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Signals Defense
1 Easter Court, Suite E
Owings Mills, MD 21117
Tel: 410-902-0356
Fax: 410-902-9609
Email: info@signalsdefense.com
Web: www.signalsdefense.com

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Building Shielding: Architectural Solutions for Security and Performance

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Building Shielding: Architectural Solutions for Security and Performance

Presented by: Signals Defense
1 Easter Court, Suite E
Owings Mills, MD 21117

Description: Buildings need protection from cyber as well as physical threats. Building shielding offers several architectural solutions that contribute to the security of both building occupants and wireless systems. These solutions also help reduce unwanted solar heat and glare while providing protection from the elements and people. This course presents the security and performance benefits of shielding technology that can improve wireless performance, energy efficiency, and occupant comfort, satisfaction, and safety.

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Purpose and Learning Objectives

Purpose: Buildings need protection from cyber as well as physical threats. Building shielding offers several architectural solutions that contribute to the security of both building occupants and wireless systems. These solutions also help reduce unwanted solar heat and glare while providing protection from the elements and people. This course presents the security and performance benefits of shielding technology that can improve wireless performance, energy efficiency, and occupant comfort, satisfaction, and safety.

Learning Objectives:

At the end of this program, participants will be able to:

- describe the fundamentals of building shielding, why it is important, and where it is needed
- explain the cyber and physical security benefits of building shielding
- discuss the in-building wireless and energy performance benefits of building shielding
- list the industry requirements and testing for shielding technologies, and
- recall the shielding technology options and methods available.

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Shielding in the Building Envelope

The Building Envelope

While the building envelope protects the people and equipment inside from the effects of the outdoor environment, the openings are the weakest point of a structure. In particular, windows provide an access point through which an array of challenges can compromise the comfort and safety of the occupants, the efficiency of the equipment, and the security of systems and data.

A range of architectural solutions is available to improve both the security and performance of the building envelope, especially at the windows. This course will present cost-effective building shielding technologies that contribute to energy efficiency while mitigating threats to people and information.

Importance of Building Shielding: Security

An unfortunate reality is that news stories about private information being compromised or stolen are not uncommon. Corporate espionage, identity theft, and malware are terms most of us now understand. Government awareness of the dangers of electronic spying has existed for decades, but private companies are realizing they may be at risk, too.

Radio frequency (RF), infrared (IR), Wi-Fi, and Bluetooth signals from printers, cell phones, and computers within a building all “leak” through glass windows to the outside, where rogue connections, monitoring, and eavesdropping pose significant security threats.

Commercial and government facilities also need to be protected against attacks on the physical structure of the building to keep occupants safe. Windows in particular serve as both a weak point and a potential danger. When windows break due to high winds, impact accidents, blasts, or break-ins, the injuries caused by the initial event are multiplied many times when the glass itself becomes a projectile.

Importance of Building Shielding: Performance

How often have you had to walk to a window to receive a strong enough signal to make or receive a call? This sort of uneven coverage in a building can frustrate tenants and diminish workplace efficiency. Building owners and occupants address inconsistent cell coverage by deploying a distributed antenna system (DAS), which broadcasts a cell phone signal throughout the building, similar to Wi-Fi. A problem remains when cell signals generated outside the building interfere with the DAS, creating signal confusion for users' cell phones. Addressing this problem at the system level with high-powered signal boosters is a more costly and complex approach than an architectural solution that attenuates interference coming through the windows.

Without building shielding, energy performance can be affected. The high-powered equipment used to boost the in-building wireless signals also increases energy consumption and mechanical heat production. While windows provide a positive impact by offering daylighting and views, they can also add unwanted glare and heat gain into a space. Besides rendering parts of a building undesirable, sunlight fades unprotected wall and floor coverings and furniture, thus shortening their replacement time.

Building Shielding Benefits

Building shielding technologies provide countless benefits in a cost-effective material that does not alter the aesthetics of the building envelope. Shielding films, foils, and paint reduce the RF footprint visibility outside the building, limiting the possibility of rogue wireless or unauthorized connections. The in-building wireless system performance is enhanced because outdoor RF/IR interference is reduced.

Films and laminates offer ballistics and blast protection along with glass fragmentation control. Films improve the energy efficiency of windows by reducing solar heat gain; they also minimize UV damage and increase occupant thermal and visual comfort with even lighting and room temperatures.

Applications

Building shielding benefits government facilities as well as many types of commercial and public buildings.

Government: RF shielding mitigates electronic eavesdropping for classified operations, and may be suitable for sensitive compartmented information facilities (SCIFs). RF shielding can be combined with ballistics and blast protection in one unit.

Real Estate: Full cellular coverage is a must for all high-rise and multi-use buildings. Property owners are able to attract elite tenants and premium rental rates when they can guarantee high-speed mobile connectivity.

Hospitality: Today's travelers are well versed in mobile technology and expect strong, uniform mobile coverage during their stays. On the other hand, poor wireless service means they will likely stay elsewhere. Uniform cellular coverage and capacity enhances staff communications to better serve guests.

Detention Centers: Detention grade glass-clad polycarbonate is designed to resist penetration from sustained, premeditated attacks while still allowing visibility.

Applications

Enterprise: Corporations of all sizes rely on uniform cellular coverage and capacity inside buildings to perform their work in a secure and safe environment. Energy-efficient windows help reduce cooling energy costs, and effective light control can improve employee comfort and satisfaction, leading to greater retention and productivity.

Colleges/Universities: Addressing the challenges of cellular coverage and capacity on campus is a major initiative at many universities and colleges across the country. The vast majority of students, faculty, and staff utilize mobile devices, and they expect them to work everywhere, relying on them for communication, social applications, and sending/receiving emergency notifications.

Healthcare: From remote monitoring of patient status and charting, to medical professionals and staff communicating efficiently in emergencies, to tracking instruments and monitoring devices throughout the facility, complete cellular coverage and capacity is an integral component of any modern hospital or medical center.

Security Benefits of Building Shielding

Signal Leaks

Most cyber risk comes over wired networks connected to the Internet, but because wireless access sometimes extends beyond the physical boundaries of a building, it can expose corporate data to devices that are out of sight.

RF/IR signal leakage allows unauthorized parties to monitor, eavesdrop, record, and steal confidential and valuable electronic information from an organization, even though encryption and other hard-wired cyber security protections have been deployed.

A wireless area network (WLAN) consists of RF transmitters or access points that service a number of computers. Generally, a WLAN broadcasts as far as 1,500 feet; if the access point is near an exterior wall, the signal may reach a point 1,500 feet outside the building where it may be accessed by unauthorized users.

Eavesdropping

Eavesdropping generally relies on a device to pick up images or audio and convert them to a transmittable form, and a remote receiver to which the information is transmitted.

Devices include:

- electromagnetic interference (EMI) and radio frequency interference (RFI) devices
- low-powered, high-frequency “bugs” that transmit audio, and
- microphones that use IR energy (i.e., lasers) to capture vibrations from a smooth surface and then convert the vibrations into audio.

Image courtesy of Danilo Rizzuti at FreeDigitalPhotos.net

RF Shielding

Surface-applied RF shielding window film reduces the emanating RF footprint so there is less access to indoor wireless transmissions, including WLAN. Building shielding is a deterrent to those attempting rogue or unauthorized connections or attempting to wirelessly penetrate the network.

