



BUREAU OF DIPLOMATIC SECURITY,
PHYSICAL SECURITY DIVISION,
FORCED ENTRY AND BALLISTIC RESISTANT
(FEBR) PRODUCT DEVELOPMENT PROGRAM

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In October 2009, the U.S. Department of State (DOS), Bureau of Diplomatic Security (DS), Physical Security Division announced the results of a research program which identified a glazing configuration utilizing DuPont's SentryGlas® (SG) interlayer to produce a laminated glass system that provides forced entry and ballistic resistance (FEBR) protection when subjected to the Department's testing protocol (SD-STD-01.01, Rev. G (Amended), Forced Entry and Ballistic Resistance of Structural Systems). This document updates that original announcement and provides insights gained since 2009 related to SG-laminated FEBR glazing systems.

Background: The goal of this effort was to identify an alternative glazing system that performs comparably to the Glass Clad Polycarbonate (GCP) glazing systems that are typically found in DS-certified FEBR products. The rationale for this was to develop a glazing system that would not de-laminate and would not require SpallShield on the interior surface for glass spall prevention. Physical delamination of GCP products is a phenomenon that has been well-documented. SpallShield is a relatively expensive, laminated product, which utilizes a Polyvinyl Butyral (PVB) interlayer to adhere polyester film to a glass substrate. Once damaged or scratched, SpallShield cannot be repaired or replaced in the field. Mindful that the most likely application of this system would be in DOS buildings, the program focused on identifying a system that featured two individual glazing panels to facilitate assembly of insulated glazing units that are a corner stone of energy efficient building design.

Updated glazing system: DS' forced entry testing protocol employs a six-man attack team and readily-available hand tools. As such it is not an empirical test. Based on the results of forced entry testing of SG laminates since 2009 **the recommended SG interlayer thickness in the inner laminated glass layer is being increased by .09" to .18"**. The full layup is listed below.

Exterior/Threat Face

.5" tempered glass –

.18" SG-

.5" tempered glass –

.25" air gap –

.25" heat strengthened –

.18 SG-

.25" heat strengthened –

8 mil shatter resistant window film (daylight or edge-to edge application)

Interior/Protected Face

These dimensions represent the minimum (“baseline”) configuration required to achieve the Department’s FEBR performance standards when installed in a typical FEBR “punched” window frame that provides approximately one inch of glazing bite. Project-specific glazing layups may exceed any of the glass thicknesses, SG laminate thicknesses, or other parameters listed here if required (e.g. making the air gap or frame bite larger). Additionally, low-emittance (low-E) coatings, glass tinting, or applied films will not affect the glazing system’s FEBR performance. FE tests performed on SG-laminated specimens revealed that larger samples performed as well or better than smaller ones. The practical implication of these tests is that an upper boundary for this glazing system’s size in DS-certified assemblies is approximately 6 feet by 12 feet. A manufacturer successfully FEBR tested and certified an SG based system measuring approximately 4 feet by 22 feet in 2014.

Adhesion of SG: There have been instances where SG-based laminated glass systems have failed the forced entry test. In most of these cases a major contributing factor was the failure of the glass manufacturer to correctly laminate the SG interlayer within the overall glazing unit. Incorrect lamination results in little or no adhesion between the SG and successive layers of glass. This results in a marked reduction in the glazing systems performance. Good process control is essential to laminating SG glazings. Valuable quality control measures include an impact test, sometimes referred to as a “pummel” test or a Compressive Shear Test (CST). The pummel test is a qualitative test that involves striking a sample piece of laminated glass with a hammer and examining the bond between the SG interlayer and the glass. The CST is a quantitative test that relies heavily on accurate material properties to determine the bond strength of the laminates.

Shatter Resistant Window Film: DS is aware of reports that as the size of individual glass panels increases, it may not be possible to utilize glass suction devices on the filmed glass. Due to practical considerations, larger SG laminates may require that the window film be added via a “day light” application after the glass has been installed.

SpallShield: DuPont no longer manufactures the SpallShield product as a one-piece product. The SpallShield product’s current configuration is separate sheets of PVB and polyester film. DS is aware of reporting that this is more difficult to laminate than the older, one-piece product. This development may positively affect the economies of selecting SG laminates which employ 8-mil shatter-resistant window film for glass spall prevention.

The Bureau of Diplomatic Security remains enthusiastic about the use of SentryGlas laminated glazing systems as a viable alternative to GCP systems. Adopting SG laminates will result in reduced life cycle costs because this product will not delaminate and because scratched shatter-resistant window film can be replaced onsite. Questions regarding this product should be directed to Russ Norris at NorrisRJ@state.gov or Keith Nelson at NelsonKM1@state.gov.