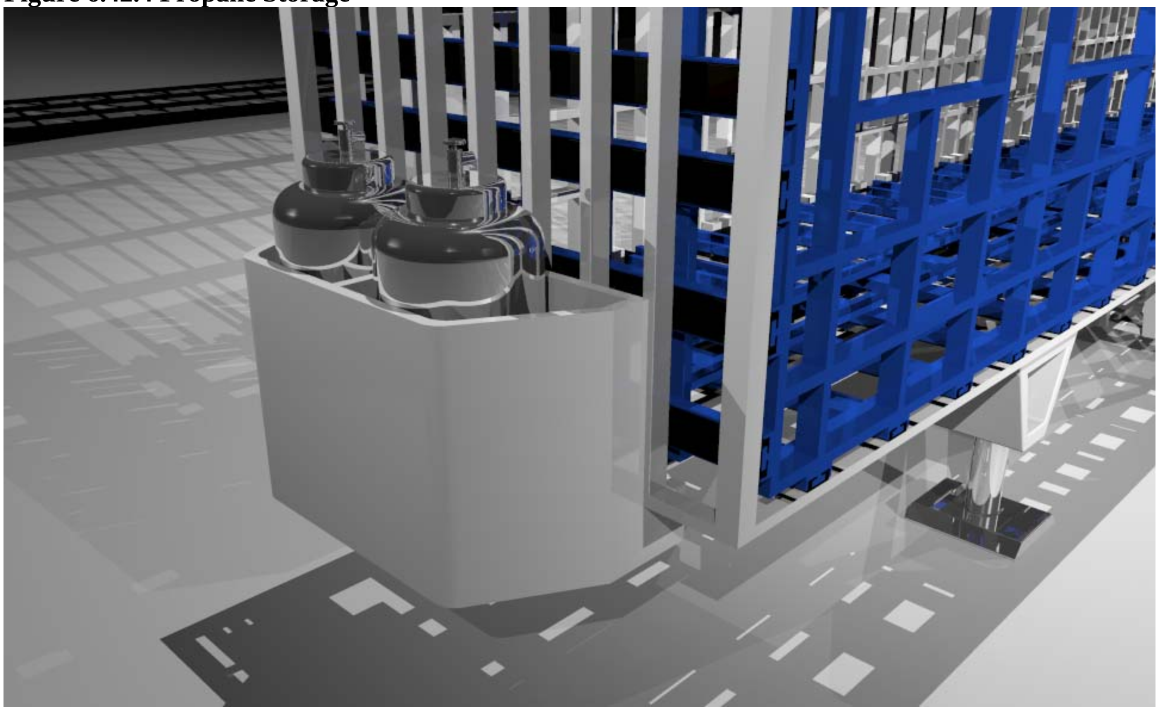
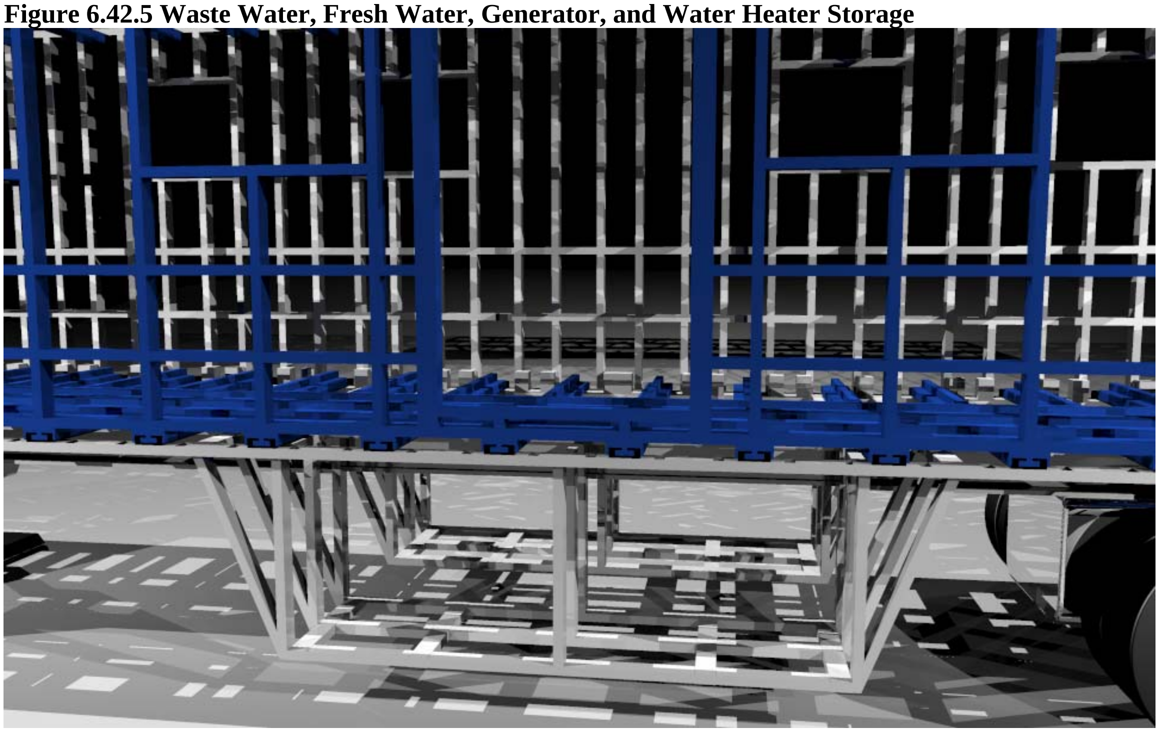


