New Options in Barrier Construction for High Containment Facilities

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The complications of barrier design and construction can be avoided – the risks to performance mitigated – when professional experience and advancing technologies merge on the forefront of modern biosafety.

Through the development of new products and materials, high containment facilities are able to display predictable and assured performance by removing the complexities and uncertainties of prior methods of construction.

This paper will explore how the experience of professionals, the core principles of biosafety, and the range of construction options are influencing the performance and function of high containment facilities. It will present a contrarian, but increasingly concordant, approach to barrier construction that is reshaping once-firm beliefs on what is fundamentally and financially possible in today's industry.

The Plight of Experience

Walls and ceilings are designed and specified to meet pre-determined needs. In many cases, the selection of materials is influenced by the prior experience of those charged with making these selections.

This is a perfectly natural process.

Humans gravitate toward what they know – they are a product of their experience. It is reasonable to assume that decisions on laboratory design and product selection is influenced by the prior knowledge and experience of what has come before. It is also reasonable to assume that sometimes these decisions – while meeting the parameters of acceptance – may still be ill-informed. That is to say, the decision maker has compromised their choice because they unknowingly made the decision too subjective to their own preference and level of familiarity.

But there is nothing inherently wrong with this.

The experienced decisions of an architect, a scientist or an administrator lend credible and sustained knowledge to a project.

So long as a specification addresses the needs of a facility in the proper context, it is difficult to label that specification a poor one. After all, a decision based on prior *experience* that achieves a desired result is a testament to their *expertise*.

Yet, just as a decision can be met with praise upon a job well done, it can also demolish good will if it fails; spurring a whirlwind of finger-pointing and jockeying to obtain the "holier than thou" position of absolution when the dust settles and fault is placed.

Conversely, sticking one's neck out by opting for an alternative method – one that goes against the status quo – can be an even more treacherous affair.

Even in the face of a successful commissioning, the decision may *still* be met with criticism from peers who stand by more familiar methods of construction as the way to go.

To take such a stance requires a firm belief in the decision and the ability to support it when challenged.

The "safe" way to navigate the waters of decision in almost any industry is to select what is widely accepted as the industry standard.

For when one selects the industry standard – influenced by familiarity and experience – it is hard to place blame on the decision itself if something goes awry.

As the saying goes: "Nobody was ever fired for using IBM."

But in the biosafety industry, are traditional methods of construction still an appropriate option with the advent of new products and technology entering the marketplace?

And are industry professionals – charged with funding and creating safe working environments – effectively embracing these advances?

Risk Mitigation

Warren Buffet, the investing magnate, once said, “Risk comes from not knowing what you’re doing.”

On that premise, risk [to a barrier] comes from not knowing what you’re doing [in barrier construction, selection, etc.].

Biosafety, by its very nature, serves the function of risk *mitigation*; to reduce or lessen the risk.

Effective risk mitigation should encompass every aspect of the industry, including professionals working within it. Their knowledge must reflect the ability to reduce biological risk in (and around) laboratory settings.

It could be said that the biosafety industry requires some of the deepest displays of ethics found in modern business. The safety and security of lives – and the advancement of scientific research – depends on it.

Plus, with millions of dollars riding on these decisions, it becomes extremely important to do it right the first time.

And while risk can never be truly eliminated, ethical decisions can be made to reduce the margin of error to a razor’s edge through the use of available technologies and products.

Such slim margins should be in the cards for every project; from the initial concept, through the assessment and budgeting processes, to the final commissioning and commencement of research operations.

However, in spite of everything, games of chance are still played – and lost.

Playing Russian Roulette

Modern facilities – right this instant – sit idle as failures; millions of dollars tied up, or even lost, to methods of design and construction which were not up to task, but approved nonetheless either by choice, circumstance, or value engineering (and most always to save a few dollars in the short run).

The walls and ceilings of a facility are one of the most dynamic areas of laboratory design. Applications and end results can vary greatly between facilities… even facilities using the same type of materials.

Errors in barrier construction are also some of the most costly to correct. And poorly completed facilities that scrape past commissioning can be an ongoing burden to maintain.

