PROJECT ARMORED ECLIPSE

REQUEST FOR PROPOSAL

FOR THE DESIGN OF A

Intelligent Building Window Covers

Baylor University Climate Control Solutions

Fall 2007

DOCUMENT HISTORY

Original Release, September 5, 2007.

I. OVERVIEW

Baylor University Climate Control Solutions (BUCCS), hereafter referred to as the *client,* is seeking qualified engineering firms to design, document, and conduct proof-of-concept testing for a system of Intelligent Building Window Covers (IBWiCs) to form a critical component of a building-level heating, ventilation, and air conditioning (HVAC) system under development by the client. The designs of invited engineering firms will be evaluated on the basis of performance, appearance, and cost, in that order, in a competitive compliance test. The intention of the client is to select a single design, largely on the basis of the competitive compliance test, but ultimately at the discretion of the client, for manufacture and installation in a multi-level beach-front hotel located in South Padre Island, Texas.

II. BACKGROUND

Research conducted by the U.S. Energy Information Agency and publicized by the National Renewable Energy Laboratory (http://www.nrel.gov/buildings/) homes and commercial buildings use 71% of the electricity in the United States, and this figure is expected to rise. Thus, energy savings related to buildings and dwellings has the potential to substantially affect domestic energy consumption. Indeed, energy savings resulting from advanced building technologies such as those being pioneered privately by the client, and publicly by organizations such as the National Renewable Energy Lab (NREL), are poised to impact the nation's energy infrastructure even more significantly than other technologies such as solar photovoltaics or wind energy, despite the latter's greater public interest and level of financial investment. The client's extensive expertise in the field of energy saving building technologies has resulted in the receipt of the 2006 Erg Award for Engineering Excellence in the field of Energy, a prestigious international reputation, and substantial financial growth.

At the same time, rising energy costs and shortages have contributed to an increased public awareness of, and appreciation for, energy saving appliances, vehicles, and structures. In short, the U.S. consumer is becoming more energy-discerning. In particular, private research on the part of the client shows that this increased public awareness and appreciation is centered in a demographic of college educated young families and singles with medium to high level incomes. Such a demographic is able to afford resort hotel products, but will prefer an energy-responsible choice, if present.

The client and the client's partners, therefore, have endeavored to construct a beach front resort hotel in South Padre Island, Texas, known as "Joule's Jewel" and holding energy-responsibility as a strategic goal, second only to public safety. Energy saving technologies will not only be employed, they will actually be marketed as attractions. Thus, the external and public nature of the building windows is a vital and strategic aspect of the overall business plan.

III. DESIGN SPECIFICATION

1. Shading Function

1.1 Window Frame Dimensions

The IBWiC shall perform shading from solar irradiation for a rectangular window opening as specified in Figure 1. Shading will be performed in a way to maximize visibility from behind the window.

