

Specification Proposal

Infrared Viewing Window Design



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Why Do We Need Standards for Infrared Viewing Windows?

Infrared Viewing Windows are an Electrical Maintenance Safety Device (EMSD). They allow infrared (IR), Ultraviolet (UV) and visual inspections to be completed safely on energized electrical switchgear, electrical motor systems and distribution equipment with no interruption to process, and as such allow for more inspections to be completed and reduce the risk of equipment failure through routine surveillance of critical assets utilizing condition monitoring equipment. They also remove the primary triggers of arc flash as the panels never need to be opened to allow inspections to be completed.

Infrared windows have been used for many years in the inspections of electrical equipment. The main confusion in the use of IR windows revolves around the certification and testing of the IR Windows and what standards are applicable to the testing of these units. During our initial design phase IRISS decided that IR windows should be tested and certified to the same standards as those required for visual viewing panes which have been used in switchgear since their inception. The testing and certification requirements of visual viewing Panes (windows) have grown and evolved from the initial use of steel wire reinforced glass through the early plastic variations all the way to the common polymeric solutions now installed in all switchgear.

Standards Organizations such as UL, CSA, IEC & IEEE have test requirements for viewing panes that are very thorough and excellent for using as a benchmark for the framework of the test requirements for IR Viewing windows. We must however realize that there are very few IR transmissive materials available to IR Viewing window manufacturers and, as such, full consideration needs to be given to this fact when attempting to set the minimum requirements to fulfill the minimum safety requirements when working with energized equipment.

It was the fragile nature of infrared transmissive materials and the need for a tough, rugged “Industrial Grade” infrared viewing window that drove the innovative patented design of the IRISS reinforced optics. We spent over 5 years testing and developing the IR lens systems that are currently used in our current VP and CAP series IR Window Systems, a system that is the only IR window capable of meeting the harsh industrial environments that our switchgear and electrical distribution equipment are subjected to on a daily basis.

The standards detailed in this document call for mechanical repeatable testing such as impact, load, flammability as well as environmental stability to determine the mechanical strength and suitability of the IR viewing window for use in the switchgear. The IRISS patented infrared lens solutions were specifically designed with this in mind to overcome the mechanical weakness and traditional failure points of impact and hygroscopic transmission failure of infrared transmissive materials used in the traditional legacy type infrared window products.

Product Certification Procedures

The process of certifying that a certain product has passed performance tests and quality assurance tests, and meets qualification criteria stipulated in contracts, regulations, or specifications.

Certifications and Standards are a good thing, although they can be difficult to understand without some basic knowledge of what are applicable to the components that you wish to use and where they are applied to meet the minimum operational and safety requirements of your business unit. The point to note here with regard to EMSD's such as IR windows is to be certain that the IR windows you intend to install meet or exceed these standards.

Important to note:

There are some IR windows in the market place that appear to meet all of these standards, but under close scrutiny they do not. By ensuring the components you wish to use comply with the applicable standards end users can be assured they have the best absolute solution to minimize the risk to their employee's. Safety is the highest objective and helps assure that end users who are directly involved in Infrared Inspection of energized electrical gear have the safest environment to apply their skills and service and do so with the highest confidence they will be able to complete their service and go home at the end of the day to their families and loved ones.

IR Windows Product Approvals

This section of this document will now detail the recommended minimum tests that IR Windows must undergo by test approval type.



UL50V

UL currently certify IR Viewing Panes under the UL50V standard--this standard is for switchgear up to 600 Volts with exemptions up to 1500 Volts. The UL 50V classification for Infrared Viewports is the only standard that relates specifically to infrared windows. It serves more as a classification than an actual standard for performance-of-build characteristics.

Specifically, it states:

Infrared Viewports are a fixed aperture, consisting of one or more openings or a solid infrared transmitting media, surrounded by a mounting bezel or frame that provide a means for the passage of infrared radiation. It doesn't cover the operational considerations or the infrared performance of the lens system.



