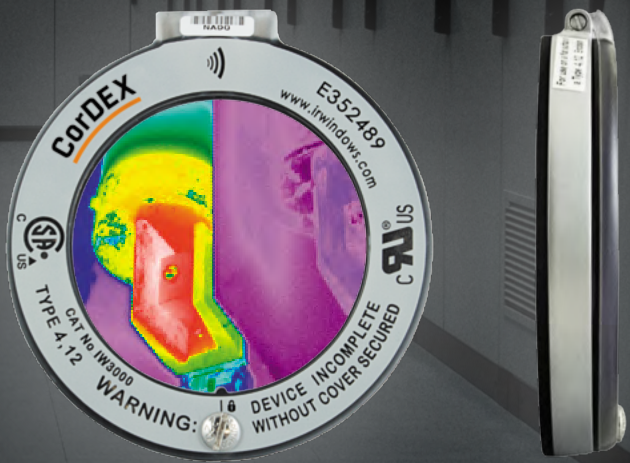
CorDEX

IR WINDOWS 101

THE **ANSWERS** TO THE **QUESTIONS** YOU DIDN'T **DARE ASK!**



Author
Tony Holliday, CorDEX Instruments Ltd.

ABSTRACT

An infrared (IR) Window, sometimes referred to as a viewport, a sightglass or a thermal window has traditionally been an inert device installed into electrical equipment to enable infrared thermal imagers to view the inside of cabinets safely, without exposing operators to live electrical equipment and dangers such as electric arc-flash.

A decade ago IR Windows were very much in their infancy, I remember attending trade-shows and having to explain what an IR Window was and why customers needed it. Back then, there was still the false belief held by many that thermal imagers could "see" through panel covers.

Today, things are very different, virtually all thermographers know about the existence of IR Windows even if they do not fully understand the value they bring. This value is not only in terms of safety it is also greater efficiency. As switchgear safety systems improve, efficiency is increasingly a key driving factor.

IR Windows can be round, square, even little more than a hole, while others are high quality crystal optics. Regardless of the design, they all perform a single simple function;

IR Windows allow infrared inspections of live electrical equipment, without removing covers or doors.

This is an important benefit to thermographers who are not always electrically trained personnel. With the widespread adoption of

NFPA70E, the risk associated with exposure to live electrical equipment and specifically I mean electric arc-flash but also electrocution (which is often overlooked but will kill just as easily), means that live work is not possible. So, there are two solutions for a company needing to undertake infrared surveys of their electrical equipment; 1. Perform a complete arc-flash hazard analysis, provide appropriate PPE and have a multi-person team remove panel covers for an infrared scan, or, 2. Install IR Windows.

In many cases, it is the arc-flash hazard analysis that is the driving force behind an IR Window installation as the analysis itself highlights and very graphically demonstrates the dangers associated with live work on a particular circuit and yes, infrared scanning is considered live work!

What is often overlooked is that so called "low voltage" switchgear, typically 415V in the UK and 480V in the US, can actually have a greater level of arc-flash energy than the medium or high voltage systems feeding it!

The purpose of this paper is to provide an unbiased view of IR Windows based on over 10 years' experience solely in that field. Do I have a personal preference on a particular design methodology? Absolutely, it is obvious by reading this paper, however, I have also attempted to be fair and impartial with my analysis on all options and will leave the reader to make up their own mind based on the information provided.

Should you wish, after reading this paper, to reach out to me directly, I am always willing to answer any legitimate question, my direct email address is tony.holliday@cord-ex.com. However, please note, I will not down sell on other products or provide direct product-product comparisons.

Okay, all that aside, let's talk IR Windows!

LET'S START WITH OPTICS.

Okay, so, the first thing we need to understand is how IR Cameras work and a little about their limitations. This will lead us to what an IR Window is and, probably the most important choice factor when looking into IR Windows, the "optic" material. In layman's terms, the stuff the camera sees through.

For the uninitiated amongst us, an IR Camera can "see" heat. There is a famous movie which involves an alien hunting and killing soldiers which is my first real recollection of seeing IR in use, but it demonstrates the technology very well. Its almost 30 years since that movie was made and the advances in infrared camera technology have been dramatic, but the bare functionality remains the same, IR cameras see heat.