Because set standards do not generally exist (industry guidelines have traditionally offered little in the way of determining a specific type of solution), interpretation and experience play large roles in influencing the decisions of barrier selection.

Therefore, it becomes of critical importance that decisions be closely examined and weighed against all available options with the intent of mitigating risk *first*, and responding to other factors (cost, time, etc.) second.

It is unconscionable to knowingly select a barrier method on anything but risk mitigation as the primary factor for determining need.

It is even worse to take a fingers-crossed approach with the selection of a method known to have failed in the past without taking a deeper look into the root cause of the failures.

The collaborative nature of laboratory design, and the supportive synergy needed between processes (barrier systems, HVAC/mechanical, protocols, etc.) makes it a complicated affair.

So who are the usual suspects of building high containment facilities? And while they "do the job", are they needlessly increasing risk and silently siphoning funds from their inefficiencies in coordination, construction and performance.

Traditional Methods of Barrier Construction

Traditionally, there have been a handful of methods used in the construction of secondary and primary barriers for containment facilities.

Gypsum board, cinder block (CMU – concrete masonry unit), stainless steel panels, FRP "glassboard" panels, and special concretes round off what has been traditionally found at BSL-3, BSL-3Ag and BSL-4 designations.

These methods use some of the same core materials that have been used for decades in the building of residential homes, schools, offices buildings and state park outhouses. Adapted for high containment, they are fundamentally flawed and require extensive measures to meet acceptable levels of performance.

Gypsum Board

Gypsum board, utilizing steel stud construction, has been one of the most widely used applications used in BSL-1, 2 and 3 laboratories.

A commonly understood form of construction for many contractors, it is easy to design with and handle, and is also one of the cheaper options available.

Benefits to using a panel-based system include chase wall (single or double stud) construction, allowing the running of utilities to the inside of the wall cavity and therefore outside of the barrier; providing unmatched versatility against more inflexible methods such as cinder block or poured concrete.

Most of all, it may be gypsum board's familiarity, coupled with its price, that makes it such a frequented choice. Yet, no two jobs of gypsum board are ever the same. And the product is merely one component of many used to craft a desired result on-site and at the mercy of coordinating and varied trades.

For instance, the required surface coating yields many variables to increase the risk of failure. Inconsistencies in application… blistering… the wrong mix ratio… pin holes… any number of things could go wrong, crippling a facility almost instantly.

But how can anyone be sure this won't happen?

The simple truth is: You won't know *until* it happens.

Well-rounded "hard data" for a pieced-together project does not exist. There are too many factors at play, so only reasonable expectations and predictions can be made in regard to performance. Human error is a prevalent risk in these situations, and there is little that can be done to circumvent this.

However, other barrier products found with the lab setting, like the biosafety cabinet, do not share this uncertain fate.

A biosafety cabinet is easily understood. Its need can be specified for the research being performed, it is then delivered, inspected, installed and certified with little worry.

It is not cut, formed, fastened, sealed and finished on-site like the walls and ceilings of a lab. Rather, it is constructed in a controlled environment within an acceptable range of tolerances for the aim of quality, satisfaction and acceptance by the end user.

Plus, it can be continually tested and engineered to maintain its functionality, with new versions able to replace the old with relative ease. Not so in barrier construction. It's a costly endeavor, and must be expected to last.

Cinder Block

Cinder block (or CMU) construction, for instance, is an antiquated method that has been used for decades because of its durability and familiarity. Its porous surface requires additional sealants. And final surface coatings are still required, contributing to the same set of risks to the barrier surface as gypsum board.

Additionally, building with cinder block becomes an undesired chore – its method of construction more suited to *increasing* risk than mitigating it. During its "wet" construction, mortar, fillers, sealants and other liquids are present as a wall moves through its phases of work.

At certain points… when the mortar joints have dried… sanding and smoothing are needed to create a flush finish; creating particulates in the environment to settle where they may.

Throughout the process, time is lost and labor costs intensified as coordination of trades and thorough cleanups are needed to conduct the cumbersome dance of cinder block construction.