CSA C22.2 No.14-10

CSA: Canadian Standards Association. The CSA is a membership organization serving industry, educational institutions, and government in the field of standardization, including the standardization of building components, materials, and testing.

IRISS is the only industrial-grade IR window manufacturer to receive formal CSA certification to the C22.2 No. 14-10 Industrial Control Equipment – 11th Edition Canadian standard. Unlike any other IR window manufacturer, all the components of the IRISS VP and CAP Series IR windows now comply with applicable Canadian Standards Class **3211 37*** and U.S. standards **3211 97**** for Industrial Control Equipment Sub-Assemblies.

“This achievement now permits IRISS to surpass the competition within Canada since the CSA standard approved is the highest standard in the industry,” IRISS’ IR windows have been issued a CSA C & US certificate. The C and US indicators adjacent to the CSA Mark signify that the IRISS IR windows have been tested to the applicable CSA, American National Standards Institute (ANSI) and Underwriters Laboratories (UL) Standards for use in Canada and U.S. respectively.

* Canadian Standards for Class 3211 37

CAN/CSA-C22.2 No 0	General Requirements – Canadian Electrical Code, Part II
CAN/CSA-C22.2 No. 0.4	Bonding of Electrical Equipment
CSA-C22.2 No. 14-10	Industrial Control Equipment
CAN/CSA-C22.2 No. 94	Special Purpose Enclosures
CAN/CSA-C22.2 No. 94.1	Enclosures for Electrical Equipment, Non-Environmental Considerations
CAN/CSA-C22.2 No. 94.2	Enclosures for Electrical Equipment, Environmental Considerations

**U.S. Standards for Class 3211 97

ANSI/UL 508	Industrial Control Equipment
ANSI/UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
ANSI/UL 50E	Enclosures for Electrical Equipment, Environmental Considerations



CE Marking for Industrial Equipment and Products:

Responsibility for CE marking lies with whoever puts the product on the market in the EU, i.e. an EU-based manufacturer, the importer or distributor of a product made outside the EU, or an EU-based office of a non-EU manufacturer.

The manufacturer of a product affixes the CE marking to it but has to take certain obligatory steps before the product can bear CE marking. The manufacturer must carry out a conformity assessment, set up a technical file and sign a Declaration stipulated by the leading legislation for the product. The documentation has to be made available to authorities on request.

Importers of products have to verify that the manufacturer outside the EU has undertaken the necessary steps and that the documentation is available upon request. Importers should also make sure that contact with the manufacturer can always be established.

Distributors must be able to demonstrate to national authorities that they have acted with due care and they must have affirmation from the manufacturer or importer that the necessary measures have been taken.

If importers or distributors market the products under their own name, they take over the manufacturer's responsibilities. In this case they must have sufficient information on the design and production of the product, as they will be assuming the legal responsibility when they affix the CE marking.

There are certain rules underlying the procedure to affix the marking:

- Products subject to certain EU directives or EU regulations providing for CE marking have to be affixed with the CE marking before they can be placed on the market.
- Manufacturers have to check, on their sole responsibility, which EU legislation they need to apply for their products.
- The product may be placed on the market only if it complies with the provisions of all applicable directives and regulations and if the conformity assessment procedure has been carried out accordingly.
- The manufacturer draws up an EU declaration of conformity or a declaration of performance (for Construction Products) and affixes the CE marking on the product.
- If stipulated in the directive(s) or regulation(s), an authorized third party (Notified Body) must be involved in the conformity assessment procedure or in setting up a production quality system.
- If the CE marking is affixed on a product, it can bear additional markings only if they are of different significance, do not overlap with the CE marking and are not confusing and do not impair the legibility and visibility of the CE marking.

Since achieving compliance can be very complex, CE-marking conformity assessment, provided by a notified body, is of great importance throughout the entire CE-marking process, from design verification, and set up of the technical file to the EU declaration of conformity.