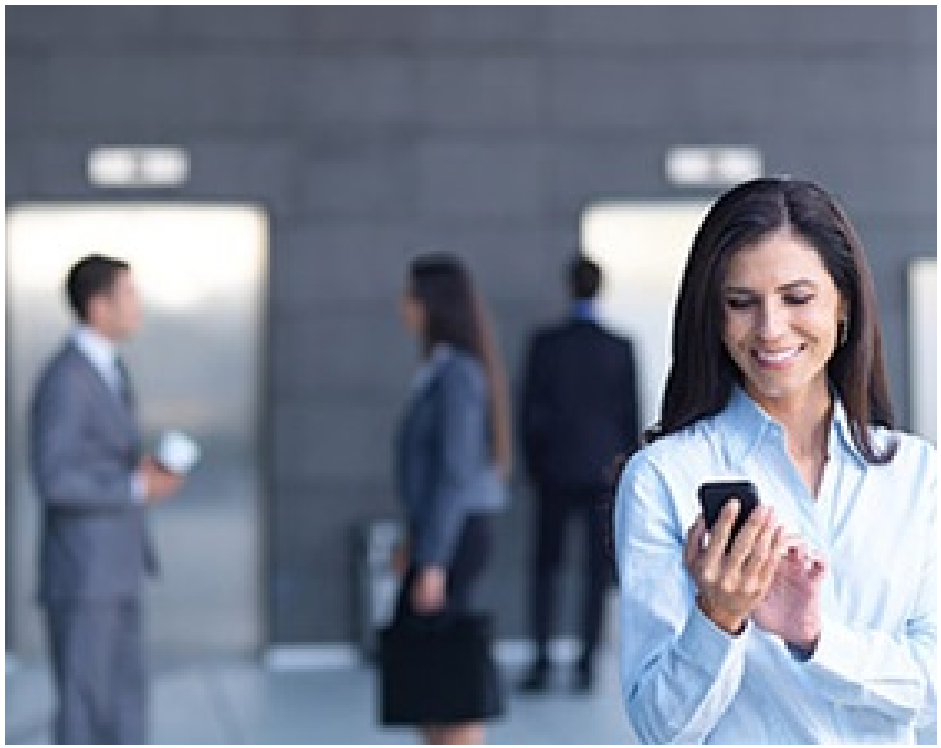
RF shielding also provides exceptional anti-eavesdropping and technical surveillance counter-measure (TSCM, a U.S. Federal Government term) security, defending against laser microphones and EMI/RFI devices by preventing their transmissions from reaching the remote receiver.

Used on interior walls, RF shielding creates secure conference rooms or workspaces for WLANs.

Physical Security

When glass is subjected to stress, it breaks into lethal shards that can be ejected from the window frame. Pieces of broken glass can be as dangerous as a knife and can result in significant injuries to tendons, loss of limbs, loss of vision, and even death.

Security film works by holding broken glass in place so it does not become a dangerous projectile. Film is strong enough to withstand a significant degree of the force that caused the glass to break. Even if the film is sheared away from the window, the glass stays with it and presents less danger than if there were no film.



Performance Benefits of Building Shielding

IBW System Performance

In-building wireless (IBW) is an evolving technology that has grown to meet the demands of many commercial building owners, managers, and tenants.

The majority of cell phone calls are initiated inside a building, so reliable cell phone service inside commercial space is a growing demand. Often the traditional cell phone network of outdoor towers does not penetrate effectively into buildings.

IBW systems are intended to provide uniform, consistent coverage and capacity in high-traffic areas throughout a building.

Image courtesy of franky242 at FreeDigitalPhotos.net

IBW System Performance

While the outdoor signal does not penetrate into the entire building, it often penetrates enough to cause interference with the indoor signal, thereby reducing the IBW system effectiveness and resulting in poor signal reception in parts of the building.

When IBW systems face capacity and coverage issues, these are often solved with such means as a distributed antenna system (DAS), or high-powered indoor amplifiers or signal boosters. These devices mitigate or otherwise combat the effects of the outside interfering signals so that mobile devices will “see” a stronger indoor signal and connect to the IBW equipment rather than to the nearby macrocell tower.

RF/IR Attenuation

However, as stated earlier, this approach adds complexity and can result in increased costs: extensive engineering costs, more expensive IBW equipment, and higher installation and testing costs.

Window shielding works by creating an RF separation at the glass to ensure cellular connectivity is made with the in-building wireless system. By insulating a building from outdoor RF interference, IBW systems face reduced competition with an outdoor signal. Especially in densely populated urban areas where significant wireless traffic exists, RF shielding helps the IBW system work as planned without high-powered supplementary techniques.

Cost Benefits

One impact of improved IBW performance is reduced operating costs. Instead of investing in more expensive and more complex systems to increase capacity and coverage, RF shielding material helps to achieve similar results at a lower cost.

DAS equipment can be replaced by a much lower-power-consuming unit, resulting in reduced energy consumption without sacrificing performance. Even cooling energy costs are lowered since mechanically-produced heat will be lessened.

With increased mobile data throughput and predictable performance, building owners can assure tenants of uniform, sustained wireless operation throughout the building, thereby adding to the building's appeal and potentially to its property value.

Energy Costs

Windows are a significant component of any building, especially in the all-glass office buildings that are common today. According to an estimate by the U.S. Department of Energy, nearly 75% of existing windows are not energy efficient, and one-third of a building's cooling load is from solar heat gain through windows.

Window film enhances the performance of any glazing system, significantly reducing the consumption of cooling energy and extending the life of HVAC equipment.

Energy costs account for approximately 30% of the total operating cost for a commercial building. Professional energy audits estimate that buildings improved with energy-saving window film could realize annual savings up to 15%. In addition, depending on the utility company, window film may qualify for rebates, making it more affordable.

Occupants and Furnishings

Another opportunity for windows to help reduce energy costs comes when occupants are able to rely on daylighting instead of electrical lighting. Besides offering energy savings, many studies have found that daylighting increases the productivity and well-being of occupants. These benefits are marginalized if glare and hotspots make occupants so uncomfortable that they take measures to cover the windows.

Window film helps achieve the goal of allowing natural light to enter a building while blocking annoying glare. Film also adds to occupant comfort by preventing inconsistent temperatures in different areas.

Ultraviolet light is the powerful wavelength that causes sunburn and can eventually lead to skin cancer. It can also damage materials indoors, fading furniture and artwork.

Window film blocks UV rays and is recommended by the Skin Cancer Foundation as part of a comprehensive skin care program. When furnishings and other building contents are protected from UV rays, savings are realized as items are given a longer life and replacement costs are delayed.

Solar Control

Films can be added at a fraction of the cost of replacement windows and provide a quick payback. When sunlight and its effects are controlled, employee comfort and productivity and tenant satisfaction rise.

Shielding Industry Requirements and Testing

RF Attenuation

The need for RF attenuation is driven by the desire to eliminate electronic eavesdropping, and to block unwanted signals emanating from or entering the space for a myriad of reasons, including efficient in-building wireless, or controlling the footprint of the Wi-Fi signal.

There may be other window solutions that provide higher attenuation than window film, but these other solutions may have characteristics such as very low light transmission and high reflectance that some consider visually unappealing. Other solutions may be prohibitive in the architectural design and/or very expensive.

RF Attenuation Measurement

RF attenuation is measured in decibels; the decibel is a logarithmic unit used to express the ratio of power. In this case, RF signals are the power source being referenced. A good rule of thumb with dB is that every 3 dB equates to a 50% reduction in power.

Examples:

- 3 dB = ½ power
- 6 dB = ¼ power
- 9 dB = ⅛ power

An office window, for example, may provide only 3 dB of attenuation (or a 50% decrease in power). A window film may provide an average of 33 dB attenuation, meaning less than 0.05% of the RF signal power is transmitted through glass with this film. While this may be adequate in some situations, even a small amount of RF frequency emanating from a building is an opportunity for eavesdropping. Just because the signal strength is decreased does not mean it is not being disseminated. Other films offer >40dB RF attenuation, while still maintaining high visible light transmission (VLT).