When finished, cinder block walls add substantial weight to a facility while reducing its useable space. It limits the routing of utilities to the outside of a barrier (causing conduit and pipes to be exposed within the envelope), and severely decreases a facility's overall flexibility.

Aesthetically, cinder block construction creates an unappealing environment. A cold, stone-based construction may be strong, but it also creates "bunker syndrome" and denotes a basement-like and outdated appearance for a facility supposedly performing critical scientific research.

Its strength, however, *is* useful as an impact-resistant solution, and is obviously better suited to this task than a gypsum board construction.

Stainless Steel

Stainless steel panels, while having the advantage of a surface produced under exacting conditions, lacks the design flexibility of other methods, making it unappealing (or impossible) to be used as a single barrier solution. This can increase the complexity and cost of a facility.

Continuous welding of stainless steel joints is an impractical task, seeing the use of gasket-type joints instead. While airtight, they are not seamless and will produce problem areas for potential contamination while being rather unsightly.

Stainless steel also creates a drab environment by soaking up a room's candlelight, and it needs regular buffing and polishing to keep its finish from becoming dull. There are no means of reasonable repair, with dents and scratches becoming part of the décor – creating a surface more reminiscent of a hail-damaged car hood than a high performance barrier. The harsh disinfecting solutions used in the facilities may also adversely react with steel, furthering the lack of professional appeal and potentially causing irreparable damage to the surface.

Concretes

For laboratories requiring the walls and ceilings to function as a primary barrier, such as in a BSL-4, the traditional method of construction has been through the use of specially formulated concretes.

This design, cost, labor and time-intensive method is not for the faint of heart or the low-funded. The time factor alone swells to a point where it becomes financial lunacy for any but the most flush (and fortunate) institutions or organizations. Curing times for some concrete can take nearly one year before being ready to finish. And the costs associated with almost any form of failure could explode even a favorably robust budget.

Perhaps this is why so few exist – many entities simply can't afford to build and maintain these high-level facilities.

And it's not for a lack of want. Research would certainly benefit from an influx of BSL-4 facilities coming online. And with more facilities, divergent and convergent research could simultaneously take place on a particular agent to explore it in greater depth.

No doubt, alternatives in materials and construction methods such as fiberglass composites are destined to replace the under-performing and/or overly-complicated systems that currently exist in high containment facilities.

Modern Barriers for an Advancing Industry

In recent years, fiberglass reinforced polymer (FRP) panel systems have entered the marketplace in response to the shortcomings.

FRP composite materials have been responsible for the advancement of a number of high profile industries, opening up possibilities which were once limited or too troublesome with previous methods.

“Innovate or die!” states the popular mantra of industry survival.

And the effects of innovation through composite materials can be witnessed in everything from the defense and aerospace industries to automobiles and consumer products.

Few, if any, high-tech industries exist today that do not utilize composites to maintain or advance their position as leaders, or to make their work easier or safer to perform.

For the biosafety industry, advanced FRP panel systems are proving to be the next innovation in laboratory design and construction as more professionals begin to embrace and understand the wide-array of advantages they bring to the field.

Composites Reducing Risks

Producing FRP walls and ceilings for 20 years, Arcoplast panels have been specifically engineered to meet the requirements of secondary and primary barriers while eliminating many of the complexities and uncertainties faced by facilities completed under traditional, less reliable and increasingly outdated methods.

When reviewing performance guidelines – such as those found in the BMBL (Biosafety in Microbiological and Biomedical Laboratories) – Arcoplast wall and ceilings echo these and other guideline requirements with a complete, pre-finished system.

They are smooth, impermeable and easy to clean – common criteria for the surfaces of high containment facilities (and just plain common sense). The system is sealed to produce an airtight barrier, and withstands many years of rigorous decontamination or wash-downs virtually maintenance-free. Until recently, meeting these types of guideline requirements took a great deal more discussion, work and execution (with success harder to predict).