Figure 6.42.5 Waste Water, Fresh Water, Generator, and Water Heater Storage



6.43 CONTAINER'S INTERIOR DESIGN

The design of the interior is relevant to the situation for which it is outfitted for. The modularity of interior is the most vital aspect of the food distribution unit. The fourth layout option from section 5.33 was chosen for further development. This layout offers the most balanced situation. The main cooking equipment is stored on the right side of the container. This distributes the heaver weights over the non-moving section of the floor. The washing and preparation areas are configured on the left side of the unit. This is the section that pops out. By having the pop-out section the unit adds thirty-six inches of work flow area. This gives the total work flow area a width of fifty inches. Fifty inches is two inches larger than the suggested forty-eight inches. The interior's design is displayed in the following figures.

Figure 6.43.1 Interior's Design from Front End

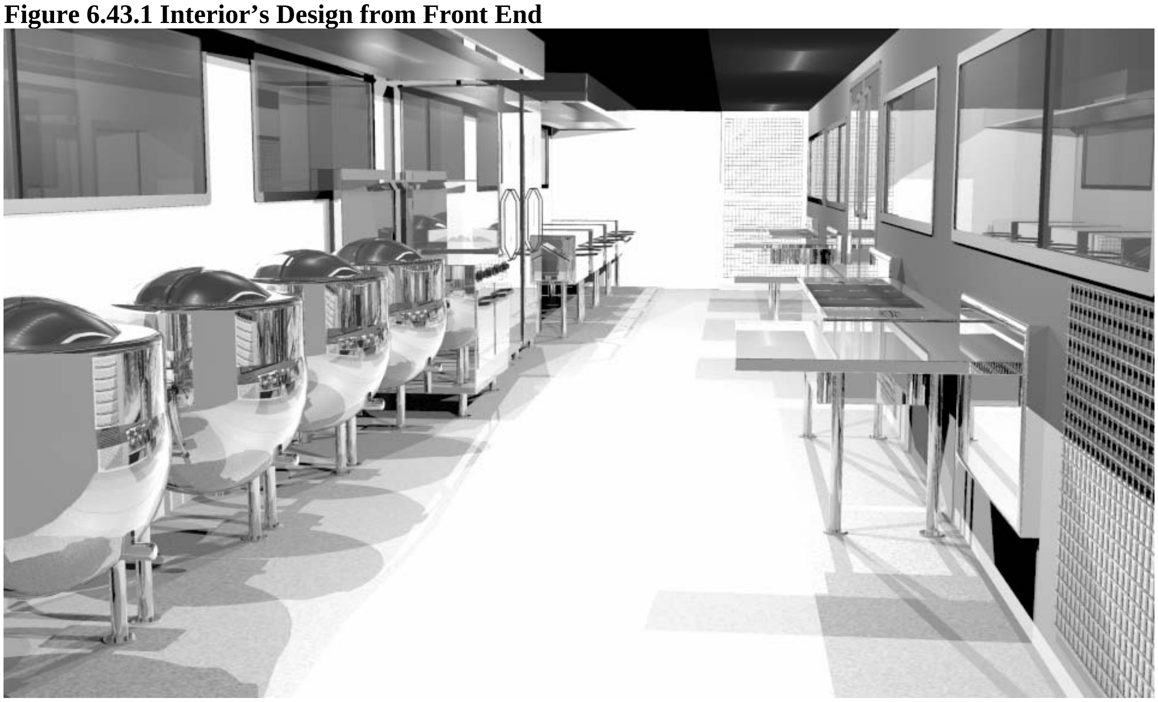


Figure 6.43.2 Interior's Design from Side View

Figure 6.43.3 Interior's Design from Back End

Figure 6.43.4 Interior's Design from Corner View

Figure 6.43.5 Interior View Including Stabilizing Cups

6.44 OUTER SHELL DESIGN

The design of the outer shell was highly dependant on the inner needs. By placing the cooking equipment on the same side it allowed for easy placement of the hood vent fans. The fans are covered with low profile design. The low profile allows for clearance relief and aerodynamic attributes. The left side of the container is outfitted with two large solar panels. The panels tilt upwards in order to catch the most solar energy available. They basically move towards the most direct sun light. At this point there was a need to address the name of the unit and the representational graphics. *Rebound*, was the name chosen for the food distribution unit. The name explains the entire purpose of the unit in one word. To represent the name a graphic of four balls was designed. The balls appear as a representation of one ball rebounding towards the viewer. The following figures represent the outer shell design of the *Rebound* food distribution unit.