In practice this means that IR Cameras use a different part of the electromagnetic (EM) spectrum to human eyes. IR cameras operate in the "infrared" part of the EM Spectrum. Around 1987 IR cameras made use of a specific part of this band, known as the "midwave" or 3-5µm band. These cameras were typically cooled units which are not so prevalent although they are still in existence.

With the advances in microbolometer technology (don't worry about the term, think of it as a sensor similar to the one in your digital camera) IR cameras are almost exclusively "uncooled" systems. This "new" type of sensor has many advantages, not least of which is the runtime extension which removes the need for a cooler. These new cameras however typically operate in a different part of the EM spectrum, known as the "longwave" or 8-14µm.

Getting back to IR Windows, we need to find a material that is transparent to infrared in the band within which your camera operates. It would be ideal if we could locate a material that is "future proof" so operates across the entire IR spectrum. These materials do exist, but there are two very good reasons why they aren't used. We will get to that later.

If we look to the market today there are three optic options typically available;

1. Mesh/polymer combination
2. Hole (port)
3. Crystal

I will discuss each in turn and then provide a comparison.

Mesh/polymer combination optics

No one can deny that a combination of a mesh and polymer results in a product that can withstand tremendous level of impact. In reality, it's the mesh providing the strength as the polymer is extremely thin, but still these optics perform very well when impacted with a hammer. I have even seen a movie of an SUV driving across a mesh/polymer optic IR window! From an objective standpoint, I do wonder what kind of person would subject the host being "live" Switchgear to a hammer blow or even worse a Road Traffic Accident, but, there is no doubt this kind of optic is very durable … against impact at least. Conversely, this kind of thin film polymer optic does not react well to flame (part of UL polymer testing) and so can quite easily melt away, leaving just the mesh and some open holes.

The image via this kind of optic can also be very good once the mesh has been "focused out" by the camera. If the target is close to the panel inside face however, this can be a problem as the camera cannot fully focus past the mesh which can cause a rippling type effect on the image in certain circumstances. With most Medium or High Voltage equipment, the depth of the enclosure and location of the target is such that this does not present a major problem. The issue is more noticeable in shallow panels or LV typical motor control centre (MCCs).

The real downside of the polymer/mesh optic comes down to actual measurement. As stated above in the right circumstances, the image these IR Windows provide can be very good, but as the saying goes "image isn't everything". It's a little known, or for those who do know, little acknowledged fact that is it not possible to measure accurately and repeatabley through mesh. This doesn't matter if there is a combination of mesh/air or mesh/polymer, it's the mesh that causes a problem for the thermal imager even though you may not be able to see it on the image.

The reason for this is based on a number of factors as it would in practice be easier on the imager in some ways if the polymer were not there at all, but this has safety implications so cannot be done. The issue revolves around the "transmission" of the polymer (how much IR can pass through it) and the comparative transmission of the mesh, which is zero.

Allow me to explain. For those of us who have completed an infrared training class, the explanation is that R+A+T=1, however for those that have not, the principle is pretty straightforward to understand. For any body above absolute zero, the total emitted energy comprises of a combination of one or all;

Reflection, the amount of energy the body reflects from its surroundings. A shiny surface reflects a lot more than a dull surface.

Absorption, the opposite of reflection, the amount a body absorbs from its surroundings which contributes to its own temperature and are then re-emitted.

Transmission, the amount of energy passing through the body.

The combination of these three items constitute the total radiance from an object, but the only one of the three which represents the targets own temperature is "A", being absorption. Both R and T are representative of energy from other bodies, either reflected by and/or transmitted through the target, so we need to discount them in the measurement equations stored in the camera.

You will be doing this everytime you use your camera to take a reading, but perhaps not realise it. After all, you set the Emissivity, right? The Emissivity is the Absorption value and so a target with an Emissivity of 1 – known as a blackbody – can have no Reflection and No transmission, so in other words all of the energy being emitted from the body itself is its own. In this case no corrections are needed. We use blackbodies when calibrating thermal imagers but in real life situations, they don't really exist so you have to put a value into the camera which represents the target Emissivity.

Let's look at an example. A switchgear internal target may be shiny copper, its emissivity value is very low – its shiny! – meaning its Reflected value is high since we know that copper is opaque and its transmission therefore is zero.