Frequency Ranges

Frequency refers to the rate at which a signal vibrates. Wireless signals occupy a wide range of frequencies. The unit of measurement for frequency is Hertz, defined as the number of cycles a signal completes in one second. Megahertz is millions of vibrations a second, and Gigahertz is billions of vibrations a second.

Below are some common wireless devices and their frequencies.

Device	Frequency
AM Radio	Around 10MHz
FM Radio	Around 100MHz
Television	Many frequencies, from 470MHz to 800MHz
Cellular Phones	850MHz, 1900MHz, and many others
Wi-Fi	2.4GHz
Satellite	3.5GHz
Wi-Fi	5GHz

RF Attenuation Testing Standards

It is important to understand the various testing standards and criteria used for building shielding in order to make sense of manufacturer performance values. Prior to 2014, several different testing methods were employed for measuring the shielding effectiveness of films, glazings, and foils.

Although newer methods attempt to standardize and create uniformity for comparison of these materials, the methods are still broad and open to the interpretation of the purchaser of the test.

Critical factors to consider:

- Earlier standards do NOT require a large quantity of tested frequencies; this hampers the ability to gain a true understanding of a material's ability to attenuate RF energy across a very wide frequency range. For example: IEEE-299 requires only one minimum tested frequency within six ranges between 300 MHz and 18 GHz, thus resulting in a test with just six test points. Consider that there are 17,700,000 individual frequencies in this range (plus channels and harmonics).

RF Attenuation Testing Standards

Critical factors to consider, continued:

- The standards do NOT specify a pass/fail criterion. Successful government SCIF construction has utilized materials that provide proven, uniform attenuation across a wide frequency spectrum. However, commercial standards and methods did not require a test report to contain data to this extent.

- These standards including ASTM F3057 discussed on the next slide do NOT delineate the differences between various conductive and non-conductive materials. An accurate comparison cannot be determined when considering data of grounded copper and attempting to compare it to an ungrounded glass coating.

ASTM F3057

In 2014, ASTM issued F3057-14, “Standard Test Method for Electromagnetic Shielding Effectiveness of Glazings.” This method defines specific parameters for testing glass, glazings, glazing systems, and coatings such as applied films, specifically with the intent of the system(s) being used for electromagnetic interference (EMI) security. Key differentiators include the following:

- Measurements are taken at a minimum of 461 radio frequencies equally spaced across the tested logarithmic scale. From 100 MHz to 18 GHz, this might mean a tested frequency point would occur in 38 MHz increments.
- Three identical samples are required to be tested, and the results are then averaged at each tested frequency.
- A large 36″x36″ sample is required to be tested. Consider that previous shielding effectiveness testing is done on a 12″x12″ sample. In addition, ADTM D4935-10, “Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials,” requires only a 5½″ diameter sample be tested inside a grounded tube. The size of the sample plays a significant role in frequency attenuation and propagation (i.e., wavelength and amplitude), and most commercial glass is not fabricated in 1 sq ft or 5″ diameter increments. One should consider the validity of results when materials are tested under such constricted sample sizes.

Testing Comparison

- **ASTM F3057** 2014, “Standard Test Method for Electromagnetic Shielding Effectiveness of Glazings.” **Intent:** RF attenuation testing of a glazing, glazing system, or glass coating.
- **IEEE 299** 1997, “Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures.” **Intent:** RF attenuation testing of a shielded enclosure/structure, as a single constructed unit.
- **ASTM D4935** 2010, “Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials.” **Intent:** Determine shielding effectiveness of a planar material for a plane, far-field EM wave; calculate near-field and E-field shielding effectiveness.

Name	Recommended Tested Frequencies		Min. # of Tested Frequencies	Frequency Spacing	Sample Size	# of Samples	Represents Window Glazing Construction?	Designed to Test for EMI Security?	Designed to Test an Individual Material?
ASTM F3057	Frequencies equally spaced across the following range:	100MHz–20GHz	461	38MHz increments max.	36″x36″ (9ft^2)	3	Yes	Yes	Yes
IEEE 299	One single frequency within the following bands:	300MHz–600MHz 600MHz–1GHz 1GHz–2GHz 2GHz–4GHz 4GHz–8GHz 8GHz–18GHz	6	Varies from 1MHz–10,000MHz	12″x12″ (1ft^2)	1	No	No	No
ASTM D4935	No minimum	30MHz–1.5GHz	None	None	5″ diam (0.14ft^2)	1	No	No	Yes

TEMPEST and SCIF

Certain patented window technology has been engineered to meet stringent U.S. intelligence community security requirements for facilities handling sensitive and/or classified information. Sensitive compartmented information, SCI, is classified information with strictly controlled access and handling protocols. A SCIF is a facility that is U.S. Government accredited to store, use, discuss, and/or process SCI. An area, room, group of rooms, or an entire building can be accredited as a SCIF.

TEMPEST is a code name used to refer to electronic communication security specifications. TEMPEST requirements are defined in the Intelligence Community Directive (ICD) 705, a document that establishes all Intelligence Community (IC) SCIF must comply with uniform IC technical and physical security requirements. Intelligence Community Standard (ICS) 705-1 and the IC Tech Spec-for ICD/ICS 705 provide the physical and technical security standards for all SCIFs.

Some window films meet the TEMPEST requirements for ICD 705 and the DoD Infrared and Radio Frequency Emanation Protection Standards, and may even exceed IC requirements for RF attenuation. Each agency within the Intelligence Community has its own standards for qualifying a SCIF, but in general, all agencies are redirected to ICD 705.

Bullet-Resisting Security Glazing Standards

UL Standard 752 and National Institute of Justice (NIJ) 018.01 are two industry standards for bullet-resisting (BR) security glazing.

BR security glazing is typically composed of clear or tinted glass, adhesive interlayers, and high-quality multilayer polycarbonate. The overall thickness varies based on the BR rating required. The chart shown here presents each different level of protection and the corresponding glass thickness.

Product Description	Film Thickness	lb/sf
UL Level 1 Bullet Resistant: 3 shots 9 mm	13/16″	8.99
UL Level 2 Bullet Resistant: 3 shots 0.357 Mag	1-1/16″	11.68
UL Level 3 Bullet Resistant: 3 shots 0.44 Mag	1-1/4″	14.23
UL Level 4 Bullet Resistant: 1 shot 30 Cal	1-5/16″	14.43
UL Level 5 Bullet Resistant: 1 shot 7.62 mm	1-9/16″	15.61
UL Level 8 Bullet Resistant: 5 shots 7.62 mm	2-3/8″	26.01
Level 2 Forced Entry 30-min Physical Attack; Level 1 Bullet Resistant: no spall	25/32″	6.16
Level 2 60-min Physical Attack; Level 2 Bullet Resistant; UL 9, 10B, and 10C	1-1/16″	10.1

Solar Control Performance

Window energy performance is measured and rated using a range of metrics that evaluate heat gain and loss, as well as sunlight transmittance.

- U-factor is the rate at which a window conducts heat away from inside a room; the lower the U-factor, the more energy-efficient the product.
- Emissivity measures the ability of a surface to absorb or reflect radiant energy.
- Solar heat gain coefficient (SHGC) is the percentage of solar energy from outside that is transmitted into or absorbed and reradiated into a building.

Solar control window films improve energy efficiency and lower solar heat gain.