Figure 6.44.1 Outer Shell's Left Side View

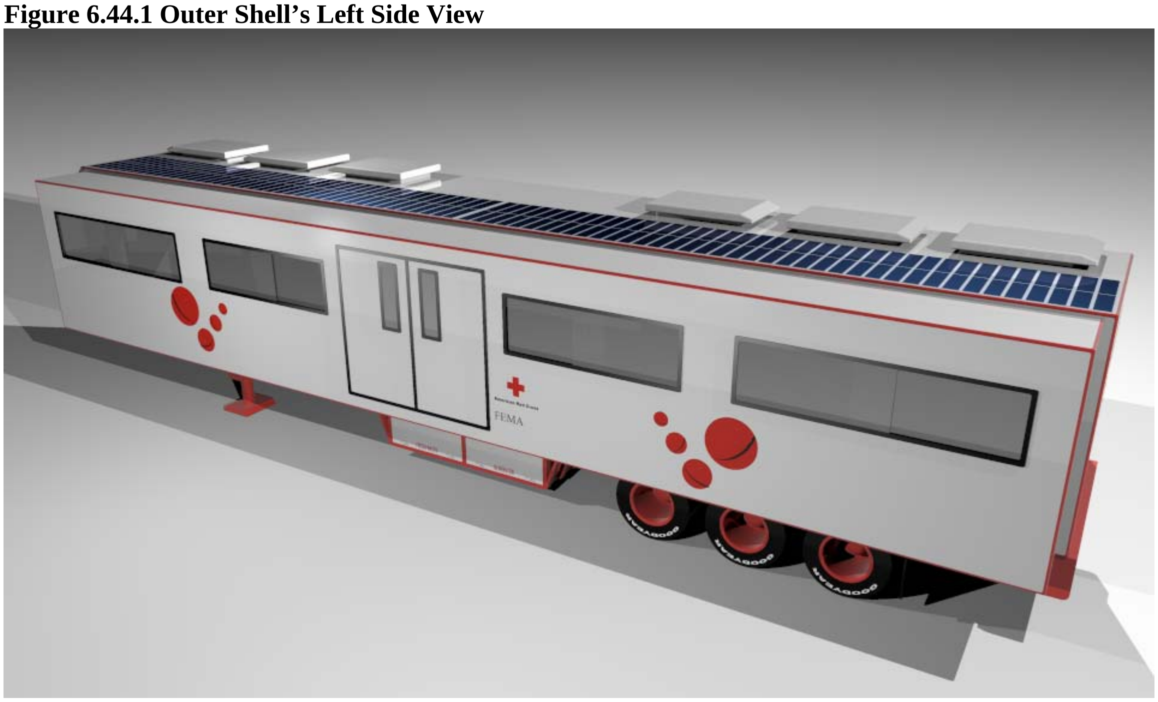


Figure 6.44.2 Opened Unit

Figure 6.44.3 Closed Unit