Copper

T=0

E= 0.03

R= 0.97 (R+A+T=1, R=1-0-0.03)

In this instance, the infrared camera has a very shiny surface to try to quantify and subtract so that we can get to the measured portion represented by "E" (A). This is not possible and as good thermographers we understand that, so, we increase the target Emissivity by using some high emissivity tape (some people use stickers but I am not a fan of that as who knows how the adhesive reacts to copper).

To continue the example, the E value has now been increased to 0.9 by using a dull material fixed to the copper target, suitably rated electricians tape for example.

So, now we have a target with a much higher emissivity and much lower reflectivity and so the camera has a much better chance of obtaining an accurate reading since the majority of the energy now being measured is coming from the target itself rather than being reflected from its surroundings.

Back to the polymer/mesh optic analysis, the same R+A+T=1 applies for the IR Window optic, but this time we know that the optic transmits IR as the camera can see through it, so the T variable now has a value also, but what do we put in there? It cannot be one single value as the transmission of the polymer is different to the mesh (which is opaque), so again, what do we put in the measurement equation? Hold this thought, it gets harder I'm afraid, unfortunately the polymer and the mesh Reflect from their surroundings and also Emit some of their own energy to the total amount being measured by the camera. Some cameras have an "optic transmission" correction within them, you will notice that without fail, this parameter is accompanied by the "optic temperature", what this parameter is doing is attempting to compensate for the error caused by the IR Window transmission (T) and the IR Window absorption (A) by having the user input an estimation of the optic temperature.

The problem is, that the only way this correction can function anywhere near accurately is if value of T and the value of A are uniform across the IR Window optic. This phenomenon is known as a homogenous optic (all one material). For a non-homogenous optic (differing materials), the correction cannot work as the camera does not know which optic material it is looking at in any specific point in time.

A theoretical example if a potential polymer/mesh optic mix may look is shown below.

	Polymer	Mesh
R	0.1	0.2
A	0.5	0.8
A	0.4	0

It is clear that the mesh Emits much more of its own energy to the camera than the polymer (0.8 compare to 0.5) but it transmits nothing from the target which we are wanting to measure. The reflected component is also different between the two materials meaning that the infrared camera correction algorithm cannot make an accurate modulation of the energy to get an accurate measurement as there are too many unknown variables.

At a snapshot in time, an emissivity adjustment may seemingly make the camera "correct" for the error in the IR Window but the moment those variables change (target temperature, ambient temperature, reflected temperature) that "field correction" will go out of the window.

Notwithstanding all of the great features of a polymer/mesh optic, this is where the fundamental problem with polymer/mesh optics lie, **it is not possible to measure through mesh, it is a non-homogenous optic.**

If you have invested in an IR camera with the intentions of making measurements, then this kind of optic is not for you. If you're happy with a qualitative approach (non-measurement), then this optic will work well.

Hole/port

A while back, a great company out of NJ came up with a solution that comprised of a view port/hole and a fisheye lens. This solution meant that the issues with transmission loss error were eradicated as the camera was effectively inserted into a socket in the panel and because the port was just a hole, there was no error caused. I believe there was a version of the port that included some kind of crystal, but I cannot say how effective or well received this was.

This solution was great for measurement, there was no error caused by an optic, because there wasn't one!

Unfortunately, from a safety standpoint, these ports defeated the purpose of a window and can be argued should not be classed as such. Here we are installing an IR Window/port into a panel because of the risk of exposure to live electrical equipment and yet, by opening the port, placing the camera in the hole and putting your eye in front of it was almost like looking down the barrel of a loaded shotgun and praying it didn't go off.

The other problem with this kind of solution is that switchgear manufacture has rules that must be followed. One of these rules is known as "fingerproof" or IP2X. Basically this means that the diameter of any opening must not be of sufficient diameter to get a finger through, basically 12mm or 0.5".

If you can get a finger through, you can get electrocuted and so it's a no-go!

This option is rarely seen in the market today, the use of "solid" optics seems to have been generally accepted, but at the time of its introduction it caused quite a stir.

Crystal optics

Okay, before we go into this, I will admit, this is my favourite option. Having researched and been exposed to many other potential options in my career, including the two main ones previously mentioned, this remains for me the optimum choice. True, you cannot hit it with a hammer and you certainly cannot drive over it with an SUV (not sure why you would want to), its much more expensive than a sliver of plastic but in my personal opinion, it benefits far outweigh its failings.