Plus, Arcoplast panels also offer an additional barrier benefit through its FRP construction. The panels are not only non-hygroscopic from their face side (providing an impermeable surface) but from their back side as well – eliminating the potential for water leaks to penetrate its cement core and destroy its integrity. Moisture from within the walls or ceiling can deteriorate gypsum board and eat away at block construction. Often, by the time it is discovered, it is already too late and a small water leak spirals into a costly and time-consuming repair.

Providing a “rear” barrier defense mitigates the risks of outside factors (like moisture, mold, fungi, or pests) from compromising the interior barrier by destroying it from the outside-in.

But now, the experience and acceptance of FRP technologies is showing that they can be met with relative ease – a much-needed boost for effective risk mitigation and performance-conscious construction.

Design Advantages of FRP Panels

Despite its composition of advanced materials, designing with Arcoplast is conventional by its very nature.

A panel system, it follows the similar principles and methods found in gypsum board design and construction. In addition to standard panels, it also incorporates modular panels to allow for added design versatility, performance and ease.

Arcoplast panels can be used with traditional steel studs and furring channels, or attached to existing walls and ceilings, offering construction possibilities beyond the reasonable reach of other methods.

Sandwich Construction

To achieve this level of effective barrier protection, Arcoplast FRP panels utilize a sandwich composition of multiple substrate options in order to provide the best-fit solution.

The substrates – from concrete to foam core to plywood – enable the Arcoplast panel system to meet various building codes, functional requirements and structural necessities while reducing the need for additional materials or construction. Projects are then able to move along at a quicker pace and with less overall costs.

For instance, Arcoplast panels manufactured with lead liners can serve as shielding for imaging rooms while simultaneously providing a high-level containment barrier.

Box within a Box

A self-supported shell within a larger facility, the "box within a box" trend of construction has grown in popularity. Arcoplast's free-standing partitions and load-bearing panels can be engineered to meet load requirements as well as interface with lightweight or heavy duty structural members to facilitate a more effective build.

The structural integrity and pre-finished composition of Arcoplast is ideal for this method of construction. It rapidly speeds up the process by reducing a myriad of coordination, labor and time costs that comes with the use of gypsum board in this type of application.

Walk-on Ceilings

A growing trend in modern design, the walk-on ceiling, is also achieved through the use of Arcoplast panels. This allows work and maintenance to be performed in the interstitial spaces without disturbing the processes taking place within the barrier, saving costs, eliminating disruptions, and mitigating risk while increasing the flexibility and value of the facility.

The design versatility of Arcoplast gives an architect immense freedom in crafting the most efficient, effective and desired results.

Retrofits

As facilities begin to age or seek to upgrade their capabilities (such as moving from BSL-2 to BSL-3 or BSL-3 Enhanced), there becomes a need to modify existing laboratories to meet current standards and/or market demands in a cost-efficient, timely and effective manner.

Arcoplast panels become a highly viable option for retrofit applications as their substrate can be specified to fit the dimensions of an existing wall or ceiling system for a direct-fit replacement. It can also be layered over existing block walls, or its versatility can be employed in a number of ways to reduce the amount of hassles found in renovating an existing structure.

Mobile Laboratories

The desire to have mobile laboratory units which can be temporarily (or even permanently) transported to a site has grown over the past decade as technology and necessity has driven the trend.

Arcoplast panels lined in container-type mobile laboratories have seen successful usage in field situations, providing uncompromised barrier security and returning unscathed – even in off-shore deployments.

Building Codes, Specifications and Fire Ratings

Arcoplast panels meet or exceed building code requirements and guidelines set forth by the FDA, CDC, NIH, NIAID, USDA and Canada Agriculture.

Additionally, the current 2003 International Building Code (in collaboration with the interpretations of code-enforcing officials, industry representatives, design professionals and other interested parties) guides the application of these building codes.

There will always be an evolution of products and applications, resulting in new building materials and new applications that challenge the present building codes and their intended function. And such is the case with FRP wall and ceiling coverings.

The acceptance and exceptions for interior finishes are based on their fire rating, flame spread and smoke development, as well as the building classification, occupancy and location.