IR Window Mechanical Testing



UL746C: Impact and Flammability Testing

Sets the impact and flammability standards for polymeric materials used in electrical equipment up to 1500 volts. Any plastic or polymer forming part of an infrared window must pass flammability tests at room temperature, and must remain intact during an impact test performed at 0°C (32°F).

Note:

Of the crystal optics capable of transmitting in the long wave portion of the infrared spectrum (8μm to 14μm), there are no fluoride-based crystals capable of passing the impact tests required in 746C. However, because they are classified as “glass” under the standard, they are not required to test for impact as long as they are thicker than 1.4 mm.



IEEE C37.20.2 Section a 3.6: Impact and Load Testing

Viewing panes mounted in medium and high voltage equipment (600 volts to 38kv metal clad and 72kv station type gear) are required to withstand impact and load per IEEE C37.20.2 Section a.3.6. Unlike UL this standard does not stipulate the types of material or give exemptions to crystals.

Instead it clearly specifies that any transparent material covering an observation opening and forming a part of the enclosure should be reliably secured in such a manner that it cannot be readily displaced in service and should meet the following requirements:

Viewing panes should not shatter, crack, or become dislodged when both sides of the viewing panes in turn are subjected to:

- A force of 445 N (100 lb.) should be exerted perpendicular to the surface in which the viewing pane is mounted. This force should be distributed evenly over an area of 0.010 m² (16 in²) (as nearly square as possible and as near the geometric center of the viewing pane as possible). If the viewing pane has an area less than 0.010 m² (16 in²), the force should be evenly distributed over the entire viewing area. The 445 N (100 lb.) should be sustained for a period of 1 min.
- The viewing pane should be subjected to an impact of 3.4 J (2.5 ft-lb) using a steel ball weighing approximately 0.54 kg (1.18 lb.) and measuring approximately 50 mm (2 in) in diameter.



UL1558: Impact and Load Testing

UL 1558 is the impact and load standard for visual viewing and IR window testing. This test is identical to the IEEE C37.20.2 Section a.3.6 test except they doubled the load and impact test requirements on the lens and did not give any exemptions to the type of material being used.

On the face of it this testing sounds perfect, but unfortunately, unlike the IEEE C37 test it has two different test criteria, one for covers fitted to the IR Window and one for covers opened or removed from the IR Window. When provided with a cover, results are considered to be acceptable if the assembly prevents insertion of a 13 mm (0.50 in.) diameter rod at the conclusion of the test. And when no cover is provided for the viewing pane, the results are considered acceptable if the view pane does not shatter, crack or become dislodged.

Important to note:

Testing the IR viewing window with the metal cover in place is a complete mockery of the test as the crystal IR window lens will shatter during the test but the window will pass the test due to the fact that you cannot pass a steel rod through the metal cover!!

"If this standard is to be referenced then the end user must insist that the test is conducted with the cover open and that it meets the minimum test requirement by not shattering, cracking or dislodging during or after the test"



IEC 60068-2-6:2007 and IEC 60068-2-3 Vibration Testing

This test provides a standard procedure to determine the ability of components, equipment and other articles to withstand specified severities of sinusoidal vibration if an item is to be tested in an unpackaged form, that is, without its packaging.

The purpose of this test is to determine any mechanical weakness and/or degradation in the specified performance of specimens and to use this information, in conjunction with the relevant specification, to decide upon the acceptability of the specimens. In some cases, the test method may also be used to demonstrate the mechanical robustness of specimens and/or to study their dynamic behavior.

IEC 60068-2-78:2012 Humidity Testing

This test provides a method for determining the ability of components or equipment to withstand transportation, storage and use under conditions of high humidity. The object of this standard is to investigate the effect of high humidity at constant temperature without condensation on a specimen over a prescribed period. It is applicable to small equipment or components as well as large equipment, and can be applied to both heat-dissipating and non-heat-dissipating specimens.