Let's look at some crystal optic material options. I was presenting a paper on transmission correction in San Fransisco when a learned fellow asked a series of "questions" regarding optic material types, so, I think this is valid.

First of all, a crystal isn't a crystal. There are many different types and options, much more than you may on the face of it think, but these need to be paired back based on safety, cost and availability. Let's look at the most commonly used IR Window material, Germanium. This is the strange looking material found on your infrared camera lens, sometimes it looks purple, sometimes an orange type ofcolour depending upon the coating used. Germanium is what's known as a "grey" transmitter, which means its transmission loss – that important "T" variable – is consistent across the infrared spectrum. This makes it very good for lenses as it modulates the IR signal the same way regardless of wavelength, that addition of anti-reflective coatings (AR) make Windows manufactured from this material extremely good infrared transmitters. Unfortunately, Germanium can be expensive, using this material to manufacture a 4" IR Window would mean the IR window would end up retailing at well over $2000 per unit, which rules it out.

A second material worthy of brief discussion is Sapphire. Sapphire is very hard and would likely be able to withstand a hammer impact, but, from a cost standpoint is similar to Germanium meaning the end product would be very expensive to manufacture.

That really leaves two "flourides", CAF2 and BAF2, or Calcium Flouride and Barium Flouride respectively. Both have been used as IR Window optics in the past, however, BAF2 in particular is very susceptible to moisture. I have actually seen (and removed) IR Windows with BAF2 optics which have degraded with nothing other than atmospheric humidity. BAF2 can also be somewhat toxic when being worked, although this is unlikely to be of any real issue to an end user as the optic is embedded in the IR Window housing by the time it is installed. BAF2 does have one great quality, it is highly transmissive, which means that the error caused by the IR Window itself is minimal, the result being it is great for measurement. BAF2 is slightly more expensive than CAF2 and were it not for its severe moisture degradation issue, would probably see greater adoption as an IR Window optic material.

Last but not least, we come to CAF2, or Calcium Flouride which is in my opinion, the optimum IR Window optic material. Let's start with the problems associated with CAF2.

1. CAF2 will shatter if subjected to significant impact. This is the reason why most CAF2 based IR Windows have a protective cover which locks, to protect the optic material from impact when not in use.

2. CAF2 may degrade with moisture, not as much as BAF2, but uncoated CAF2 may degrade under certain circumstances. The majority of CAF2 based IR Windows are coated and so this is not a worry in reality, it is worth checking though before deciding on a CAF2 IR Window. The coating should cover both sides and the edges, even though these are obscured by the mounting ring.

3. CAF2 stops transmitting IR at around 11μm, which means that there is a transmission loss when it is used, however unlike polymer/mesh optics, this material is homogenous, which means the error is the same across its area. So, we can correct for it…

So, CAF2 is brittle, degrades and causes an error in the reading, so why do I like it so much?!? Well, when its put like that, I guess I had better have some real reason and I do. Only three, but they are big ones;

1. First and foremost, CAF2 is a homogenous optic material. This means that, unlike non-homogenous composites such as polymer/mesh, the transmission characteristics are consistent across the face of the IR Window. This means that a properly configured IR Camera **can** correct for the error and hence provide the thermographer with a truly representative temperature measurement. Since the majority of IR cameras today are purchased with the intention of being measurement tools, this is a major positive.

2. Second, CAF2 is optically transparent as well as thermally. Not many IR cameras available today do not feature a digital camera to compliment the thermal, with a CAF2 IR Window this additional tool can be deployed. A CAF2 IR Window can be used to visually confirm a switch disconnect position and so dispense with additional visual viewing panes which form part of Lock Out Tag Out (LOTO) requirements, for Load Interrupt Switches (LIS) and other types of equipment.

3. Third, CAF2 is not only transmissive to IR and visual cameras, it is also transmissive to UV cameras. These camera types offer a different inspection option to that of thermal imagers and are still very much in their infancy, however, so were thermal imagers 15 years ago. An IR Window should, can and will outlast the host switchgear, why limit yourself?

Mounting hardware

IR Window mounting mechanisms come in lots of weird and wonderful options, with one goal, to attach the IR Window body to the host panel. All of them work, the choice comes down to personal preference and to some extent the amount of time a particular method requires to install.