Most manufacturers involved in the fabrication of FRP composite building materials will have acquired the proper classification for their product and intended applications. These are common products such as the FRP liners seen in public washrooms, cafeterias, commercial kitchens, food processing plants and pharmaceutical facilities.

Interior wall and ceiling finishes are classified in accordance with ASTM E 84 (American Standard Testing Materials). The interior finishes of materials are grouped into the following classes according to their flame spread and smoke development indexes:

- *Class A* – Flame Spread of 0-25, Smoke Development less than 450
- *Class B* – Flame Spread of 26 – 75, Smoke Development less than 450
- *Class C* – Flame Spread of 76 – 200, Smoke Development less than 450

As mentioned, interior finishes must address these requirements. New and emerging products such as fiberglass reinforced polymer and composite fabrication should also fit the requirements for their application. There are a growing number of prefabricated panel manufacturers that utilize FRP skin products laminated to different substrates, creating new and innovative sandwich panel constructions.

However, with laminated sandwich panel construction, a statement of an FRP surface achieving a Class A flame spread and smoke development rating is misleading and may not be accurate. The overall sandwich panel must be tested, and it would most likely yield a different rating caused by the other core materials (such as substrates). Just because there is a Class A-rated FRP laminate used does not necessarily qualify the entire composite panel as a Class A building material.

Different core substrates, glass content, resin blend and gel coat finish will all play an important role in the classification of a composite product.

The Building Code of the City of New York requires that interior building materials to be “not more toxic than wood” which requires a passing value of greater than 19.7g. (Section 27-335.1(2) and 27-348(e))

The toxicity test to obtain MEA (Material and Equipment Acceptance) from the City of New York is completed on a full composite panel construction, as it should be. The surface FRP by itself is not considered if it is an intrinsic part of the panel.

When tested in accordance with the combustion toxicity protocol developed at the University of Pittsburgh, the Arcoplast sandwich composite panel meets the requirement for interior finish material as defined by Title 27 Chapter 1, Subchapter 5, Article 5, of the Building Coder of the City of New York.

Flame spread and toxicity testing for select materials is an important tool for risk mitigation in buildings that have high human and animal occupancies. Claims by manufacturers of FRP composite panels should be documented with accredited test data – not just the FRP section or gel coat finish – before selecting products for consideration.

Surface & Barrier Performance

Consistent Production

When building with gypsum board, block or concrete, and sealing the surfaces with fillers and/or coatings, the final result cannot be verified until after extensive time, money and labor has been expended. With Arcoplast, each pre-finished panel can be assured of passing the manufacturer's quality assurance specifications. Knowing beforehand that the entire surface is of optimal performance, it can be confidently installed; eliminating the ambiguity found in other methods.

As there are no surprises from the use of Arcoplast, the need for additional discussions and selections of various materials such as coatings and sealants are eliminated. Having a barrier surface pre-produced under exacting and consistent conditions ultimately ensures a smoother delivery and commissioning of a laboratory. It is this predictable and deliverable performance that can greatly assist the function of risk mitigation in ways like never before.

Antimicrobial Gel Coat Finish

All Arcoplast panel surfaces feature a gel coat finish which, during the curing process, becomes an intricate part of the panel itself.

Because Arcoplast panels are created in a controlled environment, the gel coat results in a surface topography void of pin holes, blisters and uneven textures – an ever-present risk during the application of coatings.

Aesthetically, the Arcoplast gel coat finish is synonymous with cleanliness and a professional environment. The entire surface of the panel is of a consistent smoothness with a glossy, almost mirror-like luster. This bright-white finish has been shown to produce a light reflectivity of 97.3% at an 85 degree source angle, with its consistent surface evenly diffusing the light throughout a room.

Because of this, a laboratory can be designed with fewer lamp fixtures, reducing the amount of penetrations, to the ceiling surface while providing continual energy savings. This can attribute to lower construction and material costs and a higher certainty of risk mitigation.