Solar Control Performance

Solar radiation consists of visible light, invisible infrared (IR) light that causes heat gain, and invisible ultraviolet (UV) light that damages equipment and furniture and can lead to skin cancer.

- Visible light transmittance (VLT) measures the amount of visible light that passes into a space. VLT is expressed as a percentage, with a lower value contributing to glare reduction, and a higher value for increased natural lighting.

- Infrared rejection measures how much IR light is blocked.

- Total solar energy rejection (TSER) measures more completely how much solar energy will be blocked. A higher TSER means more visible, IR, and UV light is rejected from the window.

A solar control window film blocks IR and UV and reduces glare by absorbing VLT.

Solar Control Performance

The criteria usually used to compare films and windows to determine proper shielding for heat and energy transference are SHGC, U-value, emissivity, and TSER. The National Fenestration Rating Council (NFRC) rates the energy performance of windows, doors, and skylights with this data. They also independently certify the VLT and SHGC performance of window film.

Total solar reflectance and transmittance values of window films are determined in accordance with ASTM E424, “Standard Test Methods for Solar Energy Transmittance and Reflectance (Terrestrial) of Sheet Materials.”

Look for energy audit modeling software that utilizes accepted U.S. Department of Energy analytics to measure how solar control films improve efficiency to deliver significant savings and a rapid return on investment.

Building Shielding Components and Materials

RF/IR Film

According to the U.S. Department of Defense Signals and Physical Sciences Security Center, high RF/IR attenuating window film “is the least expensive method to mitigate the largest amount of eavesdropping threats.”

RF/IR film enhances security by:

- significantly reducing or rejecting RF and IR signals
- defending against eavesdropping and theft of electronic data, and
- significantly reducing IR/laser audio and visual threats, and EMI/RF transmissions.

Some surface-applied window films are approved by the U.S. Government’s TEMPEST endorsement program for use in SCIFs.

RF/IR Film

RF/IF attenuating films can be combined with glass fragmentation and solar control, offering high VLT and low reflectivity for minimal aesthetic impact.

Typically, RF/IR film should attenuate more than 30 dB on average, from 300 MHz to 12 GHz, and block more than 98% of IR. The table below shows examples of the RF and IR attenuation that can be achieved with window films. Check with the manufacturer for details.

Product Description	Thickness	Adhesive	RF	IR	VLT	VLR
Surface-Applied RF/IR Film	2 mil	Clear distortion-free	33 dB Avg	3%@940 nm	68%	9%
Surface-Applied RF/IR Glass Fragmentation Control Film	10 mil	Pressure-sensitive	33 dB Avg	3%@940 nm	68%	9%
Surface-Applied RF/IR Film	2 mil	Clear distortion-free	46 dB Avg	<1%@800 nm	52%	13%
Surface-Applied RF/IR Glass Fragmentation Control Film	10 mil	Pressure-sensitive	46 dB Avg	<1%@800 nm	52%	13%
RF Attenuating Film	2 mil	Pressure-sensitive	30 dB Avg	17%@940 nm	70%	8%
RF Attenuating Film	2 mil	Pressure-sensitive	28 dB Avg	17%@940 nm	70%	8%

Glass Fragmentation Control Film

Safety film helps hold shattered glass pieces in place should a break occur. Fragmentation control not only helps protect occupants from shattered glass pieces, but can also slow an intruder's entry through the glass.

A pressure-sensitive adhesive film with a low visual distortion provides exceptional optical clarity. There are many situations that benefit from glass fragmentation control film:

- Windstorms
- Blasts
- Human impact
- Earthquakes
- Spontaneous tempered glass breakage events

Solar Control Film

Solar control film applies a layer of tinting to existing windows to enhance the energy and comfort performance of a building without changing the overall exterior appearance. Tenant comfort is increased by the elimination of hot and cold spots and reduced glare. Building owners benefit through reduced tenant complaints, increased tenant retention, more comfortably usable space, and reduced cooling energy costs.

A film that allows in less than 17% IR, less than 1% UV, and about 70% VLT with a TSER of greater than 50% will substantially reduce IR, UV, and solar energy coming into the building while leaving beneficial daylighting levels relatively unchanged.

Foil

Walls can also be shielded. Foil barriers offer both wireless security and thermal enhancements, and some are designed to be used in SCIFs. In addition to serving as highly effective radiant barriers, certain types are also approved vapor barriers.

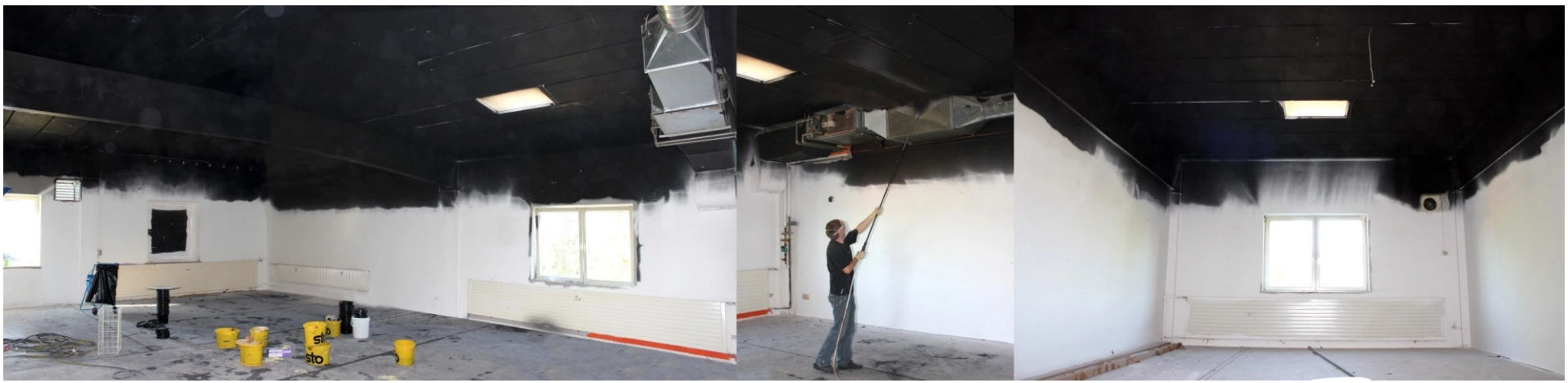
Foil barriers are made of a high-strength reinforcing scrim sandwiched between two reflective surfaces. Some foils may provide RF shielding effectiveness of 85 dB in the frequency range of 100 MHz–1GHz.

Foils reflect up to 97% of radiant heat, increase sound attenuation in secure work environments, offer thermal performance unaffected by moisture, and increase existing insulation performance.

Paint

RF paint provides an electroconductive coating for protection against high-frequency radiation and low-frequency electric fields. Depending on the manufacturer, paint can be used indoors or outdoors.

Here, paint is applied on an industrial building via airless spraying.



Paint

RF paint protects areas where a traditional foil is difficult to apply (e.g., floors, wood frames, or irregular surfaces). Look for shielding paints that are low-emitting and low-odor.

These images show RF paint used in a recording studio to minimize interference with highly sensitive recording equipment.

