

Certification of Engineered Flood Openings

In accordance with the Code of Federal Regulations for the National Flood Insurance Program

I hereby certify that the **Crawl Space Door Systems flood vents 816CS, 1220CS, 1232CS, 1616CS, 1624CS, 1632CS, 2032CS, 2424CS, and 2436CS** are **designed** in accordance with the requirements of the Code of Federal Regulations for the National Flood Insurance Program (NFIP) **to provide automatic equalization of hydrostatic flood forces by allowing for the entry and exit of floodwaters**, when properly installed and sized as set forth below. Vent opening measurements were measured and certified by Mr. Christopher Mark Loney, Virginia P.E. NO. 029000. Detailed calculations were prepared as outlined in "Review of certification of Engineered Flood Openings," prepared by Dr. Georg Reichard, Associate Professor of Building Construction, Virginia Tech (available upon request from Crawl Space Door Systems, Inc. billy@crawlspacedoors.com)

Design Characteristics

Section 2.6.2.2 of ASCE/SEI 24-05 provides an equation to determine the required net area of engineered openings (A_o) for a given enclosed area (A_e). This equation is based on the hydraulic formula for the flow rate across sharp edged orifices. I have utilized this equation to calculate 1) the restricted flow rate through the main frame opening in case the louver is blown out during a flood event; 2) the flow rate through the individual openings between louver blades; and 3) the flow rate through projected openings between louver blades following hydraulic short-tube theory. The maximum total enclosed area (A_e) that can be serviced by a single vent has then been determined by utilizing the lowest flow rate of the three assessed scenarios for each vent and is listed in Table 1.

These values are based on the following assumptions:

- In absence of reliable data, the rates of rise and fall have been assumed at a minimum rate of 5 feet/hour;
- The (maximum) difference between the exterior and interior floodwater levels shall not exceed 1 foot during base flood conditions;
- A factor of safety of 5 has been assumed, which is consistent with design practices related to protection of life and property;
- The net area of openings (A_o) as provided by the manufacturer.

| *) | Model | H x W [in] | A_o [in ²] | A_e [ft ²] |
|--------------------------|--------|---------------|-----------------------------|-----------------------------|
| <input type="checkbox"/> | 816CS | 8 x 16 | 105 | 205 |
| <input type="checkbox"/> | 1220CS | 12 x 20 | 235 | 500 |
| <input type="checkbox"/> | 1232CS | 12 x 32 | 305 | 645 |
| <input type="checkbox"/> | 1616CS | 16 x 16 | 180 | 395 |
| <input type="checkbox"/> | 1624CS | 16 x 24 | 310 | 670 |
| <input type="checkbox"/> | 1632CS | 16 x 32 | 405 | 835 |
| <input type="checkbox"/> | 2032CS | 20 x 32 | 630 | 1240 |
| <input type="checkbox"/> | 2424CS | 24 x 24 | 570 | 1230 |
| <input type="checkbox"/> | 2436CS | 24 x 36 | 850 | 1765 |

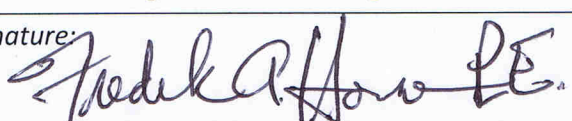
Table 1 Maximum total enclosed area (A_e) that can be serviced by each individual model based on the given net area of engineered openings (A_o)

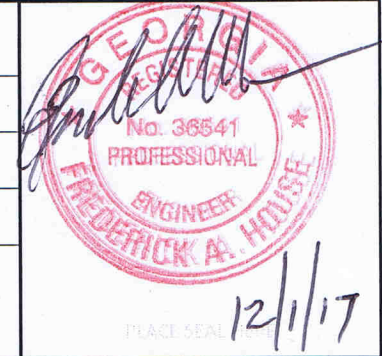
Installation Requirements and Limitations

This certification will be voided if the following installation requirements and limitations are not enforced:

- There shall be a minimum of two openings on different sides of each enclosed area subject to flooding;
- The bottom of all openings shall be no higher than one foot above the higher of the interior or exterior grade that is immediately under each opening;
- No temporary (e.g. during cold weather) or permanent solid cover may be placed into or over the flood vent that would block the automatic entry or exit of floodwaters at any time;
- Where data or analyses indicate more rapid rates of rise and fall, the required number of openings shall be increased to account for those different conditions. The number or size of the openings may be decreased if data or analyses indicate rates of rise and fall are less than 5 feet per hour.

Certifying Design Professional

| | | | |
|-------------------|---|--------------------|----------------------|
| <i>Name</i> | Frederick A House, P.E. | <i>Title</i> | President |
| <i>Company</i> | House Engineering P.C. | | |
| <i>Address</i> | PO Box 466, Kitty Hawk, NC 27949 | | |
| <i>License</i> | Georgia Professional Engineer | <i>License No.</i> | 36541 |
| <i>Signature:</i> |  | | <i>Date:</i> 12/1/17 |



12/1/17

Identification of the Building and Installed Flood Vents (By Others)

The flood vent models marked in Table 1*) are being installed at the following building:

Building Address