Having personally installed thousands of IR Windows earlier in my career, I will give one word of warning. The panel cover must ALWAYS be removed and moved to a place where metal shavings cannot enter the panel during installation. This is a real cause of arc-flash. I know of at least one manufacturer that seems to claim the IR Window can be installed without removing the panel, I would dearly love to know how this can be done safely and in the time period they claim as the only method I can see would be to use a hole saw which would spray the panel interior with shavings. Even if they could explain, I still would not do it, good luck turning that panel back on guys..

IR Window mounts come in two distinct types, those which are accessible from inside the panel and those which are not. Typically the former require a clearance hole and the latter tap their own (don't believe the hype, in reality there are issues with this, see below).

Using a series of bolts or a nut to secure the IR Window to the panel is a traditional method of doing so and it works well. A recent version uses a single large nut which threads onto the IR Window body, which itself protrudes through the panel. I have not personally tried to install this type but I can see it would be very simple, having installed IR Windows using multiple bolts, I can tell you from experience that aligning the IR Window on the front of the panel and then trying to hold it steady while threading a bolt through the clearance holes from the other side is almost impossible. An early IR Window got around this by having self-adhesive gaskets, which helped but were themselves problematic as they were extremely sticky, which was a problem if the alignment was slightly off!

Other than the issues of orientation (which the single nut version elegantly resolves), there are two primary concerns revolving around an internally fixed IR Window;

1. Panels vibrate. Those fixings had better never come loose. Ever. These fixings are always metallic and if they ever fell into the panel there would likely be a very big bang indeed. Ever is a very, very long time.

2. Panel thickness. Using internal mounting hardware means that the IR Window is limited by the thickness of the panel it is intended to be installed onto. Switchgear panels tend to be quite thin and so this would not be a problem, however, common installations such as transformer and motor boxes however can be 6mm/¼" in thickness which means that the same bolt may not fit

Fixing hardware which is accessed from the front however resolves these issues as there is no depth restriction so long as the thickness of the panel is sufficient for the fixings to thread into. Plus, there are no internal bolts, nuts or washers to work loose over time and cause problems.

I have always been a supporter of front fixings rather than internal rear fixings, I believe this comes from the days when I installed rear fixed IR Windows. I don't want to repeat that experience and nor would I wish it on anyone else!

Although I do like front fixings, they do have a problem. No matter what you are told, these things cannot be relied upon to cut their own thread. It's a great sales argument until you actually try it on a transformer or motor box. The torque needed on the screw head to cut the thread – even through a predrilled pilot hole – can be great enough to twist the head right off the screw shaft leaving you with a screw shaft half embedded in the panel. This is even worse if the IR Window itself has the screw captive as they may not be easily released.

Here is a tip. Drill the fixing hole and run a tap through it. It doesn't have to be the most perfect thread ever formed, just enough for the screw to bite. Do this and you will never break screw heads, it is also amazing how this actually speeds up the installation process.

Mounting frame

IR Window mounting frames are made from two material options. Metal (typically aluminium but some stainless steel options exist) and Plastic. In my view, either can work well if properly designed and installed but the key word here is installed.

The only real item to be aware of with plastic frames is grounding during installation and use. If there are floating metallic components within the frame itself – such as cover retaining bolts - then they should be grounded as an internal short through the frame could cause them to be live on the outside. This is not the case with metallic frames as any short would be instantly grounded via the frame to the panel cover meaning there is no chance of electrocution risk.

Although the grounding process is not particularly difficult, it does involve running a suitably rated Ground wire from each floating fixing and the performing and Earth Loop Impedance test on each fixing. Once this is complete, it should not need to be repeated unless the Ground is disturbed.

The cost difference between an aluminium frame and an injection moulded frame used to be significant. Recently, high pressure die cast frames have been introduced which reduces the cost differential, so in conclusion, a metallic frame is on-balance safer and better value for money.

Protective front cover

Again, there are two general options; metallic or plastic, the former being available in stainless steel or aluminium and the latter in clear or opaque plastic.