Figure 6.44.4 Unit's Left Side

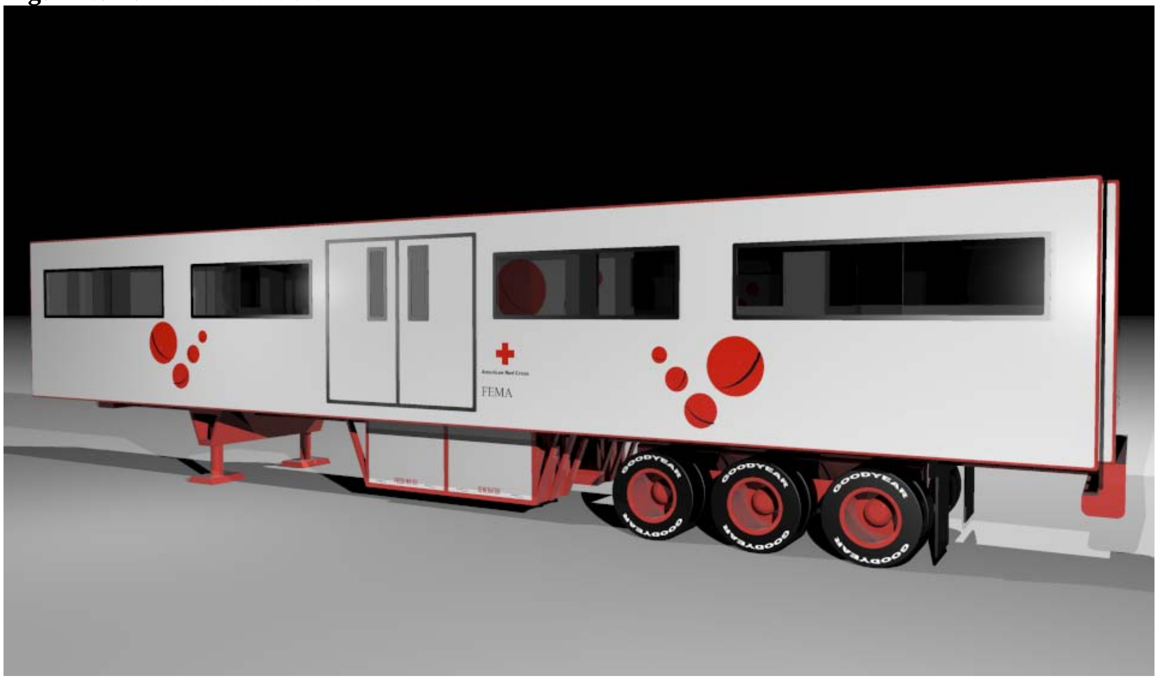
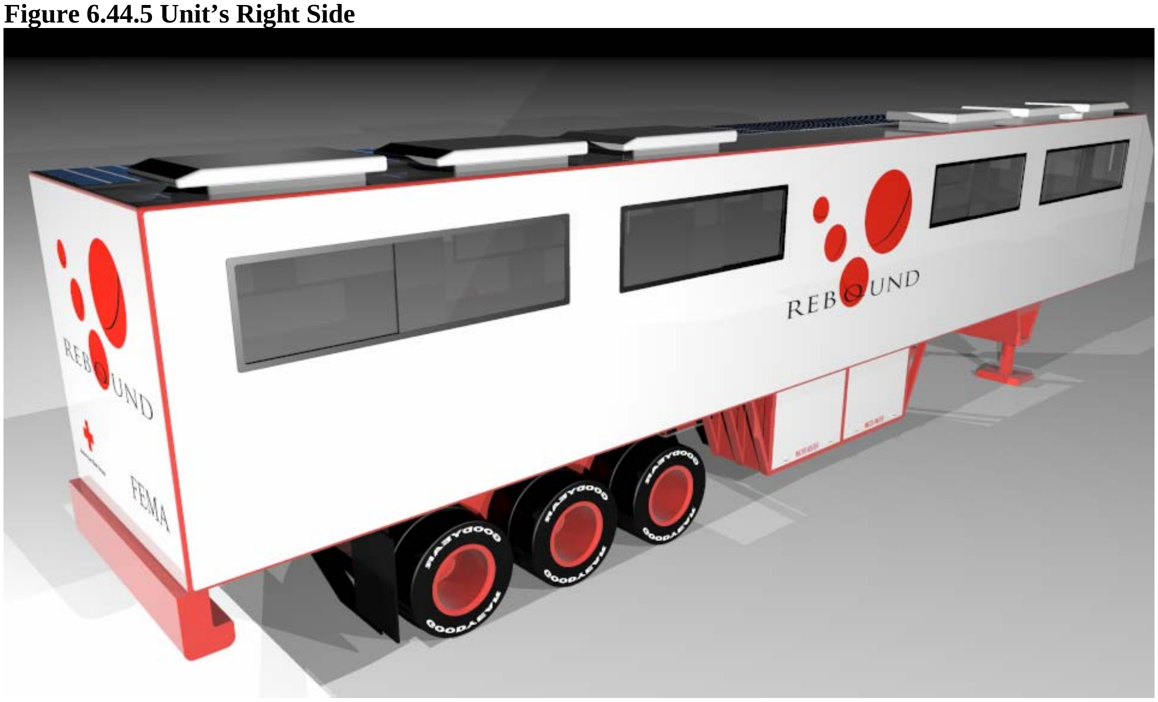