But perhaps one of the most intriguing benefits produced by the gel coat surface of Arcoplast panels is its ability to suppress microbial survival on the wall and ceiling surfaces. This defining feature opens up a new era of active barrier protection, allowing for offensive countermeasures against surface contamination.

The surface finish of Arcoplast panels has also displayed outstanding and measured performance of:

- *Impact Resistance*. Barcol Impressor testing shows the hardness of the gel coat to between 38 and 42 Brinell (HB). This durability is ideal for environments such as animal holding areas and environments subjected to high-pressure wash-downs. (Tests show no damage to the gel coat at 2,000 psi (137.90 bar) from a 4 ft. (1.2 m) distance sprayed at a 45° angle.)

- *Impermeability*. With a permeability rate 0.00999, the gel coat's non-hygroscopic characteristic is particularly important in high moisture environments, whether artificially generated or atmospherically imposed.

This low rate of permeation also exemplifies the finish's ease in meeting air pressure requirements, with documented testing and real-world applications supporting this notion.

- *Decontamination Procedures*. Concentrated tests completed on gel coat surfaces with chlorine dioxide, formaldehyde gas and hydrogen peroxide vapor, as well as sanitation procedures completed with alkaline and chlorinated solutions, resulted in no discoloration.

  The Arcoplast gel coat is non-shedding and non-particulating, and is formulated to meet the levels of stain and chemical resistance required by ANSI Z124.1.2 standards. This results in a long-lasting and worry-free surface for effective contamination control.

Bare-bones Maintenance

Of course, no surface is completely exempt from harm. In the event of damage, repairs to the gel coat surface can be quickly executed in the field without facing the extensive and expensive shut-downs encountered by coating-based applications.

With a standard and consistent 20 mils gel coat, surface scratches can be lightly sanded and polished to its original gloss finish. Deeper scratches or penetrations left by removing or relocating equipment can be easily filled with Arcoplast gel coat putty, lightly sanded, and polished with minimal cleanup needed.

The advantage of a pre-finished gel coat surface eliminates the potential issues that are encountered in application of paints or surface coatings.

Coatings, as expressed prior, can pose serious challenges to a successful commissioning. But ongoing maintenance is also a serious threat to risk mitigation.

They require sanding and surface preparation which, if not properly isolated, can cause dust infiltration of highly sophisticated equipment, contaminate delicate air balancing systems, and release volatile organic compounds (VOCs) into the laboratory environment.

In a production facility, millions of dollars worth of product could be lost if exposed to contaminants or fumes, odors from paint and coatings, and areas of research could be compromised by maintenance work being performed.

Application of paints and coatings in the field are also a concern as site conditions, trade interference, climate control, product quality and consistency and applicator reliability are all difficult factors to control. These coatings typically vary from 3 to 5 mils (usually less on metal panels) must be reapplied every few years upon detailed inspections as they fade, peeled or dissolved by chemical wash-down, chip or crack over time. Therefore, an ongoing risk is present that can never be fully mitigated. The barriers themselves become threats, their integrity compromised, and they must be acted against through the additional consumption of time and money.

A pre-finished panel system reduces construction issues and installation time, therefore allowing other trades uninterrupted progress to generate a positive impact on associated construction costs and the overall delivery schedule.

And through the life of a facility, maintenance concerns are few with Arcoplast – minor blemishes over time are quickly and cheaply addressed with a bare minimum of interruption.

It's in the Details

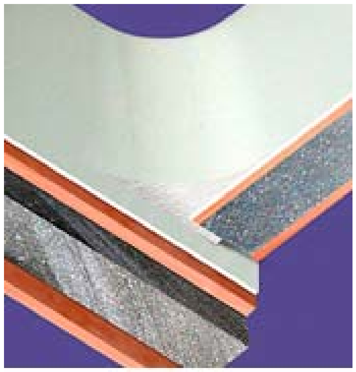
In barrier construction, the smallest details gone wrong could result in catastrophic losses.

The joints and edges of floors, walls and ceilings, service penetrations, and materials under physical strain are all critical points to consider when selecting a barrier method.

Finishing Compound

Arcoplast has developed an exclusive finishing compound for its panel system that achieves never-before-seen levels of strength and performance in laboratory environments.