IR Window Environmental Approvals



UL50E

Environmental standards which apply to electrical enclosures intended to be installed and used in non-hazardous locations as follows: enclosures for indoor locations only, Types 1, 2, 5, 12, 12K, and 13; and enclosures for indoor or outdoor locations, Types 3 and 3R.



IP65

Ingress Protection/Environmental Rating 65: International standard (defined in IEC 60529) that classifies products as “dust tight,” with complete protection against contact (with parts contained within the enclosure). It also covers resistance to directed water jets. Water projected by a nozzle (6.3 mm) against enclosure from any direction shall have no harmful effects.

Test duration:

at least 3 minutes, Water volume: 100 liters per minute. Test pressure: 100 kPa at distance of 3 m

IP67

Ingress Protection/Environmental Rating 65: International standard (defined in IEC 60529) that classifies products be able to protect from immersion at a depth of 1 meter with complete protection against contact (with parts contained within the enclosure).

Test duration:

30 minutes Immersion at depth of at least 1 meter measured at bottom of device, and at least 15 cm measured at top of device

Note:

Unlike NEMA testing, IP testing must be performed and certified by third-party testing labs, such as SIRA.



NEMA 4/4X

NEMA 4/4X and IP65: are equivalent ratings. It certifies enclosures for indoor or outdoor use; for protection against access to hazardous parts; for ingress of solid foreign objects (windblown dust); for resistance to water ingress resulting from rain, sleet, snow, splashing water, and hose directed water; and from damage due to ice formation. 4X also must resist corrosion.

Arc Containment Testing Procedures

An arc rating can only be given to a completed assembly and not to a single component within that assembly. Electrical cabinet designs and dimensions are infinite and we therefore **CAN NOT or MUST NOT** use the data from one cabinet design to another design unless they are identical in every way.

This is the reason why components can never carry a generic arc rating and must be subjected to industry standard tests to confirm that they conform to the minimum required level of mechanical strength and environmental properties for the electrical cabinets and assemblies which they are going to be fit into.

IRISS CAP and VP series windows have successfully passed the following Arc Containment testing:



IEC 62271-1: 2007 + A1:2011 IEC 62271-200: 2012

This test was completed by IRISS to specifically test the CAP and VP IR Window units under a metalclad arc containment situation.

IEC 62271-200 specifies requirements for prefabricated metal enclosed switchgear and control gear for alternating current of rated voltages above 1 kV and up to and including 52 kV for indoor and outdoor installation, and for service frequencies up to and including 60 Hz. Enclosures may include fixed and removable components and may be filled with fluid (liquid or gas) to provide insulation. CAP and VP IR Windows were successfully tested in an Arc containment test under the following conditions: **31.5kV, 80kA at 50 Hz for a total test duration of 1.1 seconds**



IEEE C37.20.7 Type 2B: 63kA, 15kV for 30 cycles at 60Hz

This test has been completed multiple times by multiple OEM clients. The tests were completed to certify the OEM assemblies. The IRISS CAP and VP IR Window units that were fitted into these assemblies have never failed under these test conditions.

ANSI/IEEE C37.20.7 defines switchgear arc resistance in two basic categories:

ANSI type 1

Arc resistance from the front of gear only

ANSI type 2

Arc resistance provided from the front, sides and rear

A suffix may be added to either of these two types to further define the type of protection provided:

- A: Basic design
- B: Arc resistance is maintained even while opening designated low voltage compartments
- C: Arc resistance is maintained even when opening designated adjacent compartments
- D: Special designation that supplements the Type 1 designation, but identifies additional arc resistance in certain structures

Note:

Even though we have never failed an arc containment test we will never claim to be “Arc Resistant” as this is misleading.... We will only claim to be Arc tested....