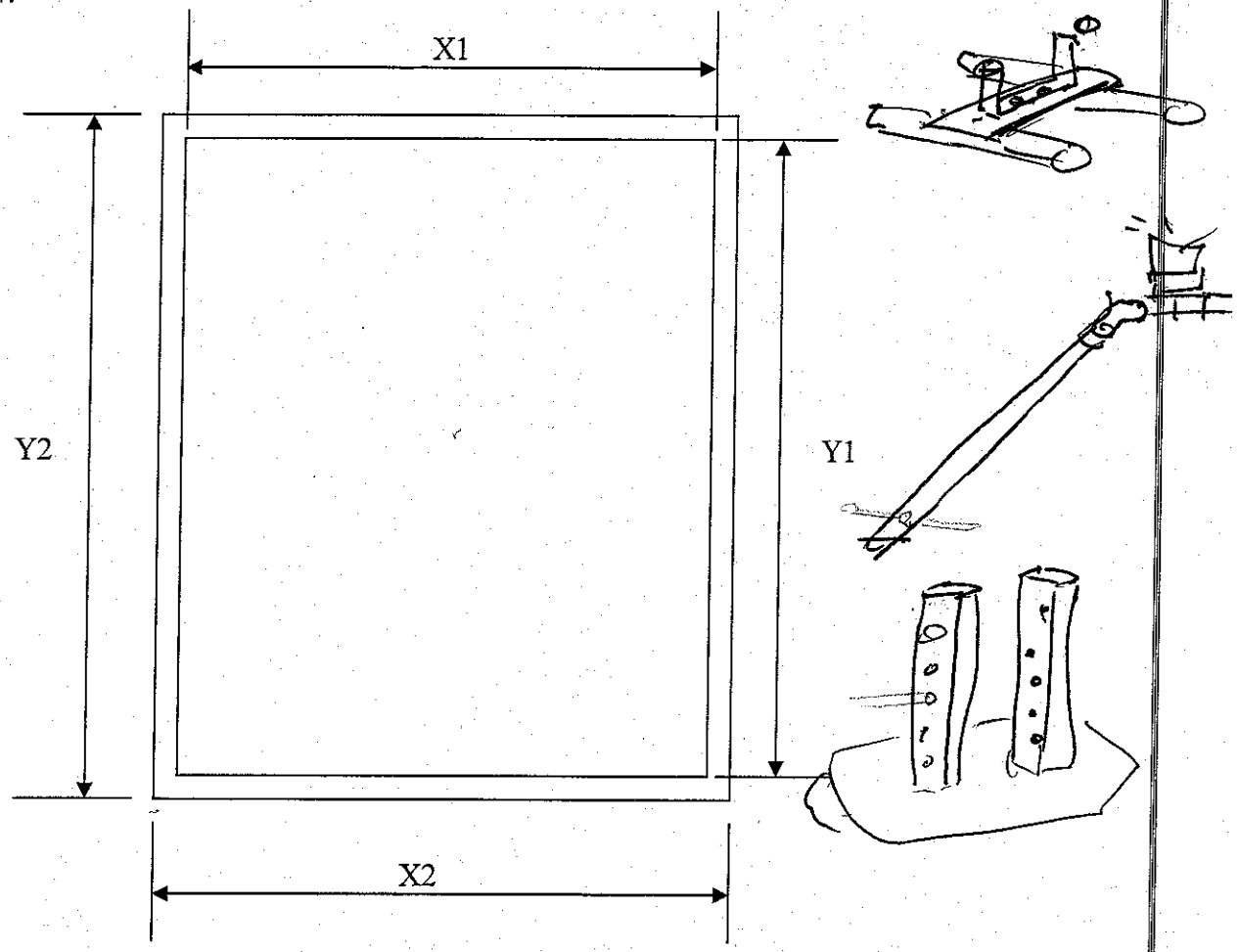

Figure 1: Window Frame Dimensions. X1 = 12.0 inches, X2 = 16.0 inches, Y1 = 20.0 inches, Y2 = 24.0 inches. All dimensions have tolerance ±0.1 inch.

The thickness of the window frame shall be uniform and between 2.0-4.0 inches.

1.2 Solar Simulation Device

For purposes of device testing, including final compliance testing, a hand-held, high intensity electric light will be used to simulate the position of the sun. A limited number of these electric lights will be made available by the client. Additional units may be purchased at Wal Mart as required (Cyclops Thor X Colossus spot light, Product ID 5839257).

For purposes of testing, the Solar Simulation Device will be operated at a radial distance of 6.0 ± 0.1 feet measured from the bottom of the Window Frame in accordance with Figure 2.

1.3 Range of Operation

The IBWiC shall operate over the range of solar positions as defined by solar altitude angle. For angles $30° < \varphi \leq 90°$, the IBWiC shall perform the shading function. It shall be capable of sensing the solar altitude angle and automatically adjusting the shading appropriately.

Figure 2 shows the solar range over which the IBWiC must provide the shading function. For solar altitude angle $\varphi \leq 30°$, the IBWiC shall assume a position of minimum shading as solar irradiance from low angles has significantly diminished intensity due to atmospheric scattering.

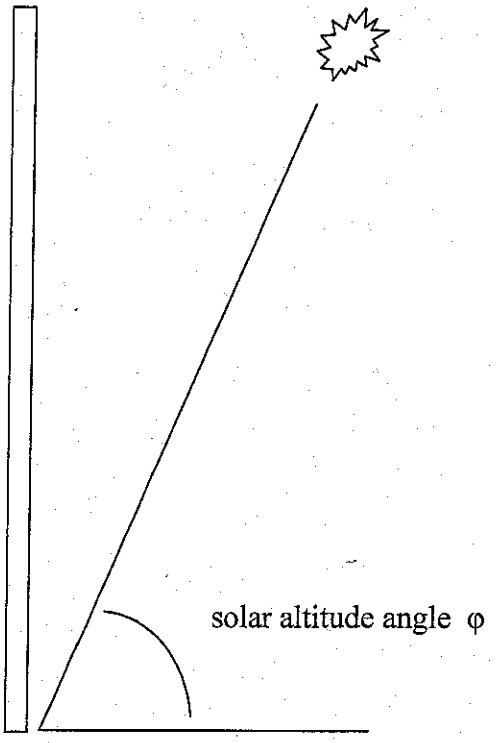

Figure 2: Side View of Window Frame showing Solar Altitude Angle φ.