The two-part compound, when applied, forms a surface that is hard and impervious, exhibiting extreme strength, bonding capabilities, and colorfastness. It dries to a bright-white finish and can be tooled in place for a smooth, consistent and seamless finish.



Corner Joint Coving

With a perm rate of 0.002 grams per sq. meter per hour (compared to silicone sealants reaching upwards of 1 gram/hr.), it becomes especially important for facilities requiring pressure decay tests.

Many facilities require either negative or positive air pressure in labs or production rooms, depending on the function. Arcoplast has displayed incredible pressure decay performance as shown through independent testing. For instance, a 4' (1.2 m) cube mock-up of panels and finishing compound (with fully completed joints) displayed a vacuum loss of only 1.76 Pascal per minute. In comparison, minimum requirements for high containment facilities often exceed six times this rate of decay (around the 12 Pa mark).

Wall sections that interface with door and window frames, penetrations of MEP (mechanical, electrical and plumbing) utilities, lighting fixtures, recessed equipment and pass-throughs, are all addressed through the use of this finishing compound to properly seal the barrier. Pressure decay tests conducted on interfacing utility penetrations, HVAC ductwork and mechanical screw fasteners produced data at the same low loss levels as those found in the non-penetrated cube test.

Panel & Pull-out Strength

It can be astonishing to discover just how many penetrations exist in a laboratory. And all can affect the ability of a barrier to pass pressure decay testing. When drilling and affixing objects to barriers walls (such as signage, racks, cabinets, MEP utilities, etc.) each point must not only be sealed and tested… the wall must be expected to maintain its structural integrity over its lifetime.

For instance, gypsum board (as any homeowner could attest) crumbles from within whenever a drill pierces its surface.

This usually requires added backer reinforcement, such as steel plates, high-density plastics, wood, etc., and is often a source of problem as locations may not be well known. Equipment updates and changes or last minute relocation require new positioning of backer reinforcements or increased dimensions (which are often overlooked until all the wall panels are installed and sealed).

These issues regrettably lead in only one direction: Costly work order changes and delayed trade schedules which compromise critical delivery dates – this leaves little to no latitude for future changes or additions during construction.

Arcoplast panels, however, offer a panel surface and core which takes advantage of its reinforced polymers and durable concrete substrate to effectively secure and hold mechanical fasteners in place, with its finishing compound providing an impermeable seal.

Testing on 1/2” (12.5 mm) gypsum board using a #10 screw fastener averaged pull-out strengths of 45 lbs (20.4 kg) to remove the screw from the panel. But, when a 3/8” (9.5 mm) cement core Arcoplast panel was subjected to the same test, it performed at an average of 200 lbs (90.7 kg) – 4.5 times stronger than gypsum board (while reducing thickness by 25%).

It is imperative that architects, engineers, facility planners and maintenance supervisors have access to pull-out strength data on fasteners that will be a part of a new or existing environmental envelope.

It is now possible to design with certainty that fixtures, equipment, and surface-mount accessories will be soundly installed and not compromise the safety and security of the barrier.

Barrier Integrity under Strain

Many research and production facilities are constructed in geographical areas with the potential for seismic activity.

What will happen to a barrier’s integrity if an earthquake were to suddenly strike? Can it be expected to tolerate impact and maintain an airtight seal? At what point will it fail? Will it fail?

Junctions and joint finishes are of great concern during any structural movement. When playing a critical role at the barrier level, they should be able to withstand a great deal of strain to allow for the highest probability of success.

And such concerns shouldn't be limited to seismic events. Natural expansion and contraction of a structure, harsh impacts from large animals (BSL-3Ag), and the possibility of explosions (accidental or intentional) could all lead to added strain on the joints and surfaces of a barrier.

Test on lateral movements of Arcoplast panels and finished joints have demonstrated strengths at an average of 330 pounds per inch (149.7 kg per 25 mm) needed to rupture a cement core Arcoplast corner joint without any damage to the finish compound (the joint outlasted the panel itself). And 390 pounds per inch (176.9 kg per 25 mm) were needed to shear a panel-to-panel joint assembly using a spline and filled with the finishing compound.