ISO and Quality Approvals



The IRISS Group of companies take quality assurance and environmental responsibility very serious. To demonstrate this, we have been an ISO 9000 registered company since the day we opened our doors and in 2016 we also achieved TUV ISO 14001 status as well.

TUV ISO 9001

The IRISS QMS is certified according to ISO 9001 and specifies who is responsible for which quality-related activities and which procedures are to be complied with. The standard requires a control circuit that provides constant further development in terms of a continuous improvement process (CIP). This ensures that quality orientation at IRISS is not a one-off exercise but is lived by each of our employees every day.

TUV ISO 14001

Environmental protection and safety is of critical concern today. Awareness and compliance with environmental standards has become a criterion for long term success. ISO 14001 is globally accepted as the environment management system standard, providing a systematic approach to controlling environmental hazards, and reducing the risk of accidents while improving business practices and processes. Valid and recognized around the world, the ISO 14001 offers a framework for voluntary development of conservation measures – such as saving energy to climate protection and waste removal. Our experts uncover areas of weakness in your environmental management and lay the foundations for a process of continual, verifiable improvements, thereby reducing environmental hazards and improving your eco-balance in the long-term.

Infrared Transmissive Lens Material Considerations

As stated the vast majority of IR Viewing Panes are using either Calcium Fluoride (CaF₂) or Barium Fluoride (BaF₂) crystals that are normally 2 – 4mm thick depending on construction and are normally provided in either 2, 3 or 4 inch diameters.

These materials are not suitable for use in IR Viewing Panes in industrial applications for the following reasons:

- CaF₂ and BaF₂ are Hygroscopic
- BaF₂ is a restricted material which carries a harmful classification
- CaF₂ and BaF₂ can NOT tolerate any form of impact
- CaF₂ and BaF₂ have a high co-efficient of thermal expansion and will suffer long term substrate failure if submitted to transient temperatures.
- CaF₂ and BaF₂ are extremely Fragile
- CaF₂ and BaF₂ are Sensitive to Energy Impact (Vibration & Noise)
- CaF₂ and BaF₂ are Sensitive to Thermal Shock
- CaF₂ and BaF₂ Both have a low “Modulus of Rupture” too fragile to maintain pressure ratings.
- **CaF₂ & BaF₂ WILL FAIL EVENTUALLY (Test data confirms their weaknesses)**

The most suitable crystal for use in IR Viewing Panes is Germanium with an Anti-Reflective coating on the inside and hard carbon on the outer side. Ge performs as well as Zinc Selenide in this circumstance and is a lot less expensive. Ultimately, the best combination is ZnSe with an Anti-Reflective coating one side and hard carbon on the other. This is however rarely used due to pricing versus performance overall. The most suitable materials for industrial applications are Infrared Transmissive Polymers. They have transmission rates of approximately 70% at 9 microns which out performs the traditional calcium fluoride Viewing Panes and is flexible. Therefore, it is not as susceptible to thermal shock and fracture due to impact. This VP and CAP series IR window systems have passed all IEC, CSA UL and IEEE Impact tests with covers removed and survived with no issues. It is rated to a working temperature of 325 °C.

With regards to the material durability our testing shows that IRISS’ Infrared Transmissive Polymers:

- Offer the least absorption loss in the 8 to 14 µm region of any of the IR polymer materials.
- Are of a Fixed and Stable Transmission Rate (FAST)
- Offer excellent transmission rates through both the LW & SW IR wavelengths, easily out performing CaF₂ at 9 microns: CaF₂ = Average 52%, CAP and VP Lens Assembly = Average 58%
- Are impact tested to IEEE, UL, CSA and IEC standards for viewing panes.
- Carry a flammability rating of 5V
- Are waterproof
- Are resistant to Light Acids & Alkalis
- Are ultraviolet stabilized,
- Carry an Unconditional Lifetime Warranty
- Are LOW COST, easily affordable, and therefore increase the likelihood of implementation.