The reason the cover is in place is to protect the optic, therefore you will find that they are invariably held in place by a locking mechanism of some kind. If the cover is made from a polymer material, then it must comply with the Underwriters Laboraties (UL) requirements for polymers, this is standard UL746C (UL is covered later in this document in more detail). Metallic components which are subject to corrosion must be protected and so aluminium covers are usually anodised or painted, obviously this is not required with stainless steel.

The reason the optic requires protection, depends on the choice optic itself; For Polymer/Mesh optics, protection is required if the polymer melts during the UL746C test leaving open holes that expose internal components. For crystal optics, protection is required to prevent impact damage, which again leaves an open hole that expose internal components.

The positive aspect of having a clear cover is not only visual inspection of the switchgear internals, but also to ensure there is no damage to the optic (whichever type you choose) prior to removing the cover. With a clear cover you can see if there is any damage and make a safe and informed decision NOT to remove the cover and expose a technician. With a metallic or opaque plastic cover, you must first remove the cover with no indication of whether the optic itself is in a dangerous state which by virtue of removing the cover itself could trigger and arc due to fall optic debris.

Front cover fixing methods

Traditionally, IR Window front covers tended to rotate around a pin perpendicular to the panel itself. Some covers were held in place with a magnet when not in use, others with bolts. The first IR Windows I was involved with designing had bolts that had to be removed to remove the cover and perform a scan. In truth and with hindsight, these were awful, for two reasons;

1. The bolts were not captive and so they were often lost, which meant I had to carry a pocket full of them when doing an infrared survey.
2. To remove the bolts was actually quite time consuming.

Modern IR windows tend to have a hinged cover of some description, although at least one still rotates. The problem with standard hinged and rotational covers is that the user is limited to the orientation of the IR Window. There are often times, especially on low voltage panelboards, the panel fronts can be crowded which means the standard IR Windows orientation would mean to cover would foul on another component. This is the main reason why modern IR Window designs use hinged rather than rotating covers, the hinge will always expose the full optic, even if it can only open 90degrees. A rotational cover may not.

The only drawback with hinged covers is that the thermographer has to hold them in the open position if they are installed with the hinge at the 12 o'clock position. This may not always be necessary but, again, due to some installation requirements it can and does happen. In which case, the thermographer has to try and hold the hinge open whilst manipulating the camera controls, not an easy task. Some IR Windows are manufactured with a spring loaded cover which overcomes this problem, providing a true "any orientation" installation solution.

The last point to cover on the cover topic (excuse the pun) is the locking mechanism. Most if not all IR Windows have a locking mechanism to hold the cover in place when not in use. This wasn't always the case, back in the day, a French company had an IR Window which used a magnet to hold the cover in place in the closed position. This was a neat solution at the time but I am unsure it would pass muster in today's safety conscious society.

Most if not all IR Windows today include some kind of locking mechanism that requires a tool to allow the cover to be removed. The key to this part of an IR Window design rests with the end-users Return On Investment (ROI) and the time taken to remove the protective cover and then replace it.

Example.

A plant intends to install 1000 IR Windows and intend to scan each of them once per quarter year. That's four thousand "open and closes" per year. There are two IR Windows being considered;

1. Type A has a single captive, quarter turn lock,
2. Type B has three captive bolts.

Both types have captive fixings which is great, the difference between the two is the time taken to remove a single quarter turn screw for Type A (1 second) and three captive bolts for Type B (10 seconds), then repeat the process to lock.

Summing up, for a quarter turn Type A, the time taken to lock and unlock a single IR Window is 2 seconds. However for a three bolt option Type B, the time taken to lock and unlock a single IR Window maybe 20 seconds.

Looking at the on-going ROI calculation based on 4000 scans;

Type A Quarter Turn – Return On Investment

Technician Hourly Rate $50p/h

4000 x 2	= 8000seconds
8000/3600	= 2.22hrs
2.22x50	= **$111.11**

Type B, three bolt – Return On Investment

Technician Hourly Rate $50p/h

4000 x 20	= 80,000seconds
80,000/3600	= 22.22hrs
22.22x50	**= $1111.11**

A quarter turn option is ten times more efficient to use than a three bolt option. Now $1000 may not seem much, but over the lifetime of that installation it certainly adds up, every time you use those three bolts over a quarter turn, you are effectively losing money...