Grounding

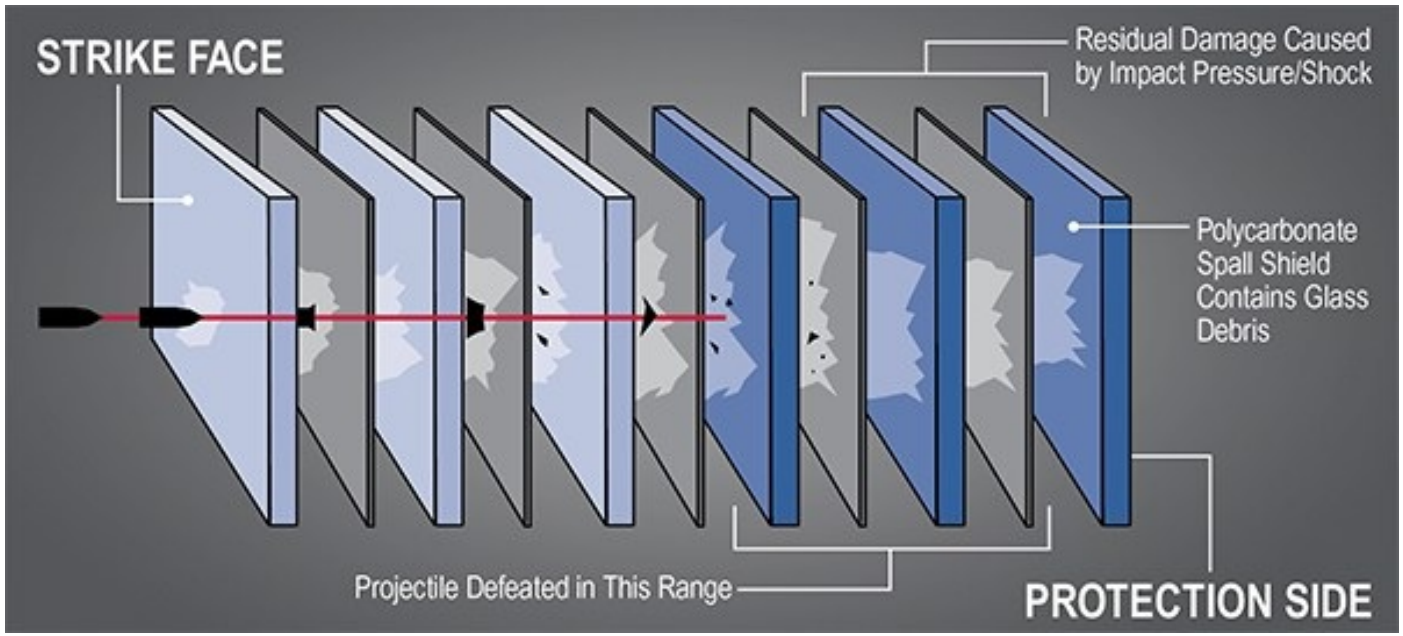
Some RF shielding products are produced and designed specifically to be grounded to achieve advertised RF attenuation levels. Grounding is accomplished primarily by connecting the window or shielding material via conductive wires, plates, or cables to either building or independent grounding.

Grounding of RF shielding window systems can be expensive and time-consuming to install, and the dissimilar metals used may induce corrosion in the shielding system upon exposure to moisture.

Paints and foils are significantly cheaper and easier to ground than windows and do not have corrosion issues. Window film is an RF shielding solution that works even when ungrounded.

Ballistics Rated and Detention Laminates

Ballistic laminates are rated to hold up to attacks from handguns, shotguns, or rifles. There are two major threats to protect against when transparent glazing comes under a ballistic attack. The first is projectile penetration of the glazing. If the laminate fails, the result is often destruction, injury, or death. The second major threat to glass windows while under a ballistics attack is spall. Spall occurs as shards of glass break away from the rear face (protection side) of a laminate as a result of the impact, becoming projectiles themselves. Significant injuries, loss of vision, and death have occurred due to high-spalling laminates.



Ballistics Rated and Detention Laminates

Detention grade glass-clad polycarbonate is used in environments where glazing is required to resist penetration for an extended period of time while still allowing at least limited visibility.

Unlike ballistic laminates, which are designed to defeat a single or multiple projectiles, detention grade products defend against sustained, premeditated attacks executed by one or multiple attackers.

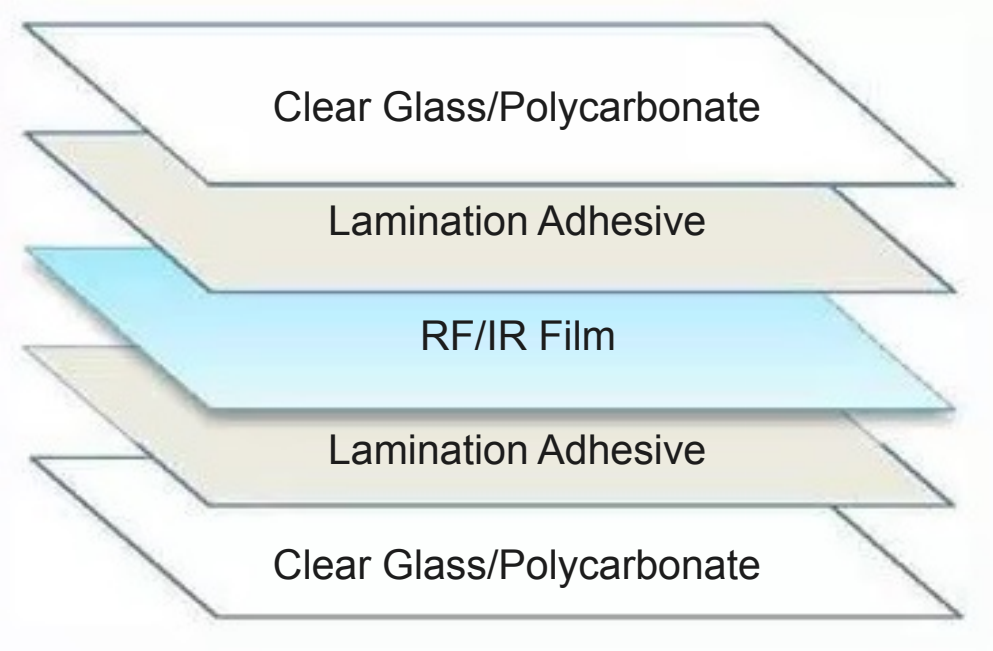
The laminates are designed and constructed with the assumption that the attacker has experience with transparent security glazing and plans to use multiple weapon types. The specification for detention grade glass ranges from physical threats such as blunt, sharp, or ballistics impact to chemical threats. In extreme cases, detention grade glass can handle thermal stress from -80°F to 6300°F.