1.4 Tracking

The unit shall be capable of sensing and tracking the sun (or solar simulation device) in order to maintain the specified level of shading. The unit shall be capable of continuous adjustment such as that required to follow the path of the sun due to the Earth's rotation. For purposes of development and testing, assume the azimuthal position of the sun is normal to the plane of the window frame. The unit shall also be capable of rapid adjustment in order to facilitate

testing. For testing, the solar simulation device will be moved to a fixed position and then turned on using the device controls. In this case, the unit shall acquire its final configuration with one minute of illumination by the solar simulation device. Further adjustment of solar altitude angle, with or without turning the solar simulation device off, will cause the IBWiC to readjust to a new configuration, if required, within one minute. Moving the solar simulation device ~~inside~~ or out of the specified range of operation will result in the IBWiC assuming a configuration for maximum Level of Visibility, as defined below.

1.5 Level of Shading

The Level of Shading is defined to be the multiplicative inverse of the surface area measured in square inches and directly illuminated by the solar simulation device incident on the flat surface on the interior side of the IBWiC window frame. For example, assume that 12 in^2 of the flat horizontal surface interior to the window frame is directly illuminated from the solar simulation device. The Level of Shading is 1/12 = 0.083.

The IBWiC shall maintain a Level of Shading greater than 0.03 during normal operation.

1.6 Level of Visibility

The Level of Visibility is defined to be (A-B)/A where A is the surface area of the window frame, specifically 240 in^2, and B is the apparent area of obscured visibility caused by the IBWiC shading device as viewed from a distance greater than or equal to 6 feet interior to the window.

The IBWiC shall maintain a Level of Visibility greater than 0.5 during normal operation.

2. Window Protection Mode

The IBWiC will have be capable of automatically configuring itself into "Window Protection Mode" in which the IBWiC will provide protection for the window against flying debris and high winds such as might be encountered in a hurricane. Operational parameters regarding shading and visibility do not apply in this mode.

2.1 Level of Protection

The IBWiC shall be subject to repeated impacts of storm related debris as defined in test document BUCCS-SRDT-001. The unit shall remain fully operational after being subject to this test. Some cosmetic degradation as a result, however, is acceptable.

2.2 Engagement/Disengagement of Mode

The IBWiC shall be capable of entering Window Protection Mode by the use of a manually operated switch. This same switch, or additional switching, may be used to return the IBWiC to its normal mode of operation. The IBWiC shall complete its transition into or out of Window Protection Mode within one minute. The system shall not be required to halt and/or reverse an incomplete transition into or out of Window Protection Mode.

3. Control and Power

For purposes of engineering evaluation, each individual IBWiC prototype shall have its own microcontroller. This microcontroller will be used to control subsystems, monitor the sun's position, and perform other tasks as required by the normal operation of the IBWiC. It is strongly recommended, though not required, that this microcontroller be the BASIC Stamp BS2 microcontroller manufactured by Parallax Inc. (http://www.parallax.com/detail.asp?product_id=BS2-IC).

The power source must ultimately be standard 120V, 60 Hz AC power. However, transformers and/or power converters may be used to change this to suitable, lower DC levels as required. No liquid fuel or batteries may be used. An optional master power switch may be used to engage/disengage the entire system.

4. Design Documentation

The design team shall document the project by use of manuscripts, calculations, and computer models/drawings. Specifications for required documentation and due dates are listed in the course calendar and/or will be distributed at appropriate times during the project.

5. Safety Requirements

The bicycle mount must be sufficiently stable and strong so as to hold the bicycle stationary while the rider pedals.

At all times circuitry must be properly grounded, shielded, and connected so as to avoid personal shock or burning out of components.

The system in operation shall not present an undue hazard to persons or property. Appropriate safeguards and/or labeling should be in place (for example, for electrical components, pinch points, rotating parts, etc.).

All fabrication required for the development of the system will be conducted with proper adherence to the general safety guidelines in place for the Engineering Department laboratories and workshops. In addition, specific safety measures will be followed for each tool used in the fabrication process.

Negligence and/or indifference in meeting these requirements, or in reporting violations thereof, are grounds for failure of this course.

Cleanliness in the workplace is expected at all times and in all work areas. Failure to observe departmental workplace rules will lead to penalties in performance evaluation. *The design team shall clean all work areas with each use.*