Seals and sealing

There has been a lot of misinformation regarding IP (Ingress Protection) ratings and their "equivalent" NEMA Type rating when it comes to IR Windows. I have put the word equivalent in inverted commas because, they aren't. I know of at least one IR Window manufacturer - they are still in business today – who in the past has claimed a European IP65 certification meant that their IR Window was "Type 4", when in fact its UL environmental rating was only Type 1 (Indoor). This meant that those IR Windows were being installed by unsuspecting and trusting North American customers into outdoor equipment and as a result were unknowingly de-rating it.

Buyer beware.

What does this have to do with seals I can hear you asking, well, as usual it comes down to certification. In Europe, the sealing material itself is not conditioned prior to performing the IP test, they blast it with dust and water, the check to see if it has leaked. In the U.S. however, the Nationally Recognized Testing Laboratory (NRTL), in this case UL, subject the material used to manufacture the gaskets and/or o-rings in an attempt to simulate ageing so that when the seals are tested they are tested in the worse possible state.

So, IP ≠ NEMA, don't believe me, check out the following NEMA document https://www.nema.org/Products/Documents/nema-enclosure-types.pdf its right from the horses mount, page #7...

Basically, once the seals are tested and certified properly then again it comes down to personal choice. In the past I dealt a great deal with a product that included a self-adhesive gasket, in some instances this was really great, it helped a lot during installation (so long as you got it lined up right first, but man they were tough to get off if you didn't!) but some customers did make a great point in that they may want to remove the IR Window if they changed their switchgear. So, now too, the idea of self-adhesive gaskets seems to have gone the way of the dodo. Today most if not all IR Windows have seals that allow removal of the IR Window without damage which is a great feature and benefit to the customer since the IR Window should outlast the host switchgear.

Certification – what a minefield

Okay, so in my personal opinion, certification of an IR Window can be broken down into two very categories; **Real value** and **Perceived value** the former being a set of tests and resulting certifications that have a real meaning and provide a real value to customers, a good example of this would be the UL recognized mark. The latter, would be something I describe as having a value in so much as it gives an indication of a products' functionality which then provides comfort to the customer, but has little real meaning, a good example of this would be an arc-test.

Let's look at the main one we need, in particular for the U.S. market, the UL mark. In the early days of IR Windows, UL did not have a specific IR Window standard to design and test to, so, instead, they used sections of UL50 which was the standard for Enclosures for Electrical Equipment. This standard required the usual impact, aging and environmental testing but was not IR Window specific. I can tell you, when the new UL50V IR Windows standard arrived unannounced in the mail, there were a few hours of panic when reading it until we realised our IR Window already complied!

The new IR Window standard, UL50V was good though, they added some real requirements that had real safety meaning to installers. One requirement was relating to Grounding of floating metallic components, other updates were relating to markings. Now, you can see that UL Recognized (Recognized remember, not Listed, you cannot List a component) IR Windows all carry the environmental Type number they were tested to. No more "equivalent" arguments, which is great for end users and installers alike.

The main question that end users and installer ask is "Will the installation of an IR Window invalidate my UL Listing?", the answer is "No". Ultimately, you are responsible for the modification, but by installing a properly recognized component onto a panel and making sure you match the **Type ratings** then there is no problem. I believe UL will actually come and update the Listing if you want them to do so, but as ever, there is a cost to this and it is generally not done. An IR Window is little different to a switch or an indicator light at the end of the day, in fact, because there are no electrical connections.

The second main question is related to arc-flash testing. A lot has been written about this subject, much of it by yours truly, but little is actually known from first-hand experience of arc-testing as it is expensive to perform and extremely unpredictable. I have had the privilege of having actually been part of an IR Window arc-test – 3 actually – at a test lab in Australia.

So, from my experience, an IR Window manufacturer can model the heat-flux and overpressure withstand of the product they have tested and use that as a guide for the products ability to withstand arc-fault events in other equipment. An extreme (albeit unrealistic) example would be that if the IR Window passed a 63kA for 1s arc-test, when attached to a totally sealed 1'x1'x1' box then we would have a high degree of confidence that it would pass a 20kA for 0.1 arc-test when attached to a 20' long, plenum ventilated cabinet.

An arc-test is a guide, nothing more, but in reality, a guide to what?

Well, in my experience, the IR Window optic almost always fails to one degree or another; crystal may shatter, plastic may melt however a **pass** from an arc-test standpoint is determined by the ability of the IR Window with the cover **CLOSED** to remain on the equipment and that any escaping gas does not burn the cotton indicators surrounding the panel itself.