In addition, linear thermal expansion of solid materials by thermomechanical analysis shows an excess of 600 pounds per inch (272.16 kg per 25 mm) being required to rupture a 3/8" (9.5 mm) Arcoplast cement core liner panel. Impressively, it takes approximately 300 pounds per inch (136.08 kg per 25 mm) to rupture an Arcoplast joint system bonded and finished with the Arcoplast finishing compound.

ASTM D 638 - Joint Failure at Peak

While it is difficult to predict just what will happen to a facility under structural stress, tests like these give architects and designers tangible results to help them make decisions about a barrier's performance during such times.

The cost of failure is so great that investing in methods displaying tested and predictable outcomes is the best insurance policy one could make.

Predictable Outcomes

The ability to answer “What if?” questions from design to delivery to operation is an essential function of risk mitigation.

Since the installation of Arcoplast is essentially the same regardless of the project, the amount of variability in design, construction and coordination are drastically reduced. This reduction cuts out factors that could lead to problems.

And with each Arcoplast project comes a growing list of facilities where experience can be drawn to move alongside its limited variations. Architects and contractors can refer to previous projects and be able to borrow heavily from the lessons learned or new uses found.

Plus, with an increasing library of test data, questions can be answered and decisions made with confidence.

Having the foresight of experience, the consistency of its manufacturing, and its reliable performance in the field, Arcoplast wall and ceiling systems lend greatly to mitigating risk and reducing the chance of failure, added costs, and/or lost time.

Future Trends of High Containment

As new technologies are being developed and implemented, the limitations and complexities of existing solutions are beginning to stifle the advancement of these practices.

Seamless Joint System

But as the industry continues to push forward, the development of ways to accommodate these needs are beginning to rise to the top as the crème de la crème of barrier production in high containment.

Radiology and nuclear imaging technologies, nanotechnology, studies in aerobiology and aerosol science place an urgent need for products that can adequately address and deliver required performances created by these industry advances.

From radiological and microbiological barriers to aerobiological rooms and nano-level research, a perimeter shell construction (envelope) can be successfully achieved through the use of Arcoplast wall and ceiling systems.

The simplicity of the panel system, its proven, tested and documented performances, and the experience of years of successful use and construction greatly reduces the reluctance of professionals to embrace new research technologies.

As new technology surpasses the old, new applications are met with levels of safety never thought achievable through the use of conventional, lightweight construction methods such as Arcoplast.

It is therefore possible that through greater understanding, BSL-4 barrier construction and the absolute highest levels of containment will become accessible to all high-level research facilities.

Better Barriers = Better Business

The cost of failure at upper levels of containment is immeasurable. Professionals in decision making roles should not be afraid to ask hard questions about a particular product and how it will perform from all angles related to the application. It is an absolutely *essential* part of risk mitigation – the very basis of the industry.

Betting against the house through improperly explored options only serves to degrade the ability to mitigate risk, and poses haphazard threats to an organization in charge of building a high containment facility.

Demanding that materials and products live up to the needs of a project, and challenging them before setting the project in motion will not only provide the best-fit choice… it will help ensure the substantial investments of time, money and energy aren't spent in vain.

Utilizing proven and predictable methods of construction reflects the experience and understanding of professionals with regard to risk mitigation – fostering a business that displays the core principles of biosafety and taking a leadership role in improving the safety and performance of high containment facilities.

Arcoplast has spent 20 years in developing and applying a barrier system for the highest levels of containment with a distinctively advantageous approach of using FRP composites to provide a predictable, long-lasting and effective method of construction. With proven test data and real-world experience displaying the system's consistent performance, and highly-refined procedures ensuring its installation, Arcoplast has become an eye-opening option for modern high containment barrier construction.

To learn more about Arcoplast wall and ceiling systems, download test data, view product specifications or to contact Arcoplast, visit www.arcoplast.com today.

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*Contribution does not necessarily reflect endorsement of products.