Container Wars – Environmental Controls

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Project Description:

Pipeline Worldwide is a non-profit organization that connects donors in the United States with communities in need in Uganda. Pipeline Worldwide has sponsored this project along with a handful of other companies with the goal of creating comfortable sleeping quarters in a shipping container for six people. The teams from Grand Canyon University (Power and Environmental Controls) are competing with two teams from Arizona State University to produce the best design for the container. The sleeping quarters must cost less than $15,000 to build because the design will be used as a model for future containers built in Uganda. The Environmental Controls team is responsible for providing a comfortable temperature, security, and privacy inside of the container. The winner of Container Wars will have their container replicated in the future.

Functional Requirements:

- **Ventilation:** Includes a ventilation system that can keep the container between 65°F and 80°F as well as introduce air flow to maintain a supply of oxygen within the container
- **Insulation:** Includes insulation that works with the ventilation system to keep the temperature inside the container between 65°F and 80°F
- **Replicability:** The unit must be able to be replicated by Ugandan workers The materials that are available in Uganda must costs and stay under $15,000. Includes an installation manual detailing the remaining construction steps
- **Privacy:** Construct individual sleeping quarters for 6 occupants with latching doors

Design Process:

- Due to power restrictions, passive ventilation was the chosen method to regulate the container's internal temperature as well as introduce airflow throughout the container
- Floor vents, awning windows, black metal roof louvers, and R-13 batt insulation were used in the environmental controls system, utilizing the stack effect to pull cool air in through the windows and floor vents and exhausting hot air through the ceiling vents
- Subframes were designed with L-angle Metal brackets to seal of the corrugated parts of the container from outside environment on parts of the exterior that will be cut into
- Awning windows were used to prevent rain from entering the container while open

Design Specifications:

- **Ventilation:** Black Louver Vents on the Ceiling utilize the stack effect to draw hot air out through the top of the container. This pulls cold air in through the floor vents and windows.
- **Insulation:** R-13 Batt Insulation counteracts any heat from the metal of the container
- **Replicability:** An installation manual was put together to allow for non-problematic construction of the container and all materials have equivalents available in Uganda
- **Privacy:** 6 individual bedrooms with separate doors and windows are fit into the container utilizing a L shaped bedroom. Each bedroom has its own bed, shelf, desk, and chair.

Safety Considerations:

- Window Size is 32" x 24" which is large enough to meet fire-exit classification requirements
- Class A Fire Rated Batt Insulation is fire retardant to prevent the rapid spread of fire.
- Window height under 6 from the ground to meet requirements for fire-exit classification
- Mosquito Protection to protect inhabitants from harmful diseases being transmitted

Verification Test Plans and Data Summary:

- **Ventilation:** To test the ventilation system, both the temperature and airflow inside the container as well as outside the container will be recorded/controlled. The airflow outside of the container will be set using a variable wattage fan that will be set at multiple points to simulate variation in windspeed throughout the day. The heat outside of the container will heat be directed toward the roof to simulate the sun.
- **Insulation:** To test the insulation in the container, the outside temperature will be compared to the ambient interior temperature. The temperature of the bare metal inside the container where the windows will be installed will be compared to the temperature of the insulated walls to prove that the insulation is keeping the walls cooler. Record the ambient temperature outside of the container.
- **Replicability:** To test that the project can be replicable, all the materials used on the products will be documented so that they can be purchased and fabricated in Uganda. The project must not cost more than $15,000 in Uganda to replicate. The installation manual will depict and describe how all the parts provided by the environmental control group are purchased and installed. This insure replicability.
- **Privacy:** A 6 room total is verified each with individual doors, windows, desks and beds. This is done using an L-shape bedroom style with alternative beds above and below the center of the room.

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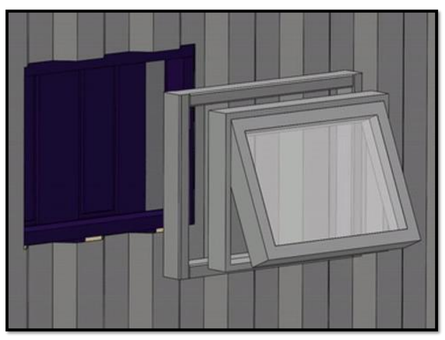



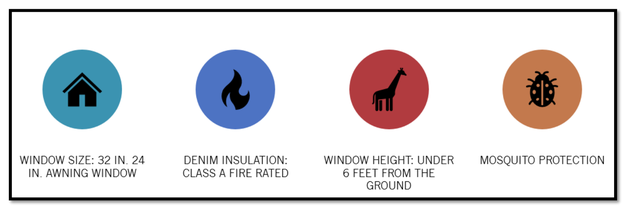

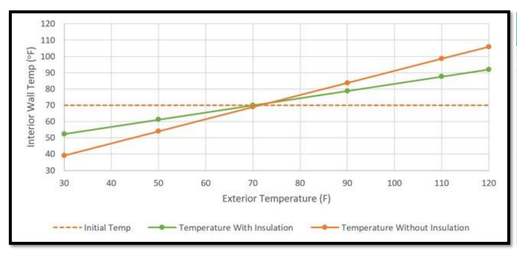

Ventilation Test

	#	1	2	3	4	5	6
Ambient Temperatures (°F)	Control Temperature (Top of Box)	55	60	65	70	75	80
	Interior Temperature	55	58	63	68	70	74
Airflow	Fan Wattage (W)	7.5	8	8.5	9	9.5	10
	Volumetric Flow (m^3/hr)	41	45	47	50	53	60

Insulation Test Temperatures (°F)

	#	1	2	3	4	5	6
Initial Ambient Temperatures	Exterior	30	50	70	90	110	120
	Interior	70	70	70	70	70	70
Interior Wall Surface	With Insulation	52.4	61.2	70.0	78.8	87.6	92.0
	Without Insulation	39.2	54.1	69.0	83.8	98.7	106