An IR Window is a risk reduction device, not a risk removal device. The risk of an arc-fault happening during an inspection via an IR Window as compared with removing the covers is so dramatically reduced that it isn't statistically possible to quantify. I have statements such as "Install IR Windows and remove 99.99% of arc-flash risk", I don't know what that really means or how this was calculated but I do get the sentiment.

However sales people choose to highlight how good IR Windows are is almost irrelevant, they are VERY good at reducing risk. There is no induced airflow, there is no chance of tools being dropped into the panel, there is no chance of falling into the panel and being electrocuted or causing an arc-flash.

If I had a choice of opening the panel in full fire retardant PPE or installing an IR Window, I would choose the IR Window. Every time.

CONCLUSIONS

IR Windows are probably the best arc-flash risk reduction device for thermographers available today. The chances of an arc-flash being triggered when an IR Window is being used is so small, I would be surprised if it could even be calculated.

IR Windows are also a super-efficient method of performing an IR scan. To remove a cover takes two guys and then a third to shoot it. Even if there were no arc-flash risk, the amount of time is the same. With an IR Window, you pop the cover, shoot and go. Simple.

So, regardless which IR Window you choose, you are going to get a great product, they are efficient, they are safe and they are easy to use. Ultimately, the final choice comes down to features, benefits and unfortunately in todays climate – cost.

It's probably obvious that I prefer the crystal option over any other. I have used mesh, I have used polymer/mesh composites and both are good products but I am a measurement man. If I have a camera with a measurement feature then I want to use it, otherwise I do not see the point in having it. I may as well have purchased a fire camera. In my experience in designing both IR windows and IR cameras, it is not possible to measure through mesh of any kind and so for me crystal is the only way to go.

The ability to measure to a certain extent would override cost for me as I do not see how even "hot-spot hunting" can work as the delta-T readings through mesh will also be wrong.

Traditionally, crystal optic IR Windows were always much more expensive than polymer, that's how the gap was actually created. However, today, the difference between crystal optic and polymer/mesh optic IR Windows cost-wise is zero. In fact, I know at least one brand of crystal IR Windows that are lower in cost than the prominent polymer/mesh brand.

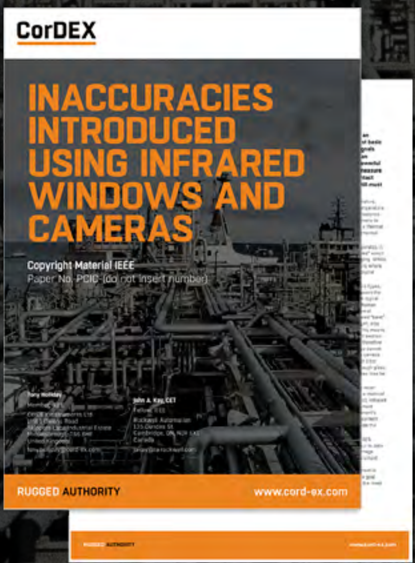
So there you have it for what its worth, my experiences on paper.

As I mentioned earlier in this document, I am always willing to answer any legitimate question, my direct email address is tony.holliday@cord-ex.com so please do reach out to me. I am happy to help.

ABOUT THE AUTHOR

Tony is a pioneer in the development, sales and marketing of IR Windows. A trained Engineer, Tony began his career designing intrinsically safe fiscal metering systems for the petrochemical industry before moving into automated switchgear design and commissioning destined for telecommunications facilities across Europe. The holder of numerous patents, including the use of RFID chips embedded within IR Windows to increase inspection efficiency, Tony's thought leadership and innovation ensure that products developed under his guidance are cutting edge. Currently holding the position of CEO at CorDEX Instruments Ltd. Tony is now ultimately responsible for the design, sales, marketing and production of the next generation of intrinsically safe handheld tools including thermal imagers, ultrasonic testers and digital cameras.

OTHER RESOURCES



CLICK TO DOWNLOAD

CLICK TO DOWNLOAD

You can also visit our CorDEX Blog for further useful industry updates, white papers, blog posts and news focusing on electrical safety, intrinsic safety and hazardous environments.

VISIT OUR BLOG