Figure 6.44.5 Unit's Right Side



6.5 CONCLUSION

This chapter was broken into three different categories. These categories correlate to the design timeline used in this design process. The first phase was the research phase. This phase helped lay a foundation of factors that must be addressed during the next phases. The second area was the conceptualization phase. This is the creative time where the research facts and the designer's ideas come to life. The last section of this chapter was the CAD section. This chapter gives a total package of the design process used to develop the *Rebound* food distribution unit, and a final representation of the end design.

7. CONCLUSION

7.1 SUMMARY OF STUDY

This study is based on the problem of feeding multiple people that are involved in the recovery of disaster areas. In our world there are many things we consider disasters; however only a few can be truly defined as tragedies. A true tragedy is something that leaves a large number of people suffering for a prolonged period of time. The focus of this project is to provide relief in this type of situation. The key word is relief. In no way can everyone be helped in a tragedy, but with the use of this system a large majority can.

This study used five disasters as reference points: hurricane, tornado, flood, earthquake, and terrorist attack. These disasters covered the majority of the disaster spectrum. Because the system is designed to handle these extreme disaster types, it automatically allows for the relief of smaller scale or new types of disasters.

The *Rebound* system is a self-contained food service system that is easily transportable. It provides clean water through innovative filtration and able to supply its own power from the sun, efficient generation, or available power source. *Rebound* utilizes professional equipment that can be modified to fit the confined area of the system, however its modular design allows for the optimal work flow. The system and equipment are easy enough for a volunteer to use, but have the quality any professional chef would be proud to use.

The purpose of the proposed system is two-fold. First it is an efficient device that is capable of feeding many people in areas of need. But the most convincing reason to employ such a system is to increase the morale of people involved in the restoration of the disaster. If you are bagging sand for a flood and every meal is served in a plastic wrapper you will begin to lose enthusiasm in the project. But if you know you are going to have a hot meal served with a little influence of the given area, you are going to work harder. This also works in raising spirits for the victims. They may have lost their homes but the reassurance of a home cooked meal will provide positive thoughts of the restored future.

Life after a disaster is never easy, but being able to make everyone feel as close to normal as possible is a great way to start. This system is the first positive step in this direction.

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