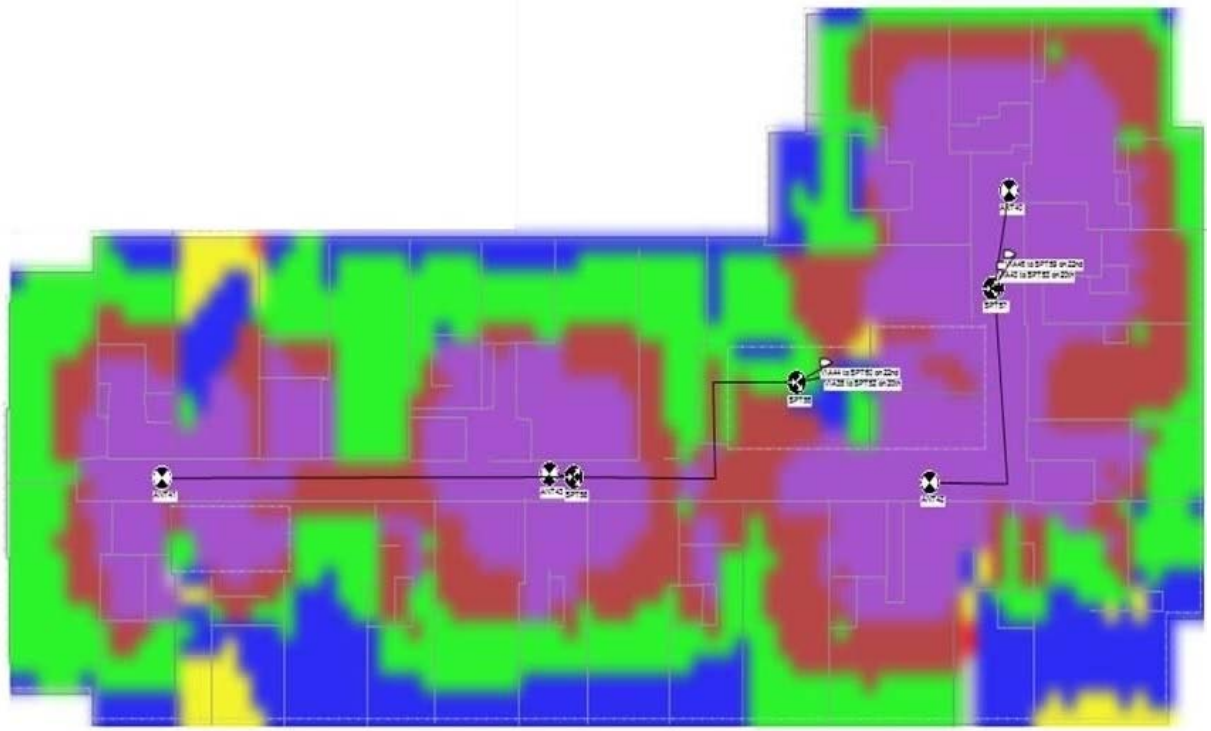
Glass and Polycarbonate Laminates

Glass and polycarbonate security solutions protect against a myriad of electronic eavesdropping techniques as well as ballistic and blast threats.

RF shielding is available encapsulated within the glazing system as an alternative to surface-applied film. Options include IGU; high-quality blast, ballistic, and forced entry; and hurricane windows.

Because the shielding is located between layers, it is protected from damage, cleaning methods, or tampering while enhancing the overall security characteristics of the window.





Case Study

Case Study: Urban Office Building

RF shielding was modeled in an IBW system design to determine RF performance in both before and after scenarios.

The building modeled is a 35-story, 300,000-square-foot building located in the New York-New Jersey market. The entire building exterior is glass panels.

The building's IBW system is a commercially-available DAS that calls for three 20-watt DAS remote units to feed the antennas throughout the building. The goal is to have a maximum achievable data rate (MADR) of at least 50 Mbps over at least 90% of the floorplan.

The interfering outside signal varies with floor height; at the 20th floor of the case study building, it is measured to be -75 dB.

Exhibit 1: Before

Shown here is the “before” MADR map. It is evident that the signals emanating from the antennas deliver the desired throughput over only a portion of the floorplan before being diminished by outside interfering signals along the perimeter of the building.

Clearly, the goal of at least 50 Mbps over at least 90% is not achieved, since only 55% of the target area has MADR equal to or greater than 50 Mbps.

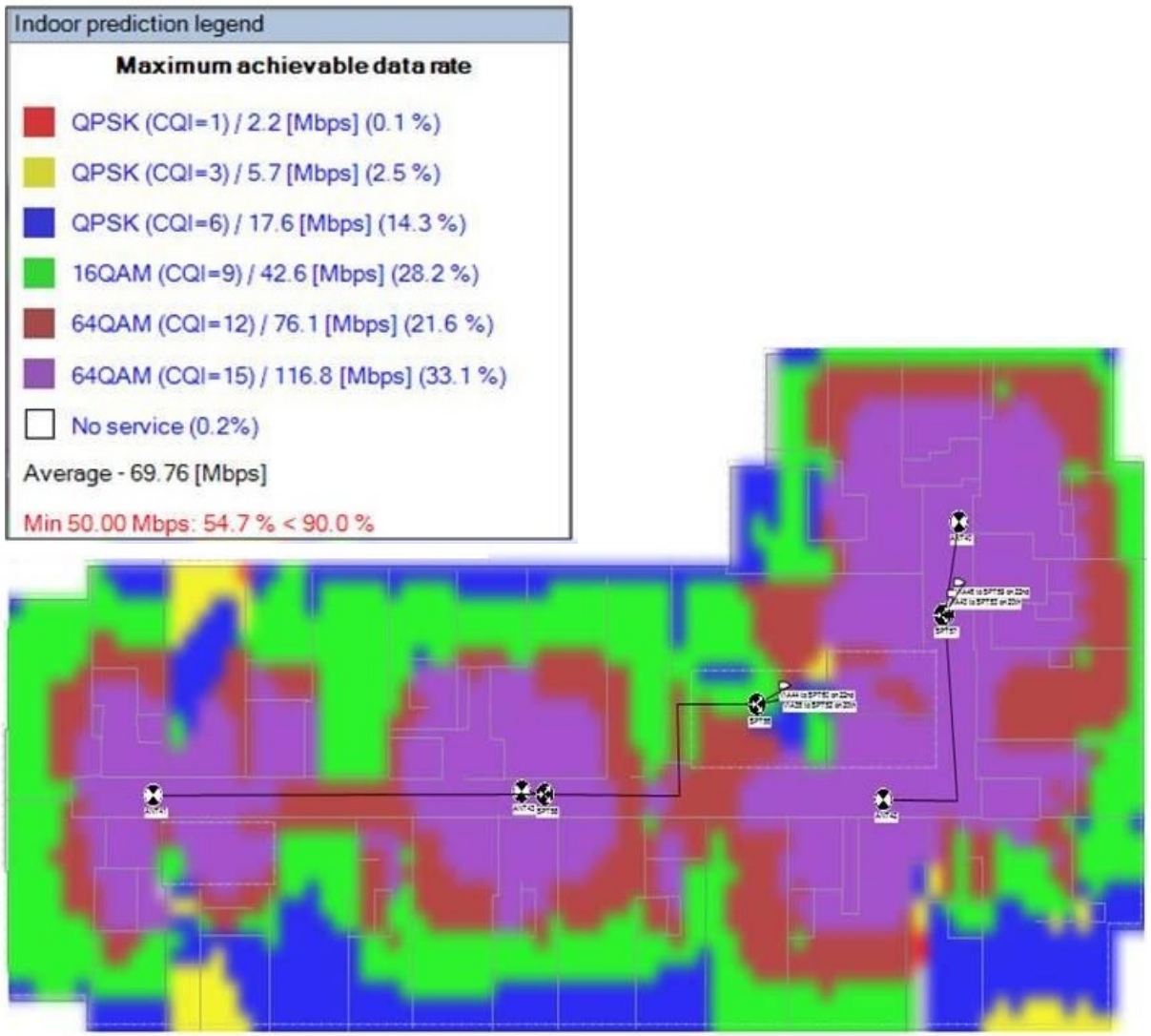
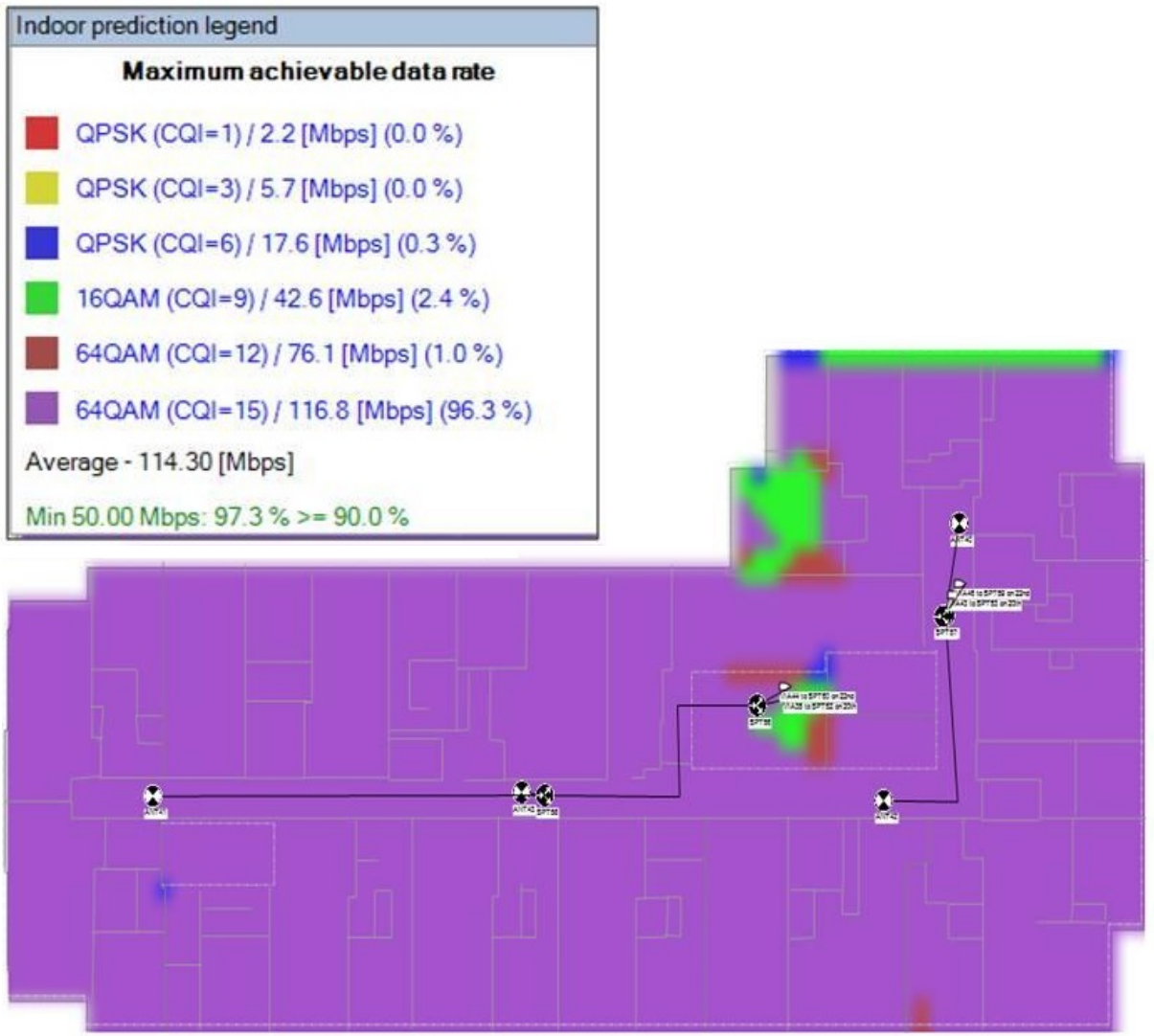


Exhibit 2: After

This “after” image shows that with RF shielding applied to all sides of the building, outside interference is significantly reduced or eliminated so that 97% of the target area now has MADR of greater than 50 Mbps, meeting the throughput goal.



Conference Rooms

Two conference rooms are located in the middle of the floor. Both are used regularly by executive level managers, so the rooms require an extra level of security for wireless transmissions, either over cellular or Wi-Fi frequencies.

In addition to the extra security, the conference rooms must be isolated from RF signals that are transmitted around the rest of the floorplan.

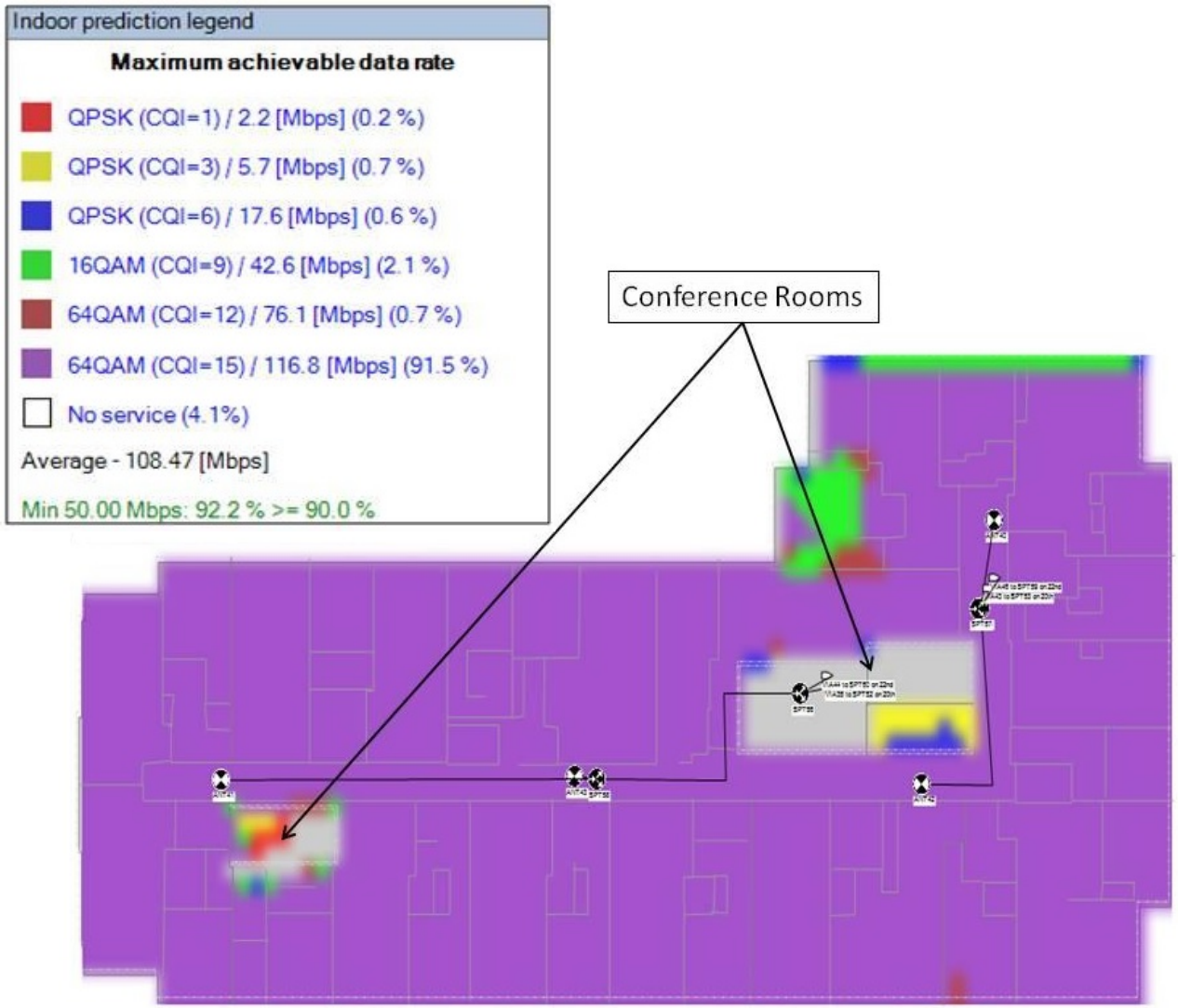
RF shielding offers a solution to both of these problems.

Please remember the **exam password SHIELDING**. You will be required to enter it in order to proceed with the online examination.

Exhibit 3: Conference Rooms

This is an “after” image with RF shielding applied to all conference room sides.

A double layer was applied to attenuate the high-powered 20-watt DAS remote units covering the floorplan.



Case Study: Final Results

The application of shielding to all sides of the building solved the interference problem, but the output power at the DAS remotes was maintained at 20 watts.

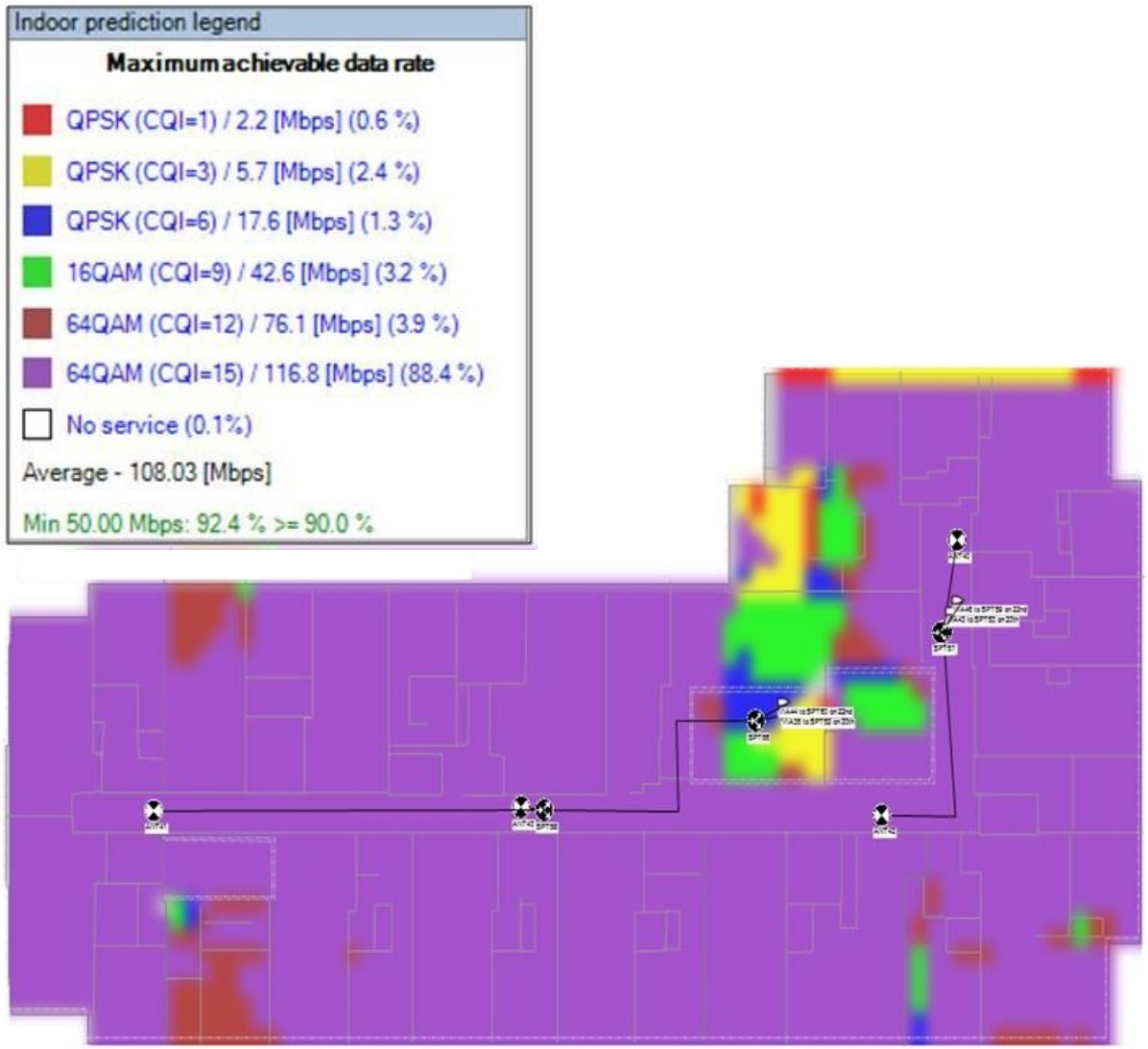
The same building underwent a second modeling scenario to determine the results if the remote units transmitted at a lower power.

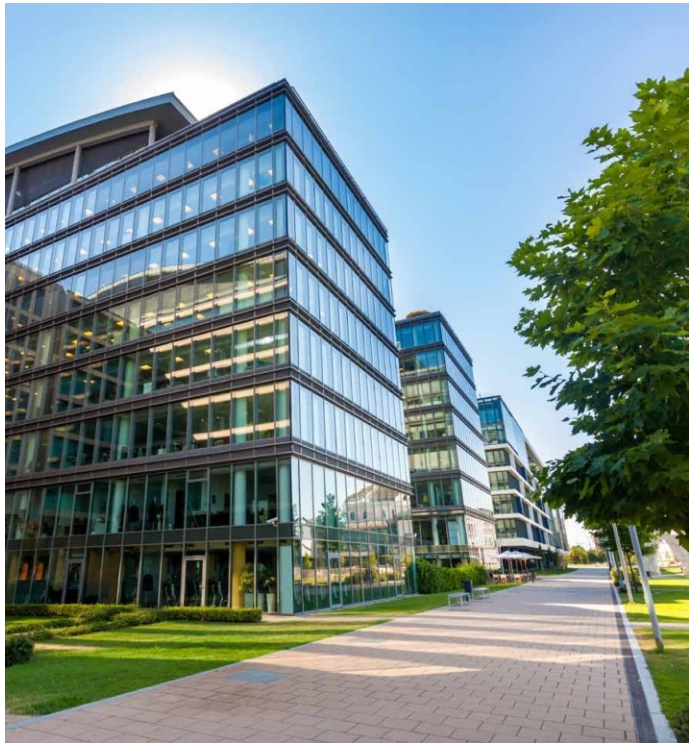
The transmitting power of each DAS remote was reduced from 20 watts (43 dBm) to 1.25 watts (31 dBm). At 1.25 watts, the interfering outside signal remained at -75 dB at the 20th floor.

Exhibit 4: Final Results

Even at this power level, the MADR averaged over the whole floorplan increased from 69.76 Mbps (Exhibit 1) to 108.03 Mbps here. The throughput goal (MADR > 50 Mbps) is greatly exceeded; it increased from 54.7% (Exhibit 1) to 92.4% here.

This outcome means that the 20-watt DAS remote unit can be replaced by a much lower-powered unit, resulting in reduced equipment costs and power consumption without sacrificing performance.





Summary and Resources

Summary

The building envelope protects people and equipment from the outdoor environment, but building openings are a weak point through which the comfort and safety of the occupants, the efficiency of the equipment, and the security of systems and data can be compromised. Cost-effective building shielding technologies can improve both the security and performance of the building envelope, especially at the windows.

Building shielding provides numerous advantages without altering the aesthetics of the building envelope. Shielding films, foils, and paint enhance in-building wireless system performance while reducing the possibility of eavesdropping or unauthorized connections. While daylighting and views benefit occupants and reduce lighting energy costs, glare and solar heat gain are unwanted side-effects; films improve window energy efficiency, minimize UV damage, and increase occupant thermal and visual comfort. Films and laminates help to reduce injury and damage in the event of a physical attack on a building, with ballistics and blast protection as well as glass fragmentation control.

Building shielding benefits government facilities as well as many types of commercial and public buildings, contributing to energy efficiency while mitigating threats to people and information.

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Conclusion

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