

How to Calculate the **SAFE** Minimum Thickness of a Crystal?



Fragility increases proportionally to the ratio of the diameter to thickness. If thickness stays the same, as the diameter increases so does the fragility factor.

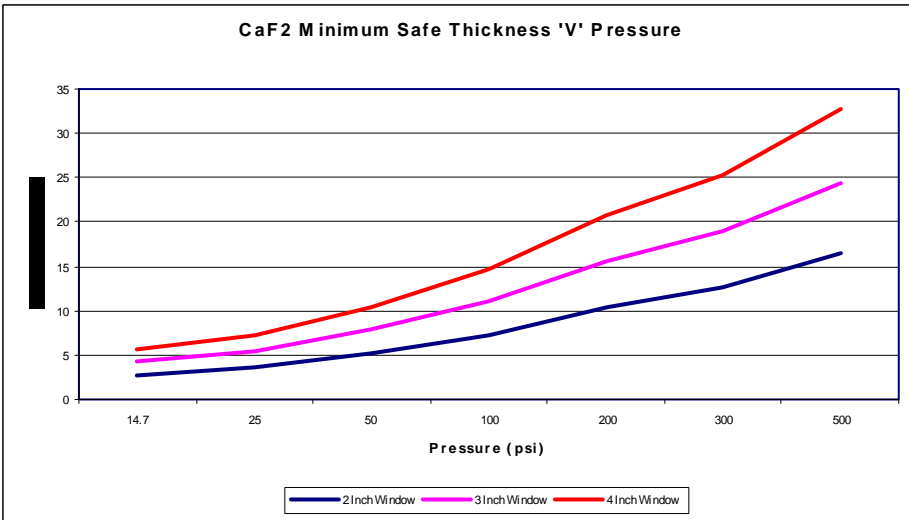
Minimum thickness of a window required to with-stand a pressure difference may be calculated by the following:

$$Th = \sqrt{\frac{1.1(P)(DIA)^2}{MR}}$$

- Th** = thickness, inches
- DIA** = unsupported diameter, inches
- P** = pressure difference, psi
- MR** = modulus of rupture, psi

Pressure at 1 atm = 14.7 psi = 101.324 kPa
 Modulus of rupture (MR, psi) of commonly used IR Crystals:

- BaF2** 3,900
- CaF2** 5,300
- ZnSe** 8,000
- Ge** 10,500
- Sapphire** 65,000



| CaF2 window Minimum Thickness Requirement | | | |
|---|------------------------------|-----------------------------------|------|
| Pressure Differential (psi) | IR Window Diameter (inch) | Minimum Required Window Thickness | |
| | | (inch) | (mm) |
| 14.7 | 2.0 | 0.110 | 2.8 |
| 25.0 | 2.0 | 0.144 | 3.7 |
| 50.0 | 2.0 | 0.204 | 5.2 |
| 100.0 | 2.0 | 0.288 | 7.3 |
| 200.0 | 2.0 | 0.407 | 10.3 |
| 300.0 | 2.0 | 0.499 | 12.7 |
| 500.0 | 2.0 | 0.644 | 16.4 |
| 14.7 | 3.0 | 0.166 | 4.2 |
| 25.0 | 3.0 | 0.216 | 5.5 |
| 50.0 | 3.0 | 0.306 | 7.8 |
| 100.0 | 3.0 | 0.432 | 11.0 |
| 200.0 | 3.0 | 0.611 | 15.5 |
| 300.0 | 3.0 | 0.749 | 19.0 |
| 500.0 | 3.0 | 0.966 | 24.5 |
| 14.7 | 4.0 | 0.221 | 5.6 |
| 25.0 | 4.0 | 0.288 | 7.3 |
| 50.0 | 4.0 | 0.407 | 10.3 |
| 100.0 | 4.0 | 0.576 | 14.6 |
| 200.0 | 4.0 | 0.815 | 20.7 |
| 300.0 | 4.0 | 0.998 | 25.4 |
| 500.0 | 4.0 | 1.289 | 32.7 |

NOTE:
 The minimum thickness of a CaF2 crystal to resist 1 atmosphere (14.7 psi) to be:
2 inch window = 2.8 mm
3 inch window = 4.2 mm
4 inch window = 5.6 mm

25 psi is the safety point where arc protected switch-gear pressure relief devices are designed to work. The minimum thickness of a CaF2 crystal at this point needs to be:
2 inch window = 3.7 mm
3 inch window = 5.5 mm
4 inch window = 7.3 mm

Can an IR window have an Arc Flash rating ?

The answer is NO: No IR window or individual component can ever be Arc Rated or can protect you from Arc Flash:

Arc flash has the potential to produce a shock blast of up to 700 miles per hour with a core temperature of 15,000 C, and there are no materials that can resist that type of temperature and force. Panel assemblies are designed to contain and survive differing levels of arc flash energy.

There are IEEE & UL standards designed to test electrical switchgear cabinets for resistance to Arc Flash. When assemblies are successfully tested with IR viewing ports fitted, the certification is awarded to the **assembly** only, this does not mean that the IR window or any other components fitted to the switchgear cabinets are Arc rated for installation to any other assembly.

The only industry standard tests that are available to confirm the structural tests on IR windows are Load, impact and flammability, the modulus of rupture allows an engineer to design a window to resist pressure, and only by using these standards can we be sure that the window we use is fit for purpose.

IF A WINDOW CAN RESIST AN ARC BLAST THE IT SHOULD BE ABLE TO AT LEAST PASS AN IMPACT